



**UNIVERSITÀ
DEGLI STUDI
DI PADOVA**

Sede Amministrativa: Università degli Studi di Padova

Dipartimento di Psicologia dello Sviluppo e della Socializzazione

SCUOLA DI DOTTORATO DI RICERCA IN SCIENZE PSICOLOGICHE
INDIRIZZO: PSICOLOGIA DELLO SVILUPPO E DEI PROCESSI DI
SOCIALIZZAZIONE
XXII CICLO

**OBESITY AND OVERWEIGHT IN ADOLESCENCE:
PREVALENCE AND FOOD-RELATED LIFESTYLES**

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**Evitiamo la morte a piccole dosi,
ricordando sempre che essere vivo
richiede uno sforzo di gran lunga maggiore
del semplice fatto di respirare**

Pablo Neruda

Abstract

Obesity and overweight are complex, multifactorial conditions that originate from the reciprocal interactions between genetic, metabolic, social, behavioral, psychological and cultural factors (Kolotkin, Meter, & Williams, 2001). In children and adolescents, obesity and overweight have several adverse effects on physical and psychological health and well-being in the short, medium and long term. Moreover, the prevalence of obesity and overweight has tripled among adolescents over the past two decades in many countries (e.g., Lobstein, Baur, Uauy, & IASO International Obesity Task Force, 2004), underlying the need to identify effective obesity prevention strategies. Thus, understanding individual, environmental, behavioral and relational factors influencing obesity and overweight in adolescence, may support the development of more effective preventive interventions and policies for adolescents and their families.

The present thesis is based on data from the Health Behavior in School-Aged Children (HBSC) survey of the Veneto Region of Italy, and it is composed of three different studies. HBSC is a cross-national survey carried out in collaboration with the World Health Organization (WHO) Regional Office for Europe to provide data and increase understanding concerning young people's health, well-being and their social context.

The aims of the first study of this work were to assess the validity of self-reported height and weight through a comparison between self-reported and measured height and weight in a broad sample of adolescents aged 11, 13 and 15 years and to determine the prevalence of overweight and obesity among adolescents from the Veneto region from 2000 to 2006. The purpose of the second study was to examine the association between Body Mass Index (BMI) status (normal weight, overweight and obesity) and dietary patterns, physical activity and food-related lifestyle variables (e.g., television viewing behaviors). Finally, the main aim of the third study was to study the association between adolescents' body mass, body image, family food-related lifestyles (e.g., frequency of meals with parents), restrictive parenting practices and family functioning (communication with parents and perceived family social support) on adolescents' body dissatisfaction.

The findings underlined significant differences between self-reported and objective height and weight. After the adjustment of bias in self-reported anthropometric values an increasing prevalence of obesity from 2000 to 2006 was found among adolescents from

Veneto Region. Moreover, after controlling for socio-demographic characteristics, results showed that dietary patterns, low levels of physical activity and several food-related lifestyles were associated with obesity and overweight. Finally, the results of the third study underlined the importance of family factors, across different domains, in influencing adolescents' body dissatisfaction. Family food-related lifestyles and parenting practices were positively associated with adolescents' weight mass, while higher perceived family social support and communication with father were negatively associated with poor body image and body dissatisfaction. Furthermore, we found that higher body mass and poor body image were positively associated with body dissatisfaction among adolescents.

In conclusion, this work underlined that excess of weight problems are common and are increasing among adolescents from Veneto Region. Obesity and overweight are part of a complex configuration of unhealthy behaviors and lifestyles in which both familial and individual factors play an important role. These findings suggest that prevention programs, targeting adolescents' obesity and overweight, which frequently are concerned with dietary behaviors and/or physical activity, should also be focused on food-related lifestyle behaviors. Moreover, families should be educated about the importance of food-related family lifestyles and trained to adopt not too strict restrictive food-rules with adolescents. Improving the relationships between parents and adolescents, in terms of social support and communication, especially with fathers, might be able to contribute to improving adolescents' body dissatisfaction. Finally, preventive programs should be focused on, not only body weight, but also on the image and the dissatisfaction that adolescents experience regarding their body.

Abstract

L'obesità e il sovrappeso sono problematiche multifattoriali la cui origine è influenzata dall'interazione di molteplici fattori di tipo genetico, metabolico, sociale, comportamentale, psicologico e culturale (Kolotkin, Meter, & Williams, 2001). In infanzia e in adolescenza obesità e sovrappeso sono collegate a numerose conseguenze negative che si ripercuotono sul piano della salute e del benessere sia fisico sia psicosociale a breve, medio e lungo termine. Inoltre, negli ultimi vent'anni la prevalenza di questi fenomeni è circa triplicata in numerose nazioni (Lobstein, Baur, Uauy, & IASO International Obesity

Task Force, 2004), sottolineando la necessità di identificare strategie preventive efficaci a riguardo. Per queste ragioni, lo studio dei fattori individuali, contestuali, comportamentali e relazionali associati all'obesità e al sovrappeso in età adolescenziale può supportare lo sviluppo di interventi preventivi e politiche più efficaci rivolte agli adolescenti e alle loro famiglie.

Il presente lavoro si basa sui dati della ricerca HBSC (Health Behavior in School-Aged Children) condotta nella regione Veneto ed è suddiviso in tre studi. HBSC è una ricerca trans-nazionale svolta in collaborazione con l'ufficio europeo dell'Organizzazione Mondiale della Sanità con l'obiettivo di incrementare le conoscenze relative alla salute, al benessere e ai contesti sociali in cui vivono gli adolescenti.

Gli obiettivi principali del primo studio di questo lavoro consistevano nel valutare la validità delle misure auto-riferite di peso e altezza da parte degli adolescenti attraverso un confronto tra valori auto-riferiti e misurati di peso e altezza in un ampio campione di adolescenti di 11, 13 e 15 anni, e determinare la prevalenza di obesità e sovrappeso negli adolescenti della regione Veneto dal 2000 al 2006. Il secondo studio, invece, aveva come obiettivo l'analisi dell'associazione tra indice di massa corporea (categorizzato in normopeso, sovrappeso e obesità) e comportamenti alimentari, svolgimento di attività fisica e stili di vita legati all'alimentazione (es., tempo trascorso guardando la televisione). Infine, l'obiettivo principale del terzo studio era determinare l'associazione tra massa corporea, immagine corporea, stili di vita familiari legati all'alimentazione (es., frequenza dei pasti svolti con i genitori), regole parentali restrittive rispetto all'alimentazione e funzionamento familiare (dialogo con i genitori e sostegno sociale familiare percepito) rispetto all'insoddisfazione corporea degli adolescenti.

I risultati evidenziano differenze significative tra valori auto-riferiti e misurati di peso e altezza all'interno del nostro campione. È stato rilevato un aumento della prevalenza del fenomeno dell'obesità tra gli adolescenti della regione Veneto dal 2000 al 2006, dopo aver corretto statisticamente le distorsioni relative ai valori antropometrici auto-riferiti. Inoltre, controllando l'effetto delle caratteristiche socio-demografiche, è stata evidenziata un'associazione tra comportamenti alimentari, bassi livelli di attività fisica e stili di vita legati all'alimentazione in relazione all'obesità e al sovrappeso.

Infine, i risultati del terzo studio sottolineano l'importanza dei diversi fattori familiari considerati in relazione all'insoddisfazione corporea adolescenziale. Gli stili di vita

familiari e le pratiche parentali restrittive relative all'alimentazione, risultano positivamente associate all'indice di massa corporea, mentre la percezione di sostegno sociale da parte della famiglia e la comunicazione con la figura paterna risultano negativamente associate all'insoddisfazione per il proprio corpo e ad un'immagine corporea più negativa. Inoltre, massa corporea e immagine corporea negativa risultano positivamente associate con l'insoddisfazione per il proprio corpo tra gli adolescenti.

In conclusione, il presente lavoro sottolinea che i problemi legati all'eccesso ponderale sono diffusi ed in aumento tra gli adolescenti della regione Veneto. L'obesità e il sovrappeso risultano parte di una complessa configurazione di comportamenti e di stili di vita non salutari in cui, sia fattori di tipo individuale, sia fattori di tipo familiare, hanno un importante ruolo. Dai risultati emerge come i programmi di prevenzione per l'obesità e il sovrappeso in età adolescenziale frequentemente centrati sui comportamenti alimentari e/o sull'attività fisica dovrebbero tenere in considerazione anche il ruolo degli stili di vita legati all'alimentazione. Inoltre, le famiglie dovrebbero essere formate relativamente all'importanza degli stili di vita familiari e sull'adozione di regole parentali non troppo restrittive con gli adolescenti. Il miglioramento della relazione tra genitori ed adolescenti, in termini di sostegno sociale e di comunicazione, soprattutto con la figura paterna, risultano importanti fattori protettivi da considerare per il miglioramento dell'insoddisfazione corporea in adolescenza. Infine, i programmi preventivi dovrebbero focalizzarsi non solo sul peso corporeo, ma anche sull'immagine e l'insoddisfazione che gli adolescenti esperiscono verso il proprio corpo.

CONTENTS

Introduction	1
Chapter 1. Definition and assessment of obesity and overweight in adolescence	5
1.1 Measures of fat in adolescence	6
1.2 Definition of overweight and obesity in adolescence	7
1.3 Validity of self-reported height and weight in adolescence	11
1.4 Adolescence: an important developmental stage for the study of overweight and obesity	13
Chapter 2. Overweight and obesity in adolescence: how widespread is the problem? prevalence, trends and costs	17
2.1 Current prevalence of overweight and obesity among adolescents from different countries	18
2.2 Increasing rates of adolescent overweight and obesity: trends among adolescents from different countries	22
2.3 Economic costs obesity-related	26
Chapter 3. Physical and psychological consequences linked with obesity and overweight in adolescents	31
3.1 Health and physical risks related to obesity in childhood and adolescence	32
3.1.1. Short term health consequences related to obesity	32
3.1.2 Intermediate and long term health consequences related to obesity	36
3.2 Psychological and psychosocial risks	37
3.2.1 Health-related quality of life	38
3.2.2 Psychological symptoms, depression and self-esteem	39
3.2.3 Weight perception, body image and body dissatisfaction	42
3.2.4 Stigmatization and discrimination	43
Chapter 4. Obesity and overweight in adolescence: theoretical frameworks	47
4.1 Management of obesity and overweight in adolescence: the importance of a preventive approach	48
4.2 Conceptual models for the study of obesity and overweight in adolescence	49
4.2.1 Conceptual models focused on individual: a brief overview	50
4.2.2 Ecological theoretical frameworks	54
Chapter 5. Obesity and overweight correlates at the individual level: socio-demographic characteristics and obesity-related behaviors and lifestyles	61
5.1 Genetic factors	61
5.2 Sociodemographic characteristics	62
5.2.1 Gender	63
5.2.2 Age and ethnicity	64
5.2.3 Socio-economic status	66
5.3 Dietary behaviors, physical activity and food-related lifestyles	68
5.3.1 Dietary behaviors	69
5.3.2 Physical activity	74
5.3.3 Food-related lifestyles	76
5.3.3.1 <i>Sedentary behaviors and television viewing</i>	77

5.3.3.2 <i>Breakfast consumption</i>	80
5.3.3.3 <i>Frequency of meals in fast food restaurant</i>	81
5.3.3.4 <i>Snacking behaviors</i>	82
Chapter 6. Familial and environmental correlates of obesity, overweight and food-related behaviors and lifestyles	85
6.1 Parents' weight status and dietary behaviors	87
6.2 Family socio-environmental factors	88
6.3 Family influences on adolescents' dietary behaviors and physical activity.....	90
6.4 Family influence on adolescents' food-related lifestyles	92
6.5 Parenting practices and parenting style	94
6.6 Family functioning: social support and communication with parents	99
6.7 General conclusion on the role of the family	103
6.8 The role of peers on adolescent overweight.....	103
6.9 Other environmental correlates related to overweight and obesity in adolescence: an overview	105
Chapter 7. Research design and general aims	109
7.1 Health behavior in school-aged children cross-national survey.....	109
7.2 Conceptual framework and aims of the hbsc survey.....	111
7.3 International network organization	112
7.4 Participants and sampling procedure.....	114
7.5 The questionnaire	115
7.6 Procedure.....	117
7.7 General aims.....	118
Chapter 8. The prevalence of obesity and overweight from 2000 to 2006 among adolescents from the veneto region: how to improve the validity of self-reported height and weight?	119
8.1 Introduction	119
8.2 Methods	122
8.2.1 Participants	122
8.2.2 Measures and procedure	126
8.2.3 Statistical analysis	126
8.3 Results	128
8.4 Discussion	133
8.5 Limitations	136
8.6 Conclusion.....	137
Chapter 9. Dietary patterns, physical activity and food-related lifestyles: are they related with obesity and overweight in adolescence?	139
9.1 Introduction	139
9.2 Method	142
9.2.1 Participants	142
9.2.2 Measures.....	145
9.2.3 Statistical analysis	150
9.3 Results	152
9.4 Discussion	160
9.4.1 Association between BMI status and food-related lifestyles	161
9.4.2 Association between BMI status and physical activity	164
9.4.3 Association between BMI status and dietary patterns.....	164
9.5 Limitations	166

9.6 Conclusion.....	167
Chapter 10. The role of behavioral, educational and relational family factors, body mass and body image in adolescents' body dissatisfaction	169
10.1 Introduction	169
10.2 Method.....	177
10.2.1 Participants	177
10.2.2 Measures	178
10.2.3 Statistical analysis.....	181
10.3 Results	182
10.4 Discussion.....	186
10.5 Limitations.....	194
10.6 Conclusion.....	195
General Conclusion	199
References.....	209

INTRODUCTION

“Adolescence is one of the most dynamic and complex transitions in the lifespan” (Story, Neumark-Sztainer, & French, 2002, p. 40). In this period young people become more autonomous and several physical, psychological, social and environmental changes occur (e.g., Palmonari, 1997). Adolescence is also a developmental period in which, on the one hand, several health behaviors change and, on the other hand, risk behaviors may emerge which influence immediate as well as long term physical and psychosocial health and well-being (Bonino, Cattelino, & Ciairano, 2003; Petrillo, & Caso, 2008). Thus, adolescence is characterized as an important stage in which the foundations are laid for future health and well-being.

In particular, this work is concerned with health behaviors associated with excess of weight problems in adolescence, indeed, the physical, developmental and social changes that take place in this developmental period also affect overweight-related behaviors and lifestyles.

Although among the broad spectrum of weight-related problems some risk and protective factors have been found to be common to excess of weight problems and disordered eating (Neumark-Sztainer, 2005; Neumark-Sztainer et al., 2007), this work is only focused on the study of the most spread weight issues among adolescents: obesity and overweight.

In fact, the increasing prevalence of adolescent obesity and overweight has recently become a major psychosocial, public health, and medical concern (Lobstein, Baur, Uauy, & IASO International Obesity Task Force, 2004). For example, the World Health Organization (Branca, Nikogosian, & Lobstein, 2007) have underlined the need of effective strategies in response to the obesity epidemic, and *Healthy People 2010* suggest that obesity and overweight should be considered as one of the most important health indicators and a priority for action.

Indeed, in children and adolescents, obesity and overweight have several adverse effects on physical and psychological health and well-being in the short-, medium- and long-term and track into adulthood (Hughes, Farewell, Harris, & Reilly, 2007; Lobstein et al., 2004). Moreover, adolescence is one of the most vulnerable periods for the onset and the stabilization of overweight (Lobstein et al., 2004), but also for the development of behaviors and lifestyles which predispose the individual to being overweight (e.g.,

unhealthy dietary behaviors) (Guillaume, & Lissau, 2002). Finally, during adolescence young people are coping with several developmental tasks, among which the completion of growth and the acceptance of puberty and body shape changes (e.g., Palmonari, 1997), thus, body experience and its perception is linked with adolescents' well-being and psychosocial adjustment.

In addition, food-related lifestyles behaviors are still developing during adolescence, meaning that this period is particularly relevant and appropriate for the implementation of preventive programs aimed at reducing overweight and obesity, but also for the implementation of interventions aimed at promoting healthy food-related behaviors and lifestyles.

Unfortunately, despite the increasing prevalence of obesity and overweight among adolescents, in a recent review study Birch and Ventura (2009) effectively and concisely affirmed: "*What do current findings tell us regarding what works to prevent childhood obesity? The short answer to this question is: 'not much'*" (p. 75). In fact, despite significant results, obesity prevention programs presently show little effectiveness compared with the scale of the problems (Lobstein et al., 2004).

For this reason, understanding individual, environmental, behavioral and relational factors influencing obesity and overweight in adolescence, may support the development of more effective preventive interventions and policies aimed at preventing obesity and overweight among adolescents (van der Horst, et al., 2007). In this psychosocial perspective, the development of health behaviors is shaped within, and in continuous interaction with, the proximal and distal contexts of life in which adolescents live (e.g., Bonino et al., 2003; Bronfenbrenner, 1979; Dahlgren, 1995; Santinello, Dallago, & Vieno, 2009; Di Blasio, 1995; Story et al., 2002). Thus, studying individual and contextual overweight-inducing behaviors and lifestyles and their interaction, is likely to contribute to the prevention of these phenomena. For this reason, the focus of this work is on overweight-related factors that are amenable to change, indeed, more than 50% of chronic disease mortality is attributable to lifestyle factors that individuals can change, and that often begin in childhood and adolescence (Anderson, Palonibo, & Earl, 1998).

Overall, this work aims to assess the prevalence, individual and familial behavioral and relational correlates linked with obesity, overweight and body dissatisfaction in a broad sample of adolescents from Veneto region in order to increase understanding of these

health outcomes and to contribute to the identification of potential effective prevention strategies.

In particular, this thesis is composed of two main sections. The first section has the aim of describing and discussing the literature about overweight and obesity in adolescence. In particular, the first six chapters describe the definition and the measurement of obesity and overweight in childhood and adolescence, the prevalence and trends of these phenomena, the physical and psychosocial consequences, the theoretical frameworks for understanding obesity and overweight in adolescence and the individual, familial and environmental correlates associated with these health outcomes.

The second section is dedicated to the description of the three studies of the present thesis. In particular, chapter seven describes the study design of Health behavior in School-Aged Children (HBSC), a cross-national survey of which the data of the current work are part.

The first study (*chapter eight*) aims to assess the validity of self-reported height and weight values from adolescents and to determine the prevalence of obesity and overweight in the Veneto region from 2000 to 2006.

The purpose of the second study (*chapter nine*) is to examine the association between Body Mass Index (BMI) status (recoded into normal weight, overweight and obesity) and several food-related behaviors across different domains: dietary patterns, physical activity and food-related lifestyle variables (e.g., television viewing behaviors).

Finally, the third study (*chapter 10*) has the main aim of studying the association between adolescents' body mass, body image, family food-related lifestyles (e.g., frequency of meals with parents), restrictive food-related parenting practices and family functioning (communication with parents and perceived family social support) on adolescents' body dissatisfaction.

CHAPTER 1

DEFINITION AND ASSESSMENT OF OBESITY AND OVERWEIGHT IN ADOLESCENCE

Obesity is a complex, multifactorial disease that originates from the reciprocal interactions between genetic, metabolic, social, behavioral, psychological and cultural factors (Kolotkin, Meter, & Williams, 2001).

In general, obesity and overweight can be defined as an excess of body fat (Cole, & Rolland-Cachera, 2002). Beyond the general definition, there is a lack of international consensus about the most appropriate methodology to measure, and subsequently to define, obesity and overweight in childhood and adolescence. In particular, there are two main topics that remain unclear and should be assessed. The first is linked with possible measures of body fat. This topic is a methodological issue involving all people regardless of whether they are normal weight or not. The second topic is linked to the definition and labels of body fat. In particular, given a measure of body fat (first level of analyses), the second level is a theoretical issue that allows us to distinguish between normal weight and not normal weight, and categorize them as normal weight, overweight or obese people.

With regard to these two levels of issues, this chapter has the aims to answer three main questions:

- How can we measure body fat?
- How can we define obesity and overweight in adolescence?
- Why is adolescence an important and critical developmental stage for the study of obesity and overweight?

Since the definition of obesity and overweight is closely related with their measurement, this chapter will first describe the possible measures of body fat in adolescence and will then go on to discuss the most appropriate definition of these phenomena.

1.1 MEASURES OF FAT IN ADOLESCENCE

“An ideal measure of body fat should be accurate, precise, accessible, acceptable and well documented. Accuracy and precision mean that the measure should be unbiased and repeatable; accessibility relates to the simplicity, costs and ease of use of the method; acceptability refers in the broadest sense to the invasiveness of the measurement and documentation concerns the existence of age-related reference values of the measurement for clinical assessment” (Cole, & Rolland-Chachera, 2002, p.4).

Even if some authors (Cole et al., 2002; Lobstein et al. 2004; Power, Lake, & Cole, 1997) affirm that no measure exists which satisfies all these criteria, there are several methods for assessing body fat in children and adolescents in the literature. Of the several methods that assess body fat the main distinction is between direct and indirect measures.

1. The direct measures are typical of health care systems because they provide a precise measure of body fat and their various components. Some examples of direct measures are Magnetic Resonance Imaging or Computerized Tomography¹. Usually these measures have high costs, require the presence of specialized personnel and in some cases are not recommended for routine evaluation with children and adolescents because of their invasiveness and side effects.
2. The indirect or anthropometric measures derive from measured and objective height and weight. Some examples of indirect measures are: weight, weight for height, waist circumference, skin-fold thickness or Body Mass Index (BMI). The indirect measures of objective anthropometric values have a good accuracy, lower economic costs and are more quickly applicable, in contrast with direct measures (Lobstein, Baur, Uauy, & IASO, 2004). However, indirect measures can be influenced by the skill of the measurer and need to be compared with internationally established standard values (Lobstein et al., 2004).

The indirect measures are more widespread than direct measures, indeed, they represent a good, although not perfect, measure of fat with some important strengths for both researchers (e.g. accuracy with low economic costs) and adolescents (e.g. indirect

¹ A detailed description and validation studies of direct (Underwater weighing (hydro-densitometry), Magnetic resonance imaging (MRI), Computerized tomography (CT), Dual-Energy X-ray Absorptiometry (DEXA), Bioelectrical impedance analysis (BIA), Air-displacement plethysmography) and indirect (Weight and weight-for-height, Body mass index (BMI), Waist circumference, Waist-to hip ratio (WHR), Skin-fold thickness) measures can be found in Lobstein et al., 2004, p. 10.

measures are not clinically suitable). Moreover, among indirect methods for assessing overweight, the BMI is the main measure, in terms of validity and diffusion, employed to assess overweight and obesity in childhood and adolescence. The BMI is not a perfect measure of adiposity in adolescence, however, it is a valid measure of relative adiposity (Pietrobelli et al., 1998).

The BMI is defined as weight (kg) / height squared (m²). The values obtained from this calculation need to be subsequently recoded to interpret the BMI values and to categorize them as: normal, overweight or obesity status.

The comparison between BMI and indirect measures shows that the BMI has good accuracy and validity. For example, Lazarus and colleagues (1996) have compared the BMI with the direct measure of Dual-Energy X-ray absorptiometry (DEXA) with participants aged 4-20 years. This finding shows that, in predicting body fat, BMI had a true positive rate of about 0.67 and a false positive rate of about 0.06. BMI also shows a good correlation with others anthropometric measures (Sardinha, Going, Teixeira, & Lohman, 1999). Therefore, although some errors (false positive) can happen, when using BMI few children and adolescents are misclassified as overweight if they are not (Lobstein et al., 2004). A BMI misclassification may happen in people with highly developed muscles or people who are particularly short or tall (Sardinha et al., 1999).

BMI is well accepted by adolescents and it is characterized by low measurement errors and by good reliability and validity. As suggested by Lobstein and colleagues (2004, p. 15) *“Body mass index should be used as the main measure of overweight and obesity in childhood and adolescence for survey purposes”*. Indeed, presently all the main international health agencies (European Childhood Obesity Group, World Health Organization and National Center for Health Statistics) show a broad consensus that BMI is the most suitable index to assess adiposity in developmental age (Cole, & Rolland-Chachera, 2002).

1.2 DEFINITION OF OVERWEIGHT AND OBESITY IN ADOLESCENCE

At present, there is no agreement about the definition of obesity and overweight in adolescence, even if its definition influences the prevalence of the problem and its

associations with determinants and outcomes. In assessing fatness and defining overweight and obesity, is important to distinguish between people that are still developing (children and adolescents) and adults.

Indeed, the peculiarity of children and adolescents is that they are growing in various stages of maturation (Engeland et al., 2003) and the cut-off points for the anthropometrics values (e.g., BMI) need to be adjusted at least for age and gender. For this reason, age and gender specific growth curves need to be used to define overweight (or pre-obesity) and obesity in childhood and adolescence.

The distinction between normal weight and overweight is based on the percentage body fat. However, an accurate measure of body fat is possible using direct measures (see paragraph 1.1) that are not applicable for population studies for the reasons explained previously. Moreover, in the adult population cut-off points to define normal weight, overweight and obese people are linked with the percentage of body fat, that in turn is linked with higher health-related risks and consequences (WHO, 1998).

Several proposals to define obesity and overweight in adolescence can be found in the literature. One proposal is the use of national representative population studies about BMI to define overweight and obesity at a national level. For example, Himes & Dietz (1994) have suggested considering as “obese” the people with BMI above the 95th centile and “overweight” the people with BMI above than 85th centile, as compared with BMI population. However, these cut-off points are closely related to national distribution and strongly limit international comparison. For example, using this approach it is not possible to evaluate if the Italian prevalence of obesity is higher than the British prevalence because the definition of obesity is country-specific. In addition, different studies diverge in the choice of centiles to define overweight and obesity (Cole, & Rolland-Chachera, 2002; Lobstein et al., 2004) with the high risk that the prevalence of these phenomena is overestimated or underestimated.

The WHO² (1995) suggests considering as overweight the people with BMI greater +2Z-scores based on NCHS/WHO³ references in the population aged 9-24 years old. Several countries (WHO, 1995), including Italy (Cacciari et al., 2002), have in recent years developed specific BMI cut-off points using local data that takes into account gender and age. On one hand, the advantage is that BMI can be assessed as above or below a certain

² WHO: World Health organization (Geneva, Switzerland).

³ NCHS: National Center for Health Statistics (Hyattsville, Maryland).

centile line which is useful and easy, especially for clinical settings (Lobstein et al., 2004). On the other hand, these guidelines for adolescents suggest the use of age- and sex-specific BMI cut-off points to identify overweight and obese adolescents at the upper end of the national distribution, with subsequent problems due to the lack of internationally representative cut-off points and the comparison across countries that they would allow (Cole, & Rolland-Chachera, 2002).

Finally, regardless of centile or reference population, the cut-off point can still be criticised as arbitrary (Cole, Bellizzi, Flegal, & Dietz, 2000) or not suitable for international comparison. Indeed, a reference population centile should be identified “*as the point on the distribution of body mass index where the health risk of obesity starts to rise*” (Cole et al., 2000, p. 1).

In order to overcome these limitations, the International Obesity Task Force (IOTF) has recommended a new approach to defining overweight and obesity in childhood and adolescence. Cole and colleagues (2000), using large samples (97,876 males and 94,851 females from birth to 25 years of age) with nationally representative data on BMI from six different countries (Brazil, Britain, Hong Kong, Netherlands, Singapore and USA), established international gender- and age-specific BMI cut-off points which can be used for international comparisons.

These cut-off points are closely linked to adult definitions of obesity and overweight which are widely accepted and employed in international research (25 kg/m^2 for overweight and 30 kg/m^2 for obesity): the cut-off points for overweight and obesity in children and adolescents were determined in relation to adult cut-off points (Cole, & Rolland-Chachera, 2002). The reference population was obtained by using data from different countries that are sufficiently homogeneous. Curves passing through BMI 25 (cut-off point for overweight in adult population) and through BMI 30 (cut-off point for obesity in adult population) at age 18 were identified for each country. The overweight and obesity national curves showed reasonable agreement (see Cole et al., 2000 for a detailed descriptions and figures) across the 2-18 years ages bracket. Subsequently, the nationally representative curves were averaged across countries (Cole, & Rolland-Chachera, 2002). Table 3.1 represents the final international cut-off points identified by Cole and colleagues (2000) for defining obesity and overweight in childhood and adolescence.

These cut-off points represent the most acceptable international definition of obesity and overweight, in part because they assure continuity with adult cut-off points (Cole, & Rolland-Chachera, 2002).

Table 1.1. International cut off points for body mass index for overweight and obesity by gender and age (2-18 years). (Source: Cole et al., 2000).

Age (years)	Body mass index 25 kg/m ²		Body mass index 30 kg/m ²	
	Males	Females	Males	Females
2	18.41	18.02	20.09	19.81
2.5	18.13	17.76	19.80	19.55
3	17.89	17.56	19.57	19.36
3.5	17.69	17.40	19.39	19.23
4	17.55	17.28	19.29	19.15
4.5	17.47	17.19	19.26	19.12
5	17.42	17.15	19.30	19.17
5.5	17.45	17.20	19.47	19.34
6	17.55	17.34	19.78	19.65
6.5	17.71	17.53	20.23	20.08
7	17.92	17.75	20.63	20.51
7.5	18.16	18.03	21.09	21.01
8	18.44	18.35	21.60	21.57
8.5	18.76	18.69	22.17	22.18
9	19.10	19.07	22.77	22.81
9.5	19.46	19.45	23.39	23.46
10	19.84	19.86	24.00	24.11
10.5	20.20	20.29	24.57	24.77
11	20.55	20.74	25.10	25.42
11.5	20.89	21.20	25.58	26.05
12	21.22	21.68	26.02	26.67
12.5	21.56	22.14	26.43	27.24
13	21.91	22.58	26.84	27.76
13.5	22.27	22.98	27.25	28.20
14	22.62	23.34	27.63	28.57
14.5	22.96	23.66	27.98	28.87
15	23.29	23.94	28.30	29.11
15.5	23.60	24.17	28.60	29.29
16	23.90	24.37	28.88	29.43
16.5	24.19	24.54	29.14	29.56
17	24.46	24.70	29.41	29.69
17.5	24.73	24.85	29.70	29.84
18	25	25	30	30

However, even if the cut-off points suggested by Cole and colleagues (2000) seem the most suitable approach to monitoring and categorising BMI in population studies, some

limitations should be considered. First, the reference data does not adequately consider non-western populations and second, the BMI cut-off points do not adequately consider the geographical origin of subjects, which could reflect differences in the risk of disease in overweight people (e.g. an overweight child living in a part of Europe may have a different risk of type 2 diabetes than a peer living in another part of Europe) (Lobstein, & Frelut, 2003). Moreover, it would be desirable to consider ethnic differences and the pubertal stage in order to obtain more accurate BMI cut-off points, especially for people with borderline BMI values (e.g. near to normal weight) (Lobstein et al., 2004).

1.3 VALIDITY OF SELF-REPORTED HEIGHT AND WEIGHT IN ADOLESCENCE

As previously described, the most common measure applied to identify overweight and obese subjects in clinical and epidemiological researches is the BMI: a measurement for the indirect assessment of adiposity in childhood and adolescence (Frontini, Bao, Elkasabany, Srinivasan, & Berenson, 2001). For practical and economical reasons self-reported weight and height are frequently adopted in place of objective measurement (Tsigilis, 2006). Self-reported measures are more feasible, especially for population studies, are undemanding for participants and have fewer costs compared with measured anthropometric values (McAdams, Van Dam, & Hu, 2007).

Several studies have examined the accuracy of self-reported anthropometric values in adolescence underlining some instances of measurement bias linked with the use of these measures. Some studies suggest that self-reported values in adolescence are valid (Davis, & Gergen, 1994), while other studies report problems with the accuracy of self-reported values (Fortenberry, 1992). However, generally most studies confirm that adolescents tend to underestimate their weight and overestimate their height (Abraham, Luscombe, Boyd, & Olesen, 2004; Brener, Mcmanus, Galuska, Lowry, & Wechsler, 2003; Himes, & Faricy, 2001; Lee, Valeria, Kochman, & Lenders, 2006; Tokmakidis, Christodoulos, & Mantzouranis, 2007; Tsigilis, 2006).

This bias in self-reported anthropometric values has a big impact on research: an underestimation of weight and an overestimation of height will underestimate BMI and the prevalence of obesity and overweight. For this reason the prevalence of obesity and

overweight, observed in studies that use self-reported values, appears lower than the real prevalence. This bias causes important consequences for the comprehension of these phenomena and for the identification of effective prevention strategies and intervention actions (Boström, & Diderichsen, 1997; Jeffery, 1996; Nyholm, Gullberg, Merlo, Lundqvist-Persson, Råstam, 2007).

Moreover, studies investigating the accuracy of self-reported anthropometric values in different population subgroups have had controversial findings. Some studies (Morrissey, Whetstone, Cummings, & Owen, 2006; Tokmakidis et al., 2007) concluded that gender did not influence the bias in self-report measures, but other studies reported gender differences: girls tended to underreport their weight to a greater degree than boys (Brener et al., 2003; Davis, & Gergen, 1994; Giacchi, Mattei, & Rossi, 1998; Rosner, Prineas, Loggie, & Daniels, 1998; Tsigilis, 2006). This greater underestimation in female adolescents might be linked with social desirability and might also be a reflection of the social emphasis on thinness for females in our society (Nieto-Garcia, Bush, & Keyl, 1990). The accuracy of self-reported values seems to also be influenced by age (Tokmakidis et al., 2007): participants from high school tend to over-estimate their height and under-estimate their weight to a greater degree than younger students. Furthermore, the literature reports that weight status influences the accuracy of self-reported values: heavier students underestimate their weight to a greater degree than their thinner peers (Fortenberry, 1992; Himes, & Faricy, 2001; Tomakidis et al., 2007; Tsigilis, 2006). Finally, the validity of self-reported values among ethnic groups has not been adequately assessed: BMI (Deurenberg, Yao, & van Staveren, 1998) and the validity of self-reported height and weight might differ across countries and ethnic population subgroups (Tomakidis et al., 2007).

In summary, the comparison of several studies suggests that bias in self-reporting values depends on demographic, cultural, social and health characteristics of a particular population at particular time (Nyholm et al., 2007; Paeratakul, White, Williamson, Ryan, & Bray, 2002). These discrepancies among different population subgroups (e.g. gender) constitute one of the main reasons for which there is no agreement concerning the validity of self-reported measures applied in different cultural contexts, concerning the population sub-groups most at risk of BMI self-report bias and concerning the potential predictors of this bias.

Since many studies use self-reported height and weight for ease of use or cost, in the light of differences between measured and self-reported BMI values just described, it would be desirable to identify new methodological strategies to improve the validity of self-reported anthropometric values in the adolescent population.

1.4 ADOLESCENCE: AN IMPORTANT DEVELOPMENTAL STAGE FOR THE STUDY OF OVERWEIGHT AND OBESITY

Many studies have examined the persistence of adiposity from birth to adulthood. The literature identifies three main developmental stages critical for the development of obesity. However, in consideration of the main target age of this work, the attention in this section will be mainly focused on early adolescence and adolescence.

The first critical developmental stage is birth. There is an association between weight at birth and the risk of later overweight. Heaviest (>3.6 kg) newborns are more at risk (four times greater) than normal weight newborns of excess weight gained during childhood and adulthood (Dietz, 1994; Johannsson, Arngrimsson, Thorsdottir, & Sveinsson, 2006; Lobstein et al., 2004).

The second critical developmental stage is childhood (around 6 years). The timing analysis of fat shows a decrease of fat mass from about 2 to 5 years of age and then a gradual rise from the sixth year until adolescence and adulthood. The age in which this increase of fat mass starts is called the “adiposity rebound”: there is a first adiposity rebound in immediate post-natal life and a second adiposity rebound around six years. Several studies have found that an earlier “adiposity rebound” is associated with a greater risk of overweight later in life (Parsons, Power, Logan, & Summerbell, 1999), although the determinants of an early “adiposity rebound” are not clear (see Lobstein et al., 2004 for a review). Previous studies (Guillaume & Burniat, 1999) found that more than 70% of obese children and adolescents have had an early adiposity rebound. Moreover, overweight in childhood is associated with earlier maturation (Parsons et al., 1999): obese children have an accelerated growth with important physical and social repercussions in adolescence.

The third critical developmental period is adolescence, one of the most vulnerable periods for the development of overweight and obesity (Lobstein et al., 2004), but also for the

development and stabilization of behaviors and lifestyles which predispose the individual to obesity (Guillaume, & Lissau, 2002).

Adolescence is an important developmental stage characterized by a significant somatic growth and maturation of sexual characteristics. In early adolescence pubertal growth is associated with significant changes in body composition: fat gain occurs in both genders, even if girls tend to accumulate more fat than boys (Lobstein et al., 2004). Moreover, the timing of sexual maturation influences BMI, for example, girls with early menarche tend to be taller, heavier and fatter than peers with later menarche age. A review of the literature found that 15 out of 21 studies showed a significant and negative relationship between maturation age and BMI in adolescence and in adulthood (Parsons et al., 1999).

Persistence, or tracking, of fatness from childhood and adolescence to adulthood has been demonstrated in a number of studies, although the magnitude of this effect depends on the cut-off points adopted to define overweight or obesity, on the age at first assessment and on the duration of follow-up (Power et al., 1997). In addition adolescents' BMI is influenced by race and distribution of body fat (Daniels, Khoury, & Morrison, 1997).

Beyond these physical changes influencing weight status, adolescence is also a critical period for the development of healthy nutritional habits that, in turn, are strongly linked with adolescents' overweight and obesity. Adolescence is a critical developmental stage for overweight and obesity maintenance and insurgence for the following reasons:

- Correlations between childhood and adulthood adiposity are poor or at most moderate, while correlations between adolescence and adulthood adiposity are good or high (Lobstein et al., 2004);
- Adolescence seems a critical period for the development of obesity-related morbidity (Dietz, 1994). The risks for obesity-related disease (e.g., cardiovascular disease, insulin resistance) increase as well as the probability of becoming obese in adulthood. Some studies suggest that the relationship between morbidity and weight, observed in the adult population, could be attributed to adolescent obesity directly, rather than the effects of adolescent obesity on adult weight (Must, Jacques, Dallel, Bajema, & Dietz, 1992).
- The development and growth during adolescence creates a need for a diet with higher nutritional quality than in childhood or during adulthood (Spear, 2002). In addition, during the transition to adolescence dietary patterns change and decline in

quality compared with childhood (Story et al., 2002), adolescents become more autonomous and social, relational and environmental influences gain more relevance.

- Eating habits and behaviors is predictive of consumption patterns in adulthood (Lien, Lytle, & Klepp, 2001) as well the development of some adult disease begins in childhood and adolescence. However, food habits are still developing during adolescence, therefore it is an important developmental stage in which to implement effective prevention programs and it is essential to understand the factors and the mechanisms influencing these behaviors (Lien et al., 2001).

In conclusion, this chapter has underlined some limitations and gaps in the literature regarding the definition and the possible measures of obesity and overweight in childhood and adolescence. However, beyond these limitations there is a clear consensus about the importance of studying obesity and overweight in early adolescence and adolescence and the importance of defining these phenomena using international gender- and age-specific cut-off points.

We have listed several reasons that encourage the study of the excess of weight problems in adolescence, but how widespread are overweight and obesity in early adolescence and adolescence? And furthermore, the prevalence is increased over time and across different geographical areas?

CHAPTER 2

OVERWEIGHT AND OBESITY IN ADOLESCENCE: HOW WIDESPREAD IS THE PROBLEM? PREVALENCE, TRENDS AND COSTS

Adolescent obesity and overweight are linked with several health and psychosocial problems (see Chapter 3) that are tracking in adulthood and are associated with increased morbidity in later life (Kohn & Booth, 2003).

Moreover, the increasing prevalence of adolescent obesity and overweight has become a major psychosocial, public health, and medical concern (Dietz, 1998). Indeed, the prevalence of obesity and overweight has tripled among adolescents over the past two decades in many countries, underlying the need for effective obesity prevention strategies (Hedley et al., 2004; Neumark-Sztainer, Van Den Berg, Hannan, & Story, 2006b; Wang, & Lobstein, 2006). Taking into account that overweight and obesity are unequally distributed among countries and populations depending on specific geographical and cultural factors (Lobstein et al., 2004), the identification and the accurate monitoring of these phenomena in adolescence have become recently one of the major research issue.

The analysis of overweight and obesity prevalence allows us to describe the frequency, the distribution and the determinants of overweight and obesity in a specific population or geographical area, to identify health policies to prevent obesity and determine geographical areas and population's sub-groups which are more at risk for a particular configuration of characteristics.

This chapter has the aim of discussing three main questions:

1. How widespread are overweight and obesity among adolescents from different countries?
2. How has the prevalence of overweight and obesity changed in recent years among adolescents from different countries?

3. To what extent are direct and indirect health-related and social costs associated with adolescents' overweight and obesity?

2.1 CURRENT PREVALENCE OF OVERWEIGHT AND OBESITY AMONG ADOLESCENTS FROM DIFFERENT COUNTRIES

The analysis of the prevalence of overweight and obesity in a specific period of time allows us to discover the magnitude of the problem and to explore cultural and geographical differences about the distribution of these phenomena. For methodological reasons, in order to have comparable data, in this paragraph we will describe two cross-sectional studies, that included European countries, investigating the prevalence of overweight and obesity using comparable cut-off points to identify overweight and obesity (Cole et al., 2000) in early adolescence.

The first study (Janssen et al., 2005) analyzes the prevalence of excess of weight in 34 countries. The main strength of this study was that the data were collected in all the participant countries in the same year (2001-2002) involving nationally representative samples. The main limitation was that the BMI was calculated using self-reported height and weight values.

The second study (Lobstein & Frelut, 2003) analyzes the prevalence of excess of weight using 21 European surveys. The main strength of this study was that the prevalence was calculated only using measured height and weight values. The main limits were that the samples were not all nationally representative, the data were collected in different years (from 1990 to 2000) and the subjects had different age ranges.

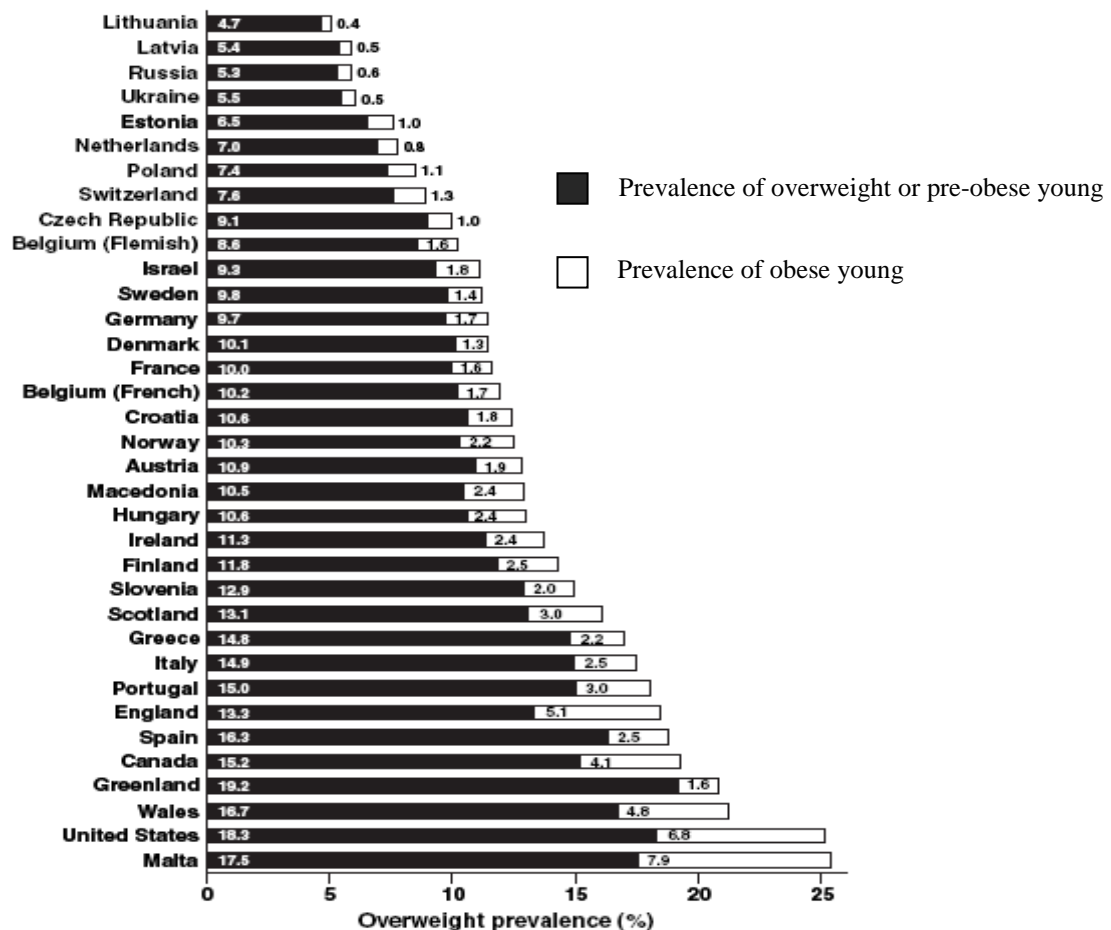
Janssen and colleagues (2005) (first study) using data from the 2001-2002 HBSC survey (Health Behavior in School Aged Children)⁴ analyzed the prevalence of obesity and overweight in 34 different countries (Figure 2.1). The study, involving 137,593 subjects aged 10-16 years, calculated the BMI based on height and weight self-reported values.

The results (Figure 2.1) show a lot of variance in the prevalence of overweight and obesity across different countries. The three countries with the highest prevalence of obesity were Malta, United States and England; in reverse the three countries with the lowest prevalence of obesity were Lithuania, Latvia and Ukraine. As far as overweight is concerned, the

⁴ The description of HBSC Survey is discussed in Chapter 7.

highest prevalence rates were reported in Greenland, United States and Malta and the lowest in Lithuania, Russia and Latvia.

Figure 2.1. Prevalence of obesity and overweight in youth (10-16 years) from 34 countries. (Source: Janssen et al., 2005).

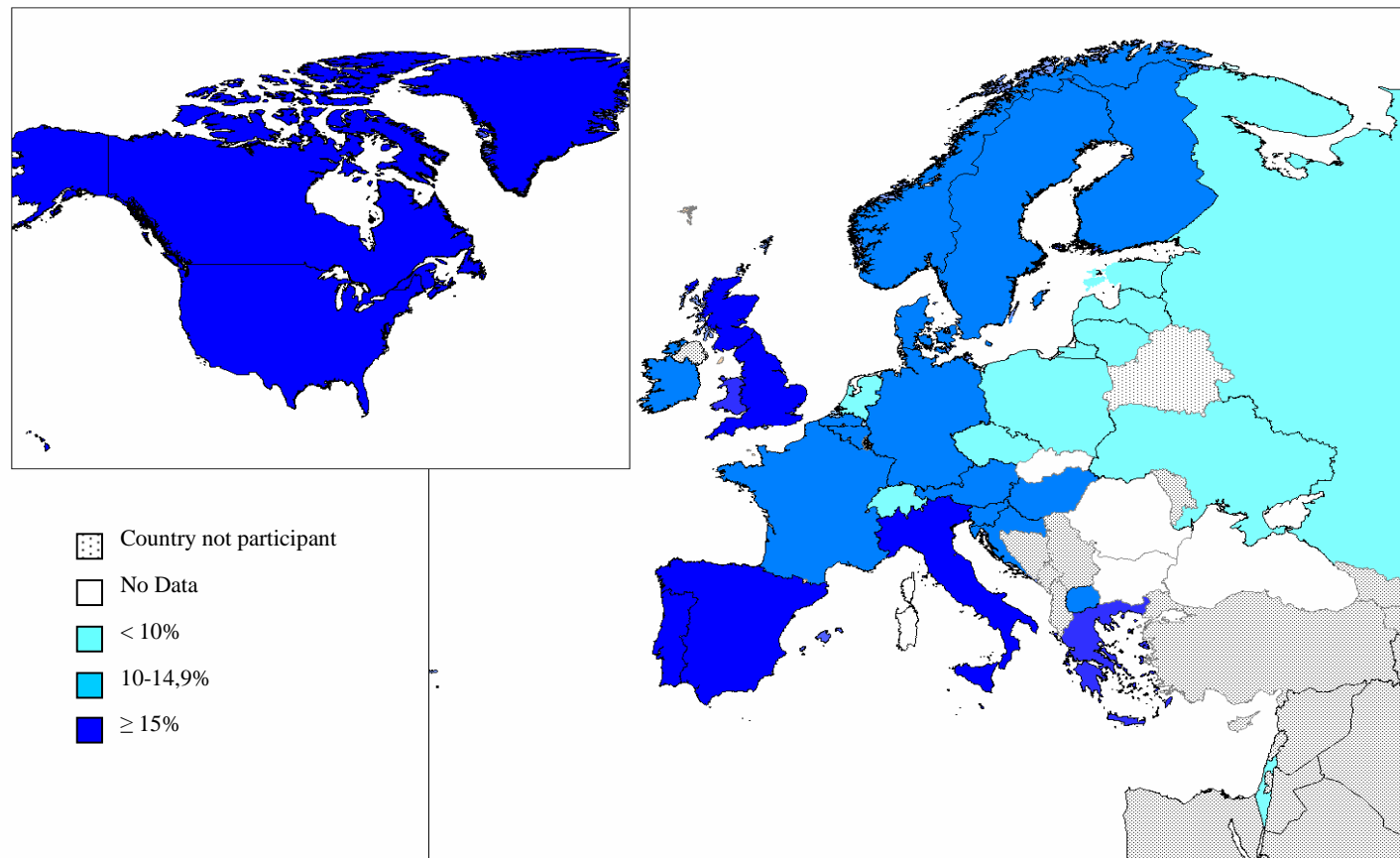


Given that overweight people are also defined in literature as pre-obese people, considering the overall prevalence of excess of weight (Figure 2.2) (overweight and obesity simultaneously) allows us to better identify some geographical patterns about the territorial distribution of excess of weight.

Figure 2.2 illustrates that the prevalence of excess of weight was $\geq 15\%$ in North American countries, in Great Britain and in five countries in the south of Europe (Greece, Italy, Malta, Portugal and Spain).

The prevalence was medium (10-14.9%) mainly in Nordic countries and in central Europe and was mainly low ($< 10\%$) in the eastern European countries.

Figure 2.2. prevalence of people with problems of excess of weight (overweight or obesity) in 34 countries. (Adapted from Janssen et al., 2005).



In line with the results from Janssen and colleagues (2005), the second study (Lobstein & Frelut, 2003) describes two main trends of prevalence distribution:

1. The lowest prevalence of excess of weight was found in the countries of central and eastern Europe.
2. The higher prevalence of overweight and obesity was found among the countries in southern European countries.

Apart from methodological differences, these studies underlined similar patterns in the distribution of overweight in Europe which constitute a north-south distribution: a higher prevalence in the southern countries than in the northern countries were found. It is interesting to note that this distribution is also observed within countries: for example an Italian study (Cacciari et al., 2002) found a prevalence of overweight of about 23% in the south of Italy and of about 13% in the north and in the center of Italy. The north-south distribution has been explained in different ways in the literature even if, taken singularly, they are not able to exhaustively explain this phenomenon. Lobstein and Frelut (2003) have identified some factors that could influence this distribution:

- It is possible that this distribution is a result of height differences between north and south: a shorter stature may be part of the explanation for the higher BMI level in the south of Europe. Anyway it is unlikely that height alone can justify this trend for two main reasons: stature is itself influenced by environmental variables and is not able to explain the increasing prevalence in many countries;
- It is possible that people in the south of Europe have a greater genetic predisposition to gain weight than people who live in other areas, even if this genetic predisposition is yet to be demonstrated;
- It is possible that the climate differences, between north and south Europe, influence this distribution: the warmer climate that characterizes the south of Europe can both reduce thermogenesis and increase the need for sedentary behaviors. This hypothesis is also not sufficient to explain the distribution because there are some northern geographical area, such as England, that show a high overweight prevalence despite the climate differences compared to the south of Europe;
- Other environmental and cultural factors should be considered as part of the explanation of the distribution such as economic and family income changes,

concomitant changes in diet and physical activities in a specific area (French, Story & Jefferey, 2001a), urbanization processes or availability and preferences for a particular food (Lobstein & Frelut, 2003).

The most plausible explanation for this distribution is a multi-causality of factors discussed above that reciprocally influences the distribution of excess of weight across northern and southern European countries. It is not possible to identify a singular cause or determinant when considering the complexity of relations between individual, environmental and cultural factors.

However, regardless of the exact causes of this distribution, the high level of prevalence of excess of weight in the south of Europe underlines the need to implement effective prevention programs, campaigns and training in order to reduce overweight and obesity in these countries.

Finally, in 77% of the 34 countries studied by Janssen and colleagues (2005) at least 10% of subjects were overweight and in 20% of the 34 countries at least 3% of subjects were obese. Therefore, beyond the north-south trend and the differences in the distribution prevalence across countries, overweight and obesity are a social, health and relational problem common in many parts of the world.

2.2 INCREASING RATES OF ADOLESCENT OVERWEIGHT AND OBESITY: TRENDS AMONG ADOLESCENTS FROM DIFFERENT COUNTRIES

Trends, indicating an increase in the portion of overweight and obesity in early adolescence and adolescence, have been reported in several studies in recent years (Johannsson et al., 2006). Studying the developmental trends of obesity and overweight in childhood and adolescence might help to understand the history of this phenomena, to have information concerning the general distribution, the association with specific at-risk population sub-groups (e.g. age, gender) and the development and the relative stability of prevalence over time (Guillaume, & Lissau, 2002). Indeed, the increasing trends in the prevalence of overweight and obesity might reflect “*a general fatness of the whole population or an expression of increased obesity in sub-groups of presumably susceptible individuals*” (Guillaume, & Lissau, 2002; p. 35). Moreover, “*An increase in mean BMI*

may be attributable either to a shift in the entire distribution or to an increase in the upper portion of the distribution only. It would be of interest to know, in the data reporting BMI increases, whether the entire population is becoming heavier or whether only heavy individuals are heavier than before and lighter individuals show little change”(Guillaume, & Lissau, 2002; p. 35).

Despite the relevance of this research topic, studying and comparing the increasing trends in the prevalence of adolescent overweight and obesity in different countries is presently difficult for several reasons:

- i. Most studies are carried out with adult population (see for example Atlantis, Lange, & Wittert, 2009; Flegal, Carroll, Ogden, Johnson, 2002; Zaninotto, Head, Stamatakis, Wardle, & Mindell, 2009;) and less studies are been conducted to examine BMI trends in adolescent populations (Johannsson et al., 2006; Lobstein et al., 2004);
- ii. In childhood and adolescence diverse methods of defining and measuring overweight and obesity exist (Kautiainen, 2005) (see Chapter 1), which complicates the comparison across countries and studies;
- iii. In childhood and adolescence different age cut-off points or age groups (e.g., only middle school) are adopted by different studies, making it difficult to compare the increase of obesity and overweight across studies;
- iv. The most extensive data are from the United States (Kautiainen, 2005) both in terms of the long duration of monitoring and the bigger samples involved in longitudinal surveys, while less is known about European countries;
- v. Few studies have involved representative samples which allow generalization of findings to the target population.

Beyond these limitations, most studies assessing trends of obesity and overweight in early adolescence and adolescence have found an increasing prevalence of excess of weight problems in the past few decades (Kohn & Booth, 2003; Lobstein et al., 2004) and have underlined that the trend of increasing overweight and obesity seems to be accelerating (Chinn, & Rona, 2001; Frye, & Heinrich, 2003).

In a nationally representative survey in the USA, the prevalence of overweight among 5- to 24-year-old people increased approximately two-fold between 1973 and 1994 (Troiano, &

Flegal, 1998). In particular, the rate of increasing prevalence in the last years of the study (1983-1994) was more or less 50% greater than that between 1973-1982 (Freedman, Srinivasan, Valdez, Williamson, & Berekson, 1997; Guillaume, & Lissau, 2002).

Other studies confirm the increasing prevalence of overweight and obesity in the United States from 1999 to 2004 in children and adolescents aged 2 to 19 years-old (Ogden et al., 2006). The prevalence was 13.8% in 1999-2000 and 16.0% in 2003-2004 for females; and 14.0% in 1999-2000 and 18.2% in 2003-2004 for males. Trends did not differ by ethnic group. Similar trends were found in Japan (Shirai, Shinomiya, & Umezono, 1990), in which the increase of prevalence was found higher in males (aged 9-11 years) than in females.

A longitudinal study carried out in Iceland (Johannsson et al., 2006), involving a large sample of people from early childhood to adolescence, found that the prevalence of obesity between children aged 6 years was higher in 1994 than in 1988 (more than twice), but no age or gender differences were found. The same study underlines that the children who were overweight at 6 years old were also more likely to be overweight at a later age: at 9 years-old they have a 72% probability of being overweight, at 12 years-old they have a 63% of remaining overweight and at 15-years-old they have a 54% probability of still being overweight.

Moreover, a review on young people obesity (Lobstein et al., 2004) underlined that the prevalence of excess of weight is increasing rapidly.

Figure 2.3. Trends in prevalence of excess of weight, 1970-2000. Overweight and obesity defined by IOTF criteria. (Source: Lobstein et al., 2004).

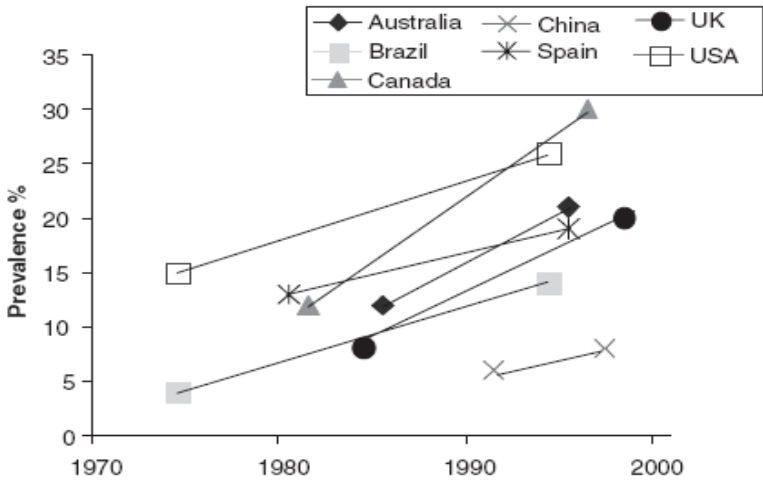


Figure 2.3, show that the rate of overweight and obesity have increased approximately every year 0.5% in USA and Brazil and around 1% in Canada, Australia and UK from 1970 to 2000.

Focusing our attention on European countries, the overweight is actually the most common disorder in childhood and adolescence in Europe (Peneau et al., 2009) that affected one child out of six in 2002, and, in certain European countries one child out of three (International Obesity Task Force, 2002).

A recent French study (Peneau et al., 2009) found a significant increase of prevalence between 1996 and 2001 and a stable prevalence between 2001 and 2006 among children and adolescents aged 6-15 years. This stabilization could be explained by two main reasons: (1) the effects of prevention and public campaigns to manage obesity and overweight; (2) a bias of sample, that in this study was not nationally representative and the subjects were involved as volunteers for a free medical check-up.

However, even if some data, as the case of France, suggest a stabilization of overweight prevalence in childhood and adolescence, most countries have reported an increasing rate of overweight and obesity in the past decade (Wang & Lobstein, 2006). For example an increasing prevalence was found in children and adolescents in England (Chinn, & Rona, 2001; Stamatakis, Primatesta, Chinn, Rona, & Falaschetti, 2005), Germany (Frye, & Heinrich, 2003), but also in Nordic countries (Finland, Sweden, Norway, Denmark) (Kautiainen, 2005) and among 9- to 11-year-old Portuguese boys (Cardoso & Padez, 2008).

To conclude, most studies finding an increasing prevalence of overweight and obesity in children and adolescents, even if the role of socio-demographic factors, such as gender or socio-economic status, and the magnitude of increasing rates is culturally and geographically influenced.

Moreover, the trends of prevalence do not correspond with individuals' diagnosis of overweight and obesity. A recent study (Benson, Heater & Kaelber, 2009) has suggested that overweight and obesity in childhood and adolescence are under diagnosed. Benson and colleagues (2009) found, in a large sample of children and adolescents in Ohio, that 19% of the sample were overweight but only 10% of them were diagnosed by health care system as overweight and 23% of the sample were obese but only 54% of them were diagnosed by health care system as obese. The trends of prevalence should aid us to

diagnose pre-obesity and obesity conditions and encourage adolescents and their parents to recognize and treat these problems.

For these reasons, documenting and monitoring the magnitude of the increasing rates of obesity in specific territorial areas is crucial to understanding and to identifying the role of geographical and community characteristics and its disparities in order to implement effective prevention programs aimed at reducing and recognizing obesity and overweight in adolescence.

2.3 ECONOMIC COSTS OBESITY-RELATED

Obesity is clearly related to increased mortality, morbidity and disability rates (Branca et al., 2007). The high prevalence of overweight and obesity is significantly influencing the global burden of disease and premature death (Knai, Suhrcke, & Lobstein, 2007).

As will be described in Chapter 3, obesity and overweight in adolescence increase the risk of chronic diseases (e.g., type 2 diabetes), acute disease (e.g. stroke) and disorders (e.g. neurological and gastroenterological disorders). The economic costs of inactivity and obesity are found, in some studies, to be similar to the total estimated impact of cigarette smoking in the United States (MacKenzie, Bartecchi & Schrier, 1994). Moreover, obesity in childhood and adolescence influence the development of health risks lifestyle-related, traditionally characteristics of the adult population (e.g., type 2 diabetes) (Knai et al., 2007) and continue into adulthood. For these reasons, studying the development and costs of childhood obesity should be useful to estimate the potential future adult burden (Knai et al., 2007). Despite this, there are few studies concerning the costs of obesity and overweight in childhood and adolescents. For this reason, the following data are mainly referred to the adult population.

In general, the economic costs linked with obesity can be estimated by referring to:

- Direct cost. The direct costs are associated with health care system expenditure: medical consultation and morbidity treatment, disability and premature death caused by obesity. Referring to 15 European countries in 1997, the Sweden National Institute of Public Health (NIPH, 1997) calculated that 3.7% of the overall burden of disease⁵ in Europe was attributable to high BMI. More recently, the

⁵ The overall burden was measured in terms of years of disability and premature death.

Global Burden of Disease study (WHO, 2005) found that around 7.8% of the global burden was linked with obesity and overweight in the WHO European Region. Italy was at twelfth position among 27 European countries, in terms of total costs due to death and disability adjusted for life years (DALY)⁶ attributable to high BMI (WHO, 2005).

- Indirect costs. The indirect costs are associated with lost productivity due to the absence from work or school caused by obesity. Several studies have investigated the direct costs of obesity but few studies and surveys have estimated the indirect costs. Estimate of indirect costs in the UK and Sweden found that these costs could amount to twice the direct costs (House of Commons Health Committee, 2004). Studies from other countries such as Germany or United States, on the other hand, do not show large differences between direct and indirect costs (Branca et al., 2007). However, the results from different studies (Branca et al., 2007; Burton, Chen, Schultz, & Edington, 1998; Knai et al., 2007), supporting the idea that obese people have a higher risk of being absent from work and of there being an associated loss in productivity.
- Direct and Indirect costs. Few studies assess both direct and indirect costs associated with obesity simultaneously. A recent study (Branca et al., 2007) suggests that the obesity-related healthcare accounts for 6% of total care expenditure in European Region and somewhat more in indirect costs of lost productivity. Other studies (Fry & Finley, 2005), referring to European countries, found that the direct and indirect costs of obesity are about 2-4% of each national health expenditure.
- Individual costs. There is a lack of studies in the literature that assess the potential economic consequences of obesity at the individual level (Knai, Suhrcke, & Lobstein, 2007). However, a recent study shows that obese people, especially women, earn less than non-obese people (Bhattacharya & Bundorf, 2009), due to both decreased productivity and social stigma. At the educational level, obese people are more likely to miss school hours because of lower self-esteem, peer and teacher stigmatisation or shame than non-obese people (Latner & Stunkard, 2003).
In any case, at the individual level costs have not been fully studied and it is not

⁶ DALY reflects the numbers of years of healthy life lost due to early death, disability or disease (Branca et al., 2007, p. 24).

possible to obtain reliable estimates. Finally, social costs, in terms of quality of life and reduced physical functioning, are not considered in economic estimates (Colditz, 1999).

The direct or/and indirect costs linked with obesity have been systematically investigated in several countries, such as the United States (e.g., Sturm, 2002; Thompson, Brown, Nichols, Elmer, & Oster, 2001), UK (House of Commons Health Committee, 2004) and in almost all European countries (see Branca et al., 2007 for a review). But what about the Italian situation? As far as the economic costs are concerned, there are very few sources available in Italy.

Based on UK data derived from Comptroller and Auditor General, Fry and Finley (2005) have extrapolated the costs of obesity in 15 European countries (using country-specific data). This study showed that in 2002 in Italy the *pro rata* direct and indirect costs linked with obesity were €5,435,000,000. However, this study is based on the assumption of trend levels of obesity and total health care expenditure and not on objective estimates.

Another study (Degli Espositi et al., 2006) found that the estimated drug costs associated with overweight and obesity in Ravenna were €5,661,126.20 and €6,688,099.85, respectively in 2001-2002. However, a limitation of this study is not it focuses on a specific Italian geographical area and only assesses drug costs and not the overall direct costs associated with obesity. Moreover, the study SPESA (No published paper available), carried out by the University of Milan (Center of Pharmaceutical Economics) estimated in 2000 that the direct cost of obesity in Italy is about €2.8 millions, that correspond to 7% of national health care costs.

In order to obtain more accurate and recent estimates about the Italian costs of obesity, we have also contacted by phone or email the National Institute of Statistics (no data available about the obesity costs), the Italian association on clinical diet and nutrition and the Health Ministry (no reply). Concerning the indirect costs, EURISPES (EURISPES, 2004; De Marchi, Casati & Tarlao, 2007) found that in Italy 7.2% of obese people are forced to work less, and 12.5% have to change their work. This lack of information suggests that further research is required in Italy to assess the economic and social impact of obesity in order to effectively prevent and manage this problem.

Finally, all the estimates of costs reported here should be read carefully for several reasons:

- 1) The variability of these findings is the results of differences in estimation methods, definitions of obesity, population characteristics and health care systems (Branca et al., 2007);
- 2) Part of the increase in healthcare costs for obesity is linked to the recognition of new co-morbidities, new drug costs, as well an increase of obesity prevalence (Branca et al., 2007);
- 3) The prevalence of overweight and associated costs is higher than the prevalence of obesity, but the majority of the studies estimate the costs only for obesity (Muller-Riemenschneider, Reinhold, Berghofer & Willich, 2008; Branca et al., 2007). Therefore, it is likely that the costs reported are lower than the actual costs. For example one study (Seidell et al., 2006) estimated that in the Netherlands overweight surpasses obesity in terms of health care costs. Moreover, Quessenberry, Caan, and Jacobson (1998) found that adult overweight people had higher healthcare costs than normal weight people.
- 4) The economic costs are calculated based on current data that do not take into account the increasing prevalence of obesity (Muller-Riemenschneider et al., 2008). This could underestimate the economic costs, because the growing prevalence of obesity should be linked with a higher economic burden;
- 5) The individual risk factor (e.g. smoking) and lifestyle (e.g. sedentary behaviors) interact and increase exponentially health risks and the healthcare costs linked with obesity.

Despite all these limitations, overall, studies suggest that obesity has reached epidemic levels. Moreover, there is a clear consensus about the association between obesity and significant morbidity, mortality, and medical costs and about the high psychosocial health risk in overweight and obese people and more specifically children and adolescents, due to the early onset of excess of weight problems. All the studies also agree about the importance of preventing weight gain in all ranges (overweight and obesity), especially in childhood and adolescence. While considering the prevalence and costs of obesity and overweight we can ask ourselves, why is it important to study obesity and overweight in early adolescence and adolescence? And, what kind of consequences in terms of health and well-being are linked with adolescent overweight? We will answer these questions in the next chapter.

CHAPTER 3

PHYSICAL AND PSYCHOLOGICAL CONSEQUENCES LINKED WITH OBESITY AND OVERWEIGHT IN ADOLESCENTS

Obesity is a complex, multifactorial disease that arises from the reciprocal interactions among genetic, metabolic, social, behavioral, psychological and cultural factors (Kolotkin, Meter, & Williams, 2001). In children and adolescents, obesity and overweight have several adverse effects on physical and psychological health and well-being in the short-, medium- and long-term (Hughes, Farewell, Harris, & Reilly, 2007). These consequences can extend into adulthood and can significantly affect individuals' psychosocial, relational and physical health with a subsequent impact at a social and a community level. In particular, it is well recognised that obese and overweight children and adolescents are likely to become obese adults (Sweeting, Wright, & Minnis, 2005) while also showing an earlier and greater severity of this condition (Guo, Wu, Chumlea, & Roche, 2002).

This chapter has the aim of discussing one main question: why is it important to study obesity and overweight in early adolescence and adolescence? To answer this question the chapter will describe the risks and consequences of obesity and overweight in adolescence. In the literature we can identify two main levels of consequences linked with obesity and overweight:

1. Health and physical consequences;
2. Psychological, relational and social consequences.

In light of the general aim and focus of this research work, we will provide a general description of health and physical consequences and we will especially focus our attention on psychological, relational and social consequences.

3.1 HEALTH AND PHYSICAL RISKS RELATED TO OBESITY IN CHILDHOOD AND ADOLESCENCE

Excess of weight problems in adolescence, and in particular obesity, are linked with several diseases, chronic illness and increased risk of mortality that will be described below.

With the increase of obesity prevalence among children and adolescents several lifestyle diseases, typical of the adult population, are appearing at these developmental stages. For example, cardiovascular disease or type 2 diabetes only began to be reported in paediatric literature from 1980 on 1990 (Lobstein et al., 2004).

It is also important to underline that medical conditions become more serious with the increased severity of overweight and with the premature onset of weight problems. For these reasons, the prevention of the management of overweight and obesity in childhood and adolescence is gaining importance. Indeed, a reduction of weight is associated with a reduction of health risks (Kolotkin et al., 2001) such as mortality risk and increased longevity (Williamson, 1997), reduced cardiovascular risks (Van Gaal, & Leeuw, 1997), improvement of pulmonary function and sleep quality (De Leiva, 1998).

3.1.1. SHORT TERM HEALTH CONSEQUENCES RELATED TO OBESITY

As suggested by Lobstein and colleagues (2004), there are few organ systems that obesity does not affect in child and adolescent populations.

This paragraph has the aim of providing a general description about the physical consequences of obesity and does not represent a detailed review of all physical illness and consequences related to obesity. Table 1.1 summarizes the main disorders related to childhood and adolescence obesity divided according to the organ systems that will be described.

Table 1.1. System and disorders related to childhood obesity (Adjusted from Daniels, 2009; Lobstein et al., 2004).

Organ System	Main disorder
Cardiovascular	Hypertension Left ventricular hypertrophy Atherosclerosis Dyslipidaemia
Metabolic/Endocrine	Insulin resistance Metabolic syndrome Type 2 diabetes Menstrual abnormalities Polycystic ovary syndrome
Pulmonary	Asthma Obstructive sleep apnea
Gastrointestinal	Non-alcoholic fatty liver disease Gastro-oesophageal reflux
Skeletal/Orthopaedic	Tibia vara (Blount disease) Slipped capital-femoral epiphysis Flat feet Ankle sprains Increased risk of fractures
Neurological	Idiopathic intracranial hypertension (e.g. pseudotumour cerebri)

Cardiovascular system consequences: Several studies have found a relation between obesity and cardiovascular disease in the adult population (Ingelsson et al., 2007). However, today it is well recognized that childhood obesity has, in the short-term, adverse effects on the cardiovascular system which are similar to those that are well known in adults (Reilly et al., 2003). It seems that the process of atherosclerosis begins in childhood and is progressive (Daniels, 2009): studies found several risk factors for myocardial

infarctum and plaque in the coronary arteries of young individuals (Mahoney et al., 1996; McGill et al., 2001). For example, Freedman and colleagues (1999), in a sample of American children (5–10 years-old), found that 58% of obese children had at least one cardiovascular risk factor, 25% had two or more, and the odds ratios for having two and three risk factors were 9.7 and 43.5 respectively, compared with non-obese children.

Obesity also plays an important role in the pathogenesis of hypertension for children, adolescents and adults (Sorof, & Danieles, 2002). Childhood levels of blood pressure and the level of overweight in childhood are two of the main predictors of blood pressure level in adulthood (Lauer, & Clarke, 1989).

Moreover, dyslipidaemia may occur in children and adolescents as a result of obesity. The most common abnormality associated with obesity is an increase in triglycerides and a decrease in high-density lipoprotein cholesterol. Finally, studies have shown that young individuals with obesity have, on average, greater left ventricular mass (Laragh, 1995). Left ventricular hypertrophy has been shown to be an independent risk factor for the development of cardiovascular disease, morbidity and mortality in adults (Yoshinaga et al., 1995).

We can conclude with the words of Reilly and colleagues (2003, p. 751) which affirm that *“obesity mediated cardiovascular morbidity in adulthood can have its origins in childhood obesity, and that the magnitude of this problem is likely to be much greater now than in the past, following the epidemic of childhood obesity”*.

Metabolic system consequences: Obesity in adolescence is associated with a variety of metabolic and endocrine complications such as insulin resistance, metabolic syndrome, and type 2 diabetes and, only for girls, menstrual abnormalities and polycystic ovary syndrome. Insulin resistance is a common problem in obese children and adolescents (Malecka-Tendera, & Molnar, 2002) and it is an important factor in the development of type 2 diabetes.

Previously reported only in adulthood, the type 2 diabetes in youth represents an important consequence of obesity in children and adolescents. In recent decades, the prevalence of type 2 diabetes has increased in adolescence (Pinhas-Hamiel et al., 1996) and a review of the American Diabetes Association (2000) reports that a high proportion, about 45%, of the diagnosis of diabetes in children and adolescents are type 2 diabetes (non-insulin

dependent form). Moreover, Scott and colleagues (1997) found an excess of weight conditions among over 90% of adolescents with type 2 diabetes, while among those with type 1 diabetes an excess of weight condition was found in only about 25% of cases.

Moreover, in girls, early menarche (Freedman et al., 2003) and abnormalities in menstruation are part of the endocrine response to overweight and obesity in girls (Lobstein et al., 2004). Insulin resistance, associated with overweight, may increase the insurgence of polycystic ovary syndrome in adolescence (Lobstein et al., 2004). Early menarche and abnormalities in menstruation could also be related with other physical consequences (e.g., cancers of the female reproductive system) or psychological problems (e.g., depression) (Mcpherson, Sellers, Potter, Bostick, & Folsom, 1996; Stice, Presnell, & Bearman, 2001). Conversely, overweight boys show a later sexual maturation than normal weight peers (Wang, 2002).

Gastrointestinal system consequences: The major disorder at this level is the “non-alcoholic fatty liver disease” (NAFLD), a disorder characterized by “the accumulation of macrovesicular fat in hepatocytes” (Daniels, 2009, p. S62). This disorder is generally progressive and can lead to hepatic fibrosis and cirrhosis (Daniels, 2009). Even if the mechanisms of this disorder are not fully understood, studies suggest that obesity, insulin resistance and type 2 diabetes are important risk factors.

Pulmonary system consequences: Obstructive sleep apnea is one of the main pulmonary problems associated with obesity in both adolescents and adults that, in turn, is associated with cardiovascular disease risks (Daniels, 2009). Obstructive sleep apnea is also associated with daytime somnolence, school difficulties, hypertension, hyperinsulinemia (de la Eva, Baur, Donaghue, & Waters, 2002) and may also contribute to weight gain and an increase in the severity of obesity (Daniels, 2009). A study has found abnormal sleep patterns in 94% of severely obese children involved in the study (Silvestri et al., 1993).

Cross-sectional studies have also found an association between obesity and asthma in children (Chinn, & Rona, 2001; Rodriguez, Winkleby, Ahn, Sundquist, & Kraemer, 2002). However, it is difficult, especially in childhood and adolescence, to establish a causal link between asthma and excess of weight (Rodriguez et al., 2002).

Skeletal/Orthopaedic system consequences. Obesity and overweight can stress the musculoskeletal system due to the impact of excess of weight on the developing skeletal system (Daniels, 2009). The most common orthopaedic problem related with severe obesity is tibia vara in children and adolescents and femoral epiphysis in early adolescence.

3.1.2 INTERMEDIATE AND LONG TERM HEALTH CONSEQUENCES RELATED TO OBESITY

Most studies also show that childhood obesity may persists in later adolescence and in adulthood (Reilly et al., 2003). The maintenance of childhood obesity in adulthood is more likely if at least one parent is obese and if the overweight status is severe (Reilly et al., 2003).

Moreover, Whitaker and colleagues (1997) underline that obesity in adolescence is more likely to persist in adulthood than childhood obesity: in a broad sample of US adolescents they found that 69% of obese children (6–9 year olds) went on to be obese as adults and 83% of obese early adolescents (10–14 year olds) went on to be obese as adults. In any case, depending on the method and sample characteristics, the risk of an obese child becoming an obese adult are 2 to 11 times higher than for normal weight peers (Zwiauer, Caroli, Malecka-Tendera, & Poskitt, 2002).

Furthermore, an excessive weight during adolescence predicts a number of adverse effects on adult health, including increased mortality risk. The persistence of obesity represents a health consequence because the medical consequences reported in the previous paragraph can persist, worsen and became chronic in adulthood (Zwiauer et al., 2002) and new health consequences can arise. For example, the increased blood pressure due to obesity in childhood may lead to hypertension in adulthood if the excess of weight condition persists. Even if few studies have investigated the long-term consequences of adolescent obesity some authors report increased mortality risk in adulthood (Reilly, 2003; Zwiauer et al., 2002). A Norwegian longitudinal study (Engeland, Bjirge, Sogaard, & Tverdal, 2003) involving more than 200,000 people (aged 14-19 years) with 32 years of follow up, found that mortality was higher among overweight people than among normal weight people. The mortality risk in the group of obese people was 80 percent for males and 100 percent for females higher compared with normal weight people. Moreover, the mortality

increased alongside increases in BMI: mortality was 30 percent higher among overweight and 80 percent higher among obese people compared with normal weight people. Finally, until 29 years no significant differences were found between normal weight and overweight people in the percentage of deaths, but for the age range of 30-58 years, the risk of mortality was more than 50 percent higher among overweight and obese people compared with normal weight people.

3.2 PSYCHOLOGICAL AND PSYCHOSOCIAL RISKS

Studies suggest that obese and overweight people experience poor psychological as well as physical health (Wardle, & Cooke, 2005).

The role of psychological and psychosocial factors in the development of obesity and overweight is recognised even if the attempts to identify a specific personality type linked with obesity are not adequately supported by population studies (Kolotkin et al., 2001). Obese people do not show more psychological disorders or pathologies than normal weight people and there is disagreement in literature about the association between obesity and psychopathology (Braet, 2005).

However, guidelines on obesity management in young people suggest that “*psychosocial problems are important consequences of overweight or obesity*” (Edmunds, Waters, & Elliott, 2001, p. 916): obese and overweight people are more likely to experience psychological distress and problems due to their excess of weight (Braet, 2005; Kolotkin et al., 2001; Stunkard, & Sobal, 1995). Some authors (Mendelson, & White, 1985) found that only physical self-perception is negatively influenced by overweight (e.g., body image), while other authors (Braet, Mervielde, & Vandereycken, 1997) found that other psychosocial components are influenced by overweight as well (e.g., social interactions). Moreover, obesity during adolescence negatively influences psychosocial well-being in young adulthood (Merten, Wickrama, & Williams, 2008).

In the literature the most commonly reported and studied psychological and psychosocial consequences linked with obesity are: prejudice, discrimination, low self-esteem, body image, quality of life and depressive symptomatology. However, the impact of psychosocial consequences related to obesity is influenced by socio-demographic factors such as gender or ethnic groups (Viner, et al., 2006). Negative psychosocial outcomes due to obesity are more prevalent among females than males (Merten et al., 2008; White,

O'Neil, Kolotkin, & Byrne 2004). Moreover, the prevalence of obesity is higher among African American samples than among Caucasian samples (Ogden et al., 2006), but for the higher prevalence or cultural belief and attitude about overweight, African American people are more accepting of large body size than Caucasian people (Averett, & Korenman, 1999; Ge, Elder, Regnerus, & Cox, 2001) resulting in a lower frequency of negative psychosocial outcome. The psychological and psychosocial problems linked with obesity and overweight in adolescents will now be described.

3.2.1 HEALTH-RELATED QUALITY OF LIFE

The terms “*quality of life*” and “*health-related quality of life*” refer to physical, psychological, and social domain of health that can be influenced by an individual's experiences, beliefs, expectations and/or perceptions (Kolotkin et al., 2001).

Schwimmer and colleagues (2003) have investigated health-related quality of life in a clinical sample of severely obese children and adolescents in comparison with healthy control children and adolescents in the USA. The results showed that obese children and adolescents reported significantly lower levels of health-related quality of life compared with normal weight children and adolescents. Moreover, the severely obese children and adolescents showed very low levels of health-related quality of life (in terms of physical functioning, social functioning and psychosocial functioning) that were similar to children and adolescents with the diagnosis of cancer. This study underlined how severe the impact of obesity is in terms of health-related quality of life in children and adolescents, even if this severity is less recognized by parents and teachers in obese people than in people with other diseases. However, this study focuses on severe obese people and did not analyse the quality of life in pre-obese or in non-clinical obese people that are the majority of adolescents with excess of weight problems, therefore, the generalizability of these findings is limited.

Other studies (Hughes et al., 2007) suggest that the health-related quality of life is lower among obese children than non-obese children, in particular in the physical-health domain. Moreover, this study (Hughes et al., 2007) found that parents report significantly lower levels of children's health-related quality of life than children themselves, especially for non-observable domains such as emotional and social functioning.

Finally, studies using a community-based sample (Williams, Wake, Hesketh, Maher, & Waters, 2005), found that parents and early adolescents reported significantly lower physical and social functioning and health-related quality of life total scores with the increase in weight. Health-related quality of life was less in overweight early adolescents compared with normal weight adolescents and in obese adolescents compared with overweight adolescents. Therefore, the quality of life difference was small for overweight early adolescents and more marked for obese early adolescents. These results (Williams et al., 2005) confirm a worse level of health-related quality of life in overweight and obese children and adolescents compared with normal weight people, even if the results are less dramatic than those reported by clinical studies (Schwimmer, Burwinkle, & Varni, 2003).

3.2.2 PSYCHOLOGICAL SYMPTOMS, DEPRESSION AND SELF-ESTEEM

Obese people reported more psychological symptoms (Berg, Simonsson, & Ringqvist, 2005) such as depression, anxiety, sleep disturbance, nervousness and suicidal thoughts, compared with normal weight peers. More psychological symptoms could reflect both a direct consequence of adolescent overweight, but it could also be an indirect consequence of their negative life situation (e.g., negative body image, few close friends) (Berg et al., 2005).

An Italian study (Santinello, & Vieno, 2007a) found that overweight in adolescence is linked with several psychosomatic symptoms. Overweight adolescents reported feeling “low” every week more often than normal weight participants. Moreover, some psychological symptoms differ by gender. Overweight was significantly correlated to weekly headache (7.8% vs 4.5% non-overweight) and weekly backache (6.4% vs 2.8% non-overweight) in males but not in females. Finally, overweight co-occurred with weekly irritability (15.1% vs 8.0%) only in female participants. Another Italian study (Verzeletti, Dallago, & Santinello, 2007) confirmed these results in the Veneto Region of Italy, finding that overweight and obese girls showed more psychosomatic symptoms than normal weight females, and obese male adolescents reported more psychosomatic symptoms than normal weight males, no associations were found for overweight males. This study

underlines that the frequency of psychosomatic symptoms increases with the increase of overweight status in adolescence.

Moreover, studies on psychological correlates of overweight found that obesity and overweight can increase the frequency of depressive symptomatology in adolescence (Atlantis, & Baker, 2008). Indeed, the social stigmatisation and discrimination linked with overweight is associated with feelings of embarrassment, shame and guilt that may, with time, lead to more frequent affective disorders (Friedman, & Brownell, 1995).

In addition, depressive symptomatology related to obesity in adolescence can also extend into adulthood (Anderson, Cohen, Naumova, & Must, 2006; Franko, Striegel-Moore, Thompson, Schreiber, & Daniels, 2005): studies found a significant association between depressive symptoms linked with overweight in adolescence and depressive symptoms in young adulthood (Franko et al., 2005). A recent study (Merten et al., 2008) suggests that the longitudinal association between overweight and depressive symptoms in adolescence is moderated by gender. Obese female adolescents report more depressive symptoms in young adulthood as compared with normal weight females. This association remained significant while also controlling for the effect of prior depressive symptoms. However, no significant associations between obesity and depressive symptoms in adolescence and depressive mood in young adulthood were found for adolescent males. Depressive symptomatology is linked with obesity especially in young adolescents and in girls due to the vulnerability of social pressure linked with body image in adolescence and in this gender (Needham, & Crosnoe, 2005). Moreover, girls view themselves as overweight more often, in comparison with males (Ge et al., 2001) which, in turn, increases the risk of depressive symptomatology. However, other studies have not found any significant moderation effect of gender (Goodman, & Whitaker, 2002).

Another question which remains open in the literature is about the causal direction of the association between overweight and depressive symptoms in adolescence. Even if several studies suggest that obesity leads to depression, few studies have assessed the psychological and cognitive mechanisms involved in this association, and few longitudinal studies have assessed the relationship between obesity and depression in order to establish the causal direction of this association (Goodman, & Whitaker, 2002; Merten et al., 2008). Indeed, even if much evidence suggests obesity might lead to depression, for example due to a negative body image or feelings linked with social discrimination, other studies

suggest that depression might lead to obesity, for example through changing eating patterns or the reduction of physical activity (Goodman, & Whitaker, 2002; Roberts, Delger, Strawbridge, & Kaplan, 2003). The question concerning causal pathways in the relationship between obesity and depressive mood in adolescence remains open, as affirmed by Wardle and Cooke (2005, p. 432) “*ten years of research have not fully explained the nature of the association between obesity and depression in children and adolescents*”. However, leaving aside the exact nature of the causal pathways, most studies show a significant association between obesity and depressive symptoms, underlining the need to pay more attention in preventive programs to psychological and social factors that might influence both the conditions, for example the reduction of social isolation or socioeconomic inequalities (Goodman, & Whitaker, 2002).

Finally, another psychosocial outcome linked with obesity and depression in adolescence is self-esteem. Overall the literature indicates a modest association between low self-esteem and obesity (French, Story, & Perry, 1996; Strauss, 2000). In particular, even if this association is not especially strong, community-based studies have found that obesity may lead to low self-esteem among adolescents and young adults (French et al., 1996). A longitudinal study following children aged 9–10 years for a period of 4 years (Strauss, 2000) found that obese children did not differ in self-esteem from normal weight peers at the baseline but they had worse self-esteem during the following years and this decline was associated with greater feelings of sadness and loneliness in early adolescence.

As far as the association with socio-demographic characteristics is concerned, low self-esteem, like depression, affects girls more than boys (French, Perry, Leon & Fulkerson, 1996; Strauss, 2000) and early adolescents and adolescents are more at risk, than young children, of weight-related low self-esteem (Israel, & Ivanova, 2002; Zeller, Saelens, Roehrig, Kirk, & Daniels, 2004). Moreover, this association differs by race: white girls report lower weight-related self-esteem levels than black girls (Brown et al., 1998; Kimm et al., 1997; Strauss, 2000).

Finally, perspective studies suggest that a high BMI status may lead to low self-esteem levels (Brown et al., 1998; Hesketh, Wake, & Waters, 2004; Strauss, 2000), however, other studies suggest that low self-esteem levels predict a high BMI status three years later (controlling for BMI level at baseline) (French et al., 1996) and involve similar mechanisms previously described for depressive symptoms.

3.2.3 WEIGHT PERCEPTION, BODY IMAGE AND BODY DISSATISFACTION

Community-based studies report greater body dissatisfaction in heavier adolescents (Wardle, & Cooke, 2005): obese and overweight adolescents are more at risk of perceiving their body negatively which can lead to negative effects on body image, and body dissatisfaction (Braet et al., 1997; Huang, Norman, Zabinski, Calfas, & Patrik, 2007; Sjoberg, Nilsson, & Leppert, 2005).

Body image can be defined as “*an individual’s body-related self-perceptions and self-attitudes, and is linked to self-esteem, interpersonal confidence, eating and exercise behaviours, sexual experiences, and emotional stability*” (Huang et al., 2007; p. 245).

In the adult population a negative body image and body dissatisfaction are linked with lower general happiness, gratification for personal interactions, decreased sexual pleasure and unhealthy eating choice (Huang et al., 2007).

In adolescence body image and body dissatisfaction are linked with unhealthy dieting behaviors and several psychosocial and relational problems (Ohring, Graber, & Brooks-Gunn, 2002; Stice, & Bearman, 2001). For example, negative body-related psychological constructs in adolescence (e.g., negative body image and body dissatisfaction) have been associated with depressive symptomatology (Franko, & Striegel-Moore, 2002).

The relation between Body Mass Index (BMI) and body image is particularly significant in girls (Ricciardelli, & McCabe, 2001). Ge and colleagues (2001) found that adolescent girls experience perceptions of being overweight to a greater extent than males, and this perception can increase the risk of depressive symptomatology. Especially during adolescence, girls are more sensitive about negative body image because of social pressure to be thin and other cultural norms (Needham, & Crosnoe, 2005). Moreover, a review study suggests that Afro-American girls consider themselves more attractive at higher BMI level than Caucasian girls (Padgett, & Biro, 2003). White adolescents reported body dissatisfaction more often and perceived themselves as being “too fat” more frequently than Afro American adolescents (Franko, & Striegel-Moore, 2002).

However, many obese and overweight children and adolescents appear not to be aware that they are overweight (Daniels, 2005; Wardle, & Cooke, 2005). For instance, Viner and colleagues (2006) report that the appropriate perceptions of weight are low among overweight and obese adolescents: only a small percentage (less than half) of overweight

and obese people recognise that they are “too heavy”, girls are more accurate than males and no differences were found across different ethnic groups. However, other studies conducted in the US found that adolescents are more accurate about their weight perception: 75% of girls and 40% of boys overweight recognised this status (Strauss, 1999).

Moreover, even if an overweight or obese adolescent perceives his/her body realistically and categorizes it as overweight, is not obvious whether this adolescent is satisfied or not by their own body.. For example, in a Swedish study (Berg et al., 2005) focusing on boys, just 44% of the obese boys reported not being satisfied with their weight and just 21% reported not being satisfied with their looks.

Finally, some limitations in this research topic should be underlined: body image has been measured in several ways across studies and the differences between body image and body dissatisfaction are not clear. In practice, body image and body dissatisfaction are often considered to be synonymous, resulting in theoretical and methodological confusion. Further studies assessing differences, associations and causal relationship between “body image” and “body dissatisfaction” are needed in order to assess the role of weight perception and satisfaction in the well-being of overweight people.

3.2.4 STIGMATIZATION AND DISCRIMINATION

The greatest social problems for obese people, in all age ranges, are stigmatization, prejudice and discrimination (Kolotkin et al., 2001). Overweight and obese youths are victims of prejudice and stereotype by peers (Kraig & Keel, 2001; Latner & Stunkard, 2003; Neumark-Sztainer et al., 2002b), educators (Bauer, Yang, & Austin, 2004; Neumark-Sztainer, Story, & Harris, 1999a), and parents (Crandall, 1995; Davison & Birch, 2004). This is particularly the case during childhood and adolescence when the formation of social relationships is salient and when people may be especially vulnerable and sensitive to weight stigmatization and its consequences (Puhl, & Latner, 2007, p. 557).

At a very early stage (already at age three) (Cramer, & Steinwert, 1998), obese children are, on the basis of their weight and appearance, stigmatized (Braet, 2005; Kolotkin et al., 2001). Consequently, the stigmatisation engenders shame, guilt and embarrassment

influencing relationships and social interactions with peers and adults and increasing the risk of affective disorders (Friedman, & Brownell, 1995).

School attendance for obese adolescents is more problematic, they like school less and are more frequently absent than normal weight peers (Berg et al., 2005). They report suffering violence and loneliness more often than normal weight peers, which may lead to bullying and depression (Berg et al., 2005). Moreover, peer rejection and lower popularity are associated with reduced psychological functioning in adulthood (Bagwell, Newcomb, & Bukowski, 1998).

Studies found that prejudice and stigma are common in both genders (Kraig, & Keel, 2001), while other studies have found that victimisation and weight-based teasing are more commonly reported by girls than males (Eisenberg, Neumark-Sztainer, & Story 2003; Neumark-Sztainer et al., 2002b). It may be possible that gender differences are linked with the type, rather than the amount, of stigma (Puhl, & Latner, 2007). As far as age is concerned, weight stigmatisation and prejudice begin in early childhood and become worse with the increase of age (adolescence), following by a more tolerant attitude in young adulthood (Latner, & Schwartz; 2005; Latner, Stunkard, & Wilson, 2005). Some studies also found ethnic differences in the expression of weight bias among youth (see Puhl, & Latner, 2007 for a review), even if the results are controversial, especially because few studies have examined these differences with the resulting difficulties of cross-comparison. Moreover, the degree of excess of weight influences the frequency and the degree of stigma: the vulnerability to weight bias is greater among people with higher levels of obesity (Puhl, & Latner, 2007). Confirming the results of Janssen and colleagues (2004a), a recent Italian study (Verzeletti, Santinello, & Vieno, In press) found a relationship between BMI values and the frequency of bullying victimization in adolescence. Obese youths were at greater relative odds of being victims of bullying as compared with normal weight and overweight youths, and overweight youths were more at risk than normal weight peers. This association remained significant even when gender and age effects were controlled for.

Weight stigma in adolescence contributes to negative psychosocial, academic and physical outcomes. For instance, studies suggest that weight stigma mediates the relationship between obesity and self-esteem and depression (Eisenberg et al., 2003). Moreover, weight-related stigma influences poor body image and interpersonal relationships with

peers: obese adolescents are less liked by peers, less chosen as friends and more rejected than normal weight peers (Puhl, & Latner, 2007).

The consequences of prejudice and discrimination towards obese and overweight people strike again in later adolescence and in adulthood. Overweight and obesity in adolescence negatively influence the future socioeconomic status of individuals (Gortmaker, Must, Perrin, Sobol, & Dietz, 1993). Studies report that obese people are considered as less qualified for a job and having more emotional and interpersonal problems (Klesges et al., 1990; Merten et al., 2008), they report lower income and lower marriage rates than normal weight people (Gortmaker, Must, Perrin, Sobol, & Dietz, 1993). Overweight and obese adolescents, in particular females, are less likely to enrol in college or in higher education (Ball, Crawford, & Kenardy, 2004; Crosnoe, 2007) although there is no evidence that obesity is related to lower academic aptitude or to a lesser desire to attend college (Lobstein et al., 2004). Conversely, individuals with a higher education level are less likely to be obese and engage in better overall health behavior (Himes, & Reynolds, 2005; Nayga, 2000).

Taking into account the several factors linked with obesity and overweight involving adolescents' physical, relational, and psychosocial well-being, a growing number of studies in recent years have studied the determinants, correlates and mechanisms involved in the onset and maintenance of overweight and obesity in adolescence. So, what kind of theoretical models are best able to explain overweight and obesity in adolescence? And, what kind of theoretical models are adopted most commonly in the research literature concerning individual and environmental correlates of obesity and overweight? We will try to answer these questions in the next chapter.

CHAPTER 4

OBESITY AND OVERWEIGHT IN ADOLESCENCE: THEORETICAL FRAMEWORKS

In previous chapters we have analysed the importance of obesity and overweight in adolescence in terms of prevalence, economic consequences and impact on psychosocial and physical health.

According to the energy balance equation, adiposity can be defined as “*the net result of inadequate energy expenditure for the energy being consumed*” (Baranowski, Cullen, Nicklas, Thomson, & Baranowski, 2003, p. 23). Thus, obesity and overweight are strictly linked with the levels of physical activity, the level and quality of nutrient intake (dietary behaviors) but also with several obesity-related lifestyles (e.g., overweight is inversely associated with daily breakfast consumption).

Several conceptual models are adopted in literature to explain and to understand obesity and overweight correlates and their inter-relationship in adolescence. The aim of this chapter is to describe briefly the most common theoretical frameworks adopted in literature to explain and, subsequently, modify obesity, overweight and their correlates in adolescence and to answer two main questions:

1. Why adopt a preventive approach in management of obesity and overweight?
2. What kind of conceptual models are most commonly adopted in the research literature concerning individual and environmental correlates of obesity and overweight?

4.1 MANAGEMENT OF OBESITY AND OVERWEIGHT IN ADOLESCENCE: THE IMPORTANCE OF A PREVENTIVE APPROACH

The individual clinical treatment of obesity and overweight requires a considerable amount of time and the experience of a multi-professional team including, for example, physicians, psychologists and so on. For adolescents who are severely overweight today the treatments are mainly palliative and designed to manage and control, rather than permanently resolve the problem (Lobstein et al., 2004). The clinical approach also needs a long time, because it should take into account the importance of a gradual approach. Indeed, strictly modified diets cannot be maintained for long periods of time and strong rebound effects are observed as consequences of strict diets. Moreover, a strict approach could have both adverse physical effects (e.g., low basic nutrient intake) and adverse psychological effects (e.g., risk of developing eating disorders) (Lobstein et al., 2004). Beyond the efficacy of clinical approaches, that might even include pharmacological or surgical therapy, obesity and overweight among children and adolescents continue to rise (see Chapter 2) and is not possible in terms of timing, costs and spread of these problems to manage them adopting exclusively a clinical approach. Some authors (Lobstein et al., 2004) suggest that a clinical approach is more appropriate to treat severe forms of overweight, but that it is appropriate that less severe forms of overweight are managed in primary care settings and with a preventive approach.

Lobstein and colleagues (2004, p. 7) suggest that for the management and control of obesity and overweight “*prevention is the only realistic solution*” for several reasons:

- given that prevalence of obesity and overweight continue to rise, it is important to adopt not only a curative perspective, but also a preventive approach in order to reduce the risk of onset of overweight in the population;
- adolescents’ obesity is likely to lead to obesity in adulthood with stronger psychosocial and physical health-related consequences (see Chapter 3);
- obesity and overweight are difficult to treat, especially for the cases with early onset;
- some obesity prevention strategies aimed to educate people (e.g., promoting healthy dietary behaviors) can improve lifestyles and health behaviors for all

adolescents, both overweight and normal weight (whether they are at risk of becoming overweight or not).

Moreover, obesity and overweight have a complex aetiology and, with a preventive approach, different strategies can be adopted simultaneously (e.g., improvements in dietary behaviors, raised levels of physical activity, promoting healthy lifestyles). For adolescents who are moderately overweight, strategies to prevent further weight gain (e.g., increase of physical activity or the reduction of sedentary behaviors) can also lead to a BMI decrease. At the same time, for normal weight adolescents, the same strategies can be expected to lead to maintenance of a normal weight status and a reduction of the risk of becoming overweight.

Finally, obesity and overweight are not only an the responsibility of the individual, but they are also a social and community problem that involve several settings, such as school, family, neighbourhood and so on. In order to improve the effectiveness of preventive interventions the use of a combined approach is desirable: an effective and ideal prevention action should ensure that strategies and actions adopted at different levels of interventions and by various professional roles should be complementary (Lobstein et al., 2004).

Even if the priority in the management of childhood and adolescent obesity is prevention (Lissau, Burniat, Moskitt, & Cole, 2002; Lobstein et al., 2004) at different levels and with different risk-groups, no current preventive programs for the management of obesity and overweight is particularly effective, when compared with the scale of the problem (Campbell, Waters, O'Meara, Kelly, & Summerbell, 2005; Lissau, Burniat, Moskitt, & Cole, 2002). This highlights the importance of studying this topic, of analysing the correlates and the risk factors linked with obesity and overweight and their inter-relationships, in order to improve the effectiveness of interventions aimed at reducing obesity and overweight in adolescence.

4.2 CONCEPTUAL MODELS FOR THE STUDY OF OBESITY AND OVERWEIGHT IN ADOLESCENCE

Several conceptual models have been adopted in the literature to explain and to understand obesity and overweight correlates, their inter-relationship and the mechanisms involved in the onset and maintenance of overweight and obesity in adolescence.

Overall, the theoretically frameworks that are useful for the explanation of obesity and overweight can be subdivided in two main categories: the conceptual models that mainly focus on individual characteristics and the ecological models. The next paragraphs will describe the main conceptual models adopted to study obesity, overweight and their correlates using, as starting point, a recent review on this topic proposed by Baranowski and colleagues (2003).

4.2.1 CONCEPTUAL MODELS FOCUSED ON INDIVIDUAL: A BRIEF OVERVIEW

One of the conceptual models that focuses on individuals adopted to explain health behaviors obesity related is the Knowledge-Attitude-Behavior model (Baranowski et al., 2003; Bettinghaus, 1986; Lytle, 2005). The overall idea of the model is that knowledge (level and kind) influences the intention to carry out a particular health behavior (Baranowski et al., 2003; Bettinghaus, 1986; Lytle, 2005). Different kinds of knowledge influence health behaviors, and the Knowledge-Attitude-Behavior (KAB) model tries to explain the role of knowledge in health behavior accomplishment and to describe how increased knowledge can gradually change the individual's health behaviors (Baranowski et al., 2003; Bettinghaus, 1986; Lytle, 2005). For example, parents with lower levels of knowledge concerning dietary behaviors are more likely to have overweight children.

In this model the engine of change is knowledge which can promote changes in individual attitudes and/or behaviors. Thus, health behavioral change is firmly linked with the provision of information. However, this model does not explain how behavioral changes should occur and it assumes that the people's health behaviors are based mainly on rational choices. Moreover, no studies have demonstrated that intervention programs based only on knowledge level lead to behavioral change for a long time (Contento et al., 1995), and how different kinds of knowledge can predict a given health behavior. For example, even if knowledge seems related to the accomplishment of physical activity, no changes in physical activity behaviors seem to be influenced by knowledge accumulation alone (Rinal, 2001). For these reasons, some authors (Baranowski et al., 2003) suggest that individual knowledge regarding health behaviors should be included in a broader framework, for example, as mediating variables, in order to better understand the mechanisms influencing health behavior.

Another conceptual model, more often applied in this research topic is The Health Belief Model (HBM). The HBM (Rosenstock, 1974; Rosenstock, Strecher & Becker, 1994) includes several sets of variables and constructs which are useful in predicting health behaviors, including obesity and overweight.

According to the HBM, health behaviors are influenced by: (1) perceived susceptibility (the individual's perceived risks of contracting an illness or diseases), (2) perceived severity (individual's perceived severity of disease) (3) perceived benefits that might occur as a result of the accomplishment of a behavior (4) perceived barriers (the individual's perception of the difficulties in performing a behavior), (5) cue to action (e.g. mass media campaigns, illness of family member). In a later version of HBM self-efficacy was added to the model, meaning a person's belief about his own skills to perform a specific behavior as a resource able to change the behavior. Other mediating factors were added in the following version and adjustment of the model, such as sociodemographic characteristics (e.g., age) or psychosocial variables (e.g., coping strategies). However, beyond specific changes, in this model the main motivation influencing a health behavior is the level of perceived threat (perceived susceptibility and perceived severity).

For example, each person has some cues about obesity influencing the perceived threat of disease and obesity-related quality of life. The health behaviors performed by each person will be the result of the individual's perceived benefits, the perceived barriers and self-efficacy. Thus, individuals choose to perform a particular behavior with the aim of minimizing the perceived threat (Baranowski et al., 2003).

However, the HBM also has some limitations. For example, studies found that people with family members that have experienced cardiovascular disease do not change their behavior by increasing, for example, their level of physical activity (Kip, McCreath, Roseman, Hulley, & Schreiner, 2002). Having a disease risk factor is not always linked with the individual's perceived susceptibility or with the intention to change their unhealthy behaviors (Humphries, & Krummel, 1999). In fact, some studies found discrepancies between subjective perceptions of disease risk and the real estimates (Baranowski et al., 2003; Fisher et al., 2002). The knowledge and the individual's perception of risk are not necessarily linked with healthy behaviors as underlined, for example, by the failure of fear-based health communications in which only small behavioral changes are found (e.g., Witte, & Allen, 2000). Moreover, the HBM needs further studies on the topic of obesity

and overweight because studies assessing dietary behaviors and related lifestyles in overweight and normal weight people are still lacking. Finally, as Baranowski and colleagues (2003) suggest, adolescents tend to perceive themselves as immortal and adolescence is characterized by few health symptoms, therefore, a model based on perceived seriousness of and susceptibility might not be the most suitable model to explain, study and promote changes in dietary behaviors and food-related lifestyles in adolescence. Another conceptual model focused on individuals is the Theory of Planned Behavior (TPB) (Ajzen, & Madden, 1986; Ajzen, 1991), one of the theories most commonly applied to study nutrition behavior, physical activity and food-related lifestyles. The TPB asserts that the probability of performing a behavior is higher when people intend to carry out that behavior (higher level of intention). In turn, the intention to perform a behavior is higher among people with a positive attitude and higher subjective norms toward that behavior (Baranowski et al., 2003). The attitude towards the behavior refers “*to the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behavior in question*”, the subjective norms are defined as “*the perceived social pressure to perform or not to perform the behavior*” (Ajzen, 1991, p. 188). Finally, the intention, is influenced by perceived behavioral control, that is defined as “*the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments and obstacles*” (Ajzen, 1991, p. 188).

The TPB is the theory with most empirical validation in the topic of nutrition behaviors and food-related lifestyles. In adolescence this model explains different amounts of variance, depending on the dependent variables being investigated, for example the TPB explained 7% of variance in fruit and vegetable intake (Lein, Lytle, & Komro, 2002), 35% in soft drink intake (Kassem, Lee, Modeste, & Johnston, 2003), 6% in carrying out vigorous physical activity (Troost, Saunders, & Ward, 2002).

Like the other models, the TPB has some limitations. (1) Some behaviors are not under the individual’s control, for example, studies found that sugar-sweetened beverage consumption may not always be a planned behavior (Kremers et al., 2006). (2) The behavior cannot always be controlled by the individual’s intention (e.g., in a family with low socio-economic status, physical activity levels can be influenced, for example, by poor access to appropriate physical activity facilities). For these reasons, at present, many modified versions of the TPB can be found in literature: for example, some studies have

added new variables to extend the model (e.g., moral norms) (Conner, & Armitage, 1998), other studies have hypothesized a mediation effect of added micro-level determinants (e.g., parenting practice) between intention and behavior (de Bruijn, Kremers, de Vries, van Mechelen, & Brug, 2007). (3) The mechanisms for changing the components of TPB are not fully understood, limiting its application in preventive intervention programs (Baranowski et al., 2003). (4) While in the TPB, distal and social variables are hypothesized to be influencing behaviors, thoughts, attitudes, subjective norms and perceived behavioral control, studies found that TPB is unable to fully explain the role of distal variables and their influence on health behaviors (Conner, & Abraham, 2001; de Bruijn et al., 2005; de Bruijn et al., 2007).

Finally, as well as the Theory of Planned Behavior, the Social Cognitive Theory (SCT) is one of the theories most commonly applied to understand dietary behaviors, physical activity and food-related lifestyles.

The SCT is based on the idea that health behavior is the result of reciprocal interactions between environment and person. The fundamental constructs for understanding health behavior are, at the individual level: skills, self-efficacy, and outcome expectancies and, at the environmental level: modelling and availability. People can change their behavior with several strategies linked to the ability to control their behavior through self-control (Bandura, 1986; Cullen, Baranowski, & Smith, 2001a). The primary motivational strength in changing behavior, in this model, is the outcome expectancies, and the main resources for this change are the individual's skills and self-efficacy (Baranowski et al., 2003).

Several studies have tested the SCT in relation to dietary behaviors, physical activity and obesity, with the results being quite varied (see Baranowski et al., 2003 for a review). In general, among adults, self-efficacy seems more related with the intention to perform healthy eating practices than outcome expectancies (Sheeshka, Woolcott, MacKinnon, 1993). However, among children and adolescents there are less studies available on the role of self-efficacy and outcome expectancies and the results are influenced by the dependent variables of the study and by socio-demographic characteristics (Ball et al., 2009; Corwin, Sargent, Rheaume, & Saunders, 1999; Resnicow et al., 1997; Strauss, Rodzilsky, Burack, & Colin, 2001; Trost, Kerr, Ward, & Pate; 2001).

However, the SCT has explored several constructs influencing dietary behaviors, food-related lifestyles and physical activity, with interesting results for preventive interventions

(Elder et al., 2007), even if the results should be generalized to patterns of dietary behaviors to reduce the fragmentarily of current findings. Finally, the mixed results found with children and adolescents (Baranowski, Cullen, & Baranowski, 1999) might reflect the importance of environmental variables in the developmental age, in which there is less individual control, compared with adulthood, in terms of dietary behaviors and physical activity (Baranowski et al., 2003).

4.2.2 ECOLOGICAL THEORETICAL FRAMEWORKS

In obesity and overweight research, ecological models have received more attention, especially in recent years because of the low predictive power of conceptual models focused mainly on the individual and the limited effectiveness of preventive programs (Baranowski et al., 2003; Contento et al., 1995). Consequently, ecological and social frameworks have gained importance in the literature, focusing more attention on the influence of social and physical environments on health behaviors and on the interaction between individual level factors and social level factors (de Bruijn et al., 2007).

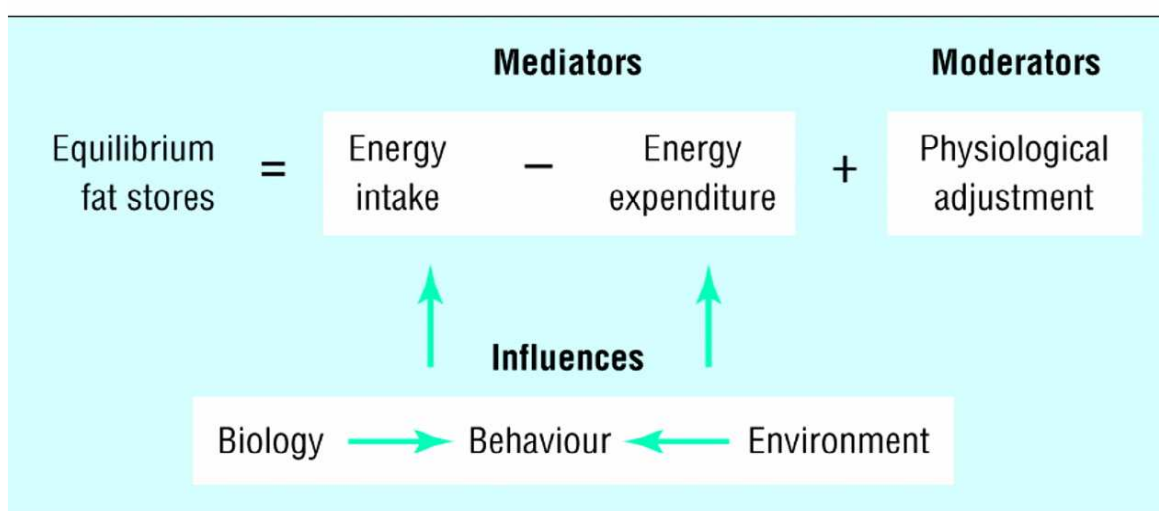
Obesity is a societal problem, and psychological models need to recognize that people live in an obesogenic environment, which can influence people on a macro- and a micro-level, as well as on psychological and individual levels (Braet, 2005).

Indeed, beyond the individual responsibility, the environment directly affects health (MacIntyre, & Ellaway, 2000) at different levels, through “*multilevel (e.g., regions, nations, states, cities, and neighbourhoods), multi-structural (e.g., physical environment, socioeconomic status, and social capital), multifactorial (e.g., diet, physical activity, smoking, and stress), and multi-institutional (e.g., local government, family, and local agency)*” influences and the interrelationships among these influences (Baranowski et al., p. 32). People are vulnerable to relational, social and environmental pressures that can raise the risk of overweight. For these reasons, obesity and overweight prevention and research should involve the individuals and the different levels (micro and macro settings) of the obesogenic environment (Lobstein et al., 2004).

One of the first “ecological” paradigms to explain the equilibrium fat store that can lead to obesity and overweight was proposed by Egger and Swinburn (1997). The paradigm, represented in Figure 4.1, affirms that the equilibrium of fat is influenced and caused by three main factors: (1) Biological influences (e.g., age, gender, genetic and hormonal

factors): these factors are considered unchangeable. However, as the authors affirm “*These biological influences explain much of the variance in body fat in individuals within a given environment, but they do not explain the large population increases which represent the epidemic itself*” (Egger, & Swinburn, 1997, p. 479); (2) Behavioral influences (e.g. physical activity): these factors are influenced by other psychological and cognitive factors (e.g., beliefs, attitudes); (3) Environmental influences: these influences include both macro-environmental factors (factors involving the wider population, such as mass media advertising) and micro-environmental factors (factors involving settings proximal to the individual, such as the proximity of fast food outlets).

Figure 4.1. Ecological paradigm for understanding overweight and obesity proposed by Egger and Swinburn, 1997. (Source: Egger, & Swinburn, 1997, Figure reprinted with the authors permission).



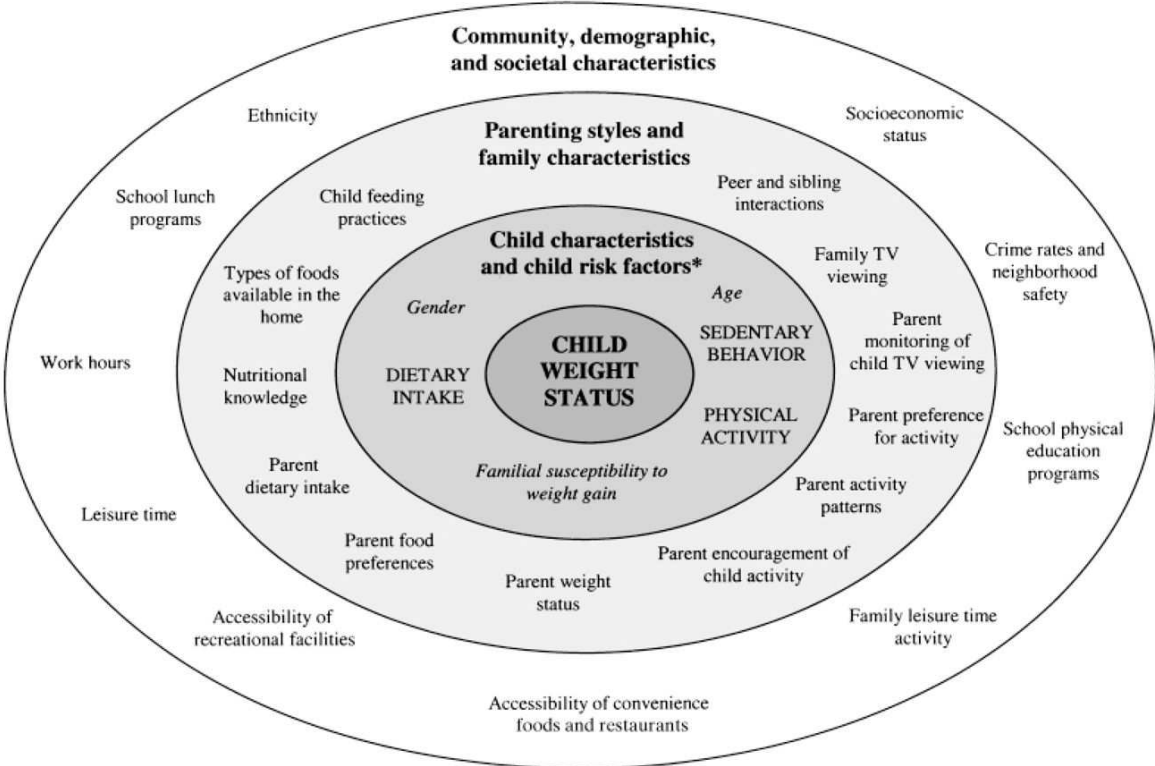
Moreover, the equilibrium levels of body fat is mediated through individual energy intake and/or energy expenditure and moderated by numerous physiological adjustments.

This theoretical framework is useful for understanding the complex relationship between different domains influencing obesity (behavior, environment, biology). However, some limitations should be underlined: first it doesn't explain how environmental factors influence overweight and obesity, secondly it is not clear how micro-environmental and macro-environmental factors interact with different results on individual behaviors and lifestyles. Finally, as the authors assert “*this paradigm is more helpful in explaining*

changes in body fat within an individual over time, but it does not account for the wider influences within and around individuals on obesity” (Egger, & Swinburn, 1997, p. 477).

Another interesting contextual and ecological framework to explain the predictors of child weight status has been proposed by Davison and Birch (2001). The authors focus the attention on childhood overweight and obesity to propose a conceptual framework (Figure 4.2) useful for the study of the complex and multifactorial aetiology and risk factors of these phenomena. The conceptual model is based on the “Ecological Systems Theory” (Bronfenbrenner, 1979; Bronfenbrenner, 1986, Bronfenbrenner, & Morris, 1988) and describes the interrelations between individual overweight risk factors (dietary intake, physical activity, and sedentary behavior) and contextual (familial and community) characteristics that might influence individual overweight risk factors. In line with the “Ecological System Theory”, the authors underline the multilevel influences on child weight status including individual, micro- and macro- setting of influences.

Figure 4.2. Ecological model of predictors and risk factors of childhood overweight. (Source: Davison, & Birch, 2001, p. 171; Figure reprinted with the authors permission).



However, even if these different levels interact and are influenced by reciprocal interrelationships, the mechanisms and the processes involved in these relations are not fully understood and addressed by research and preventive intervention studies.

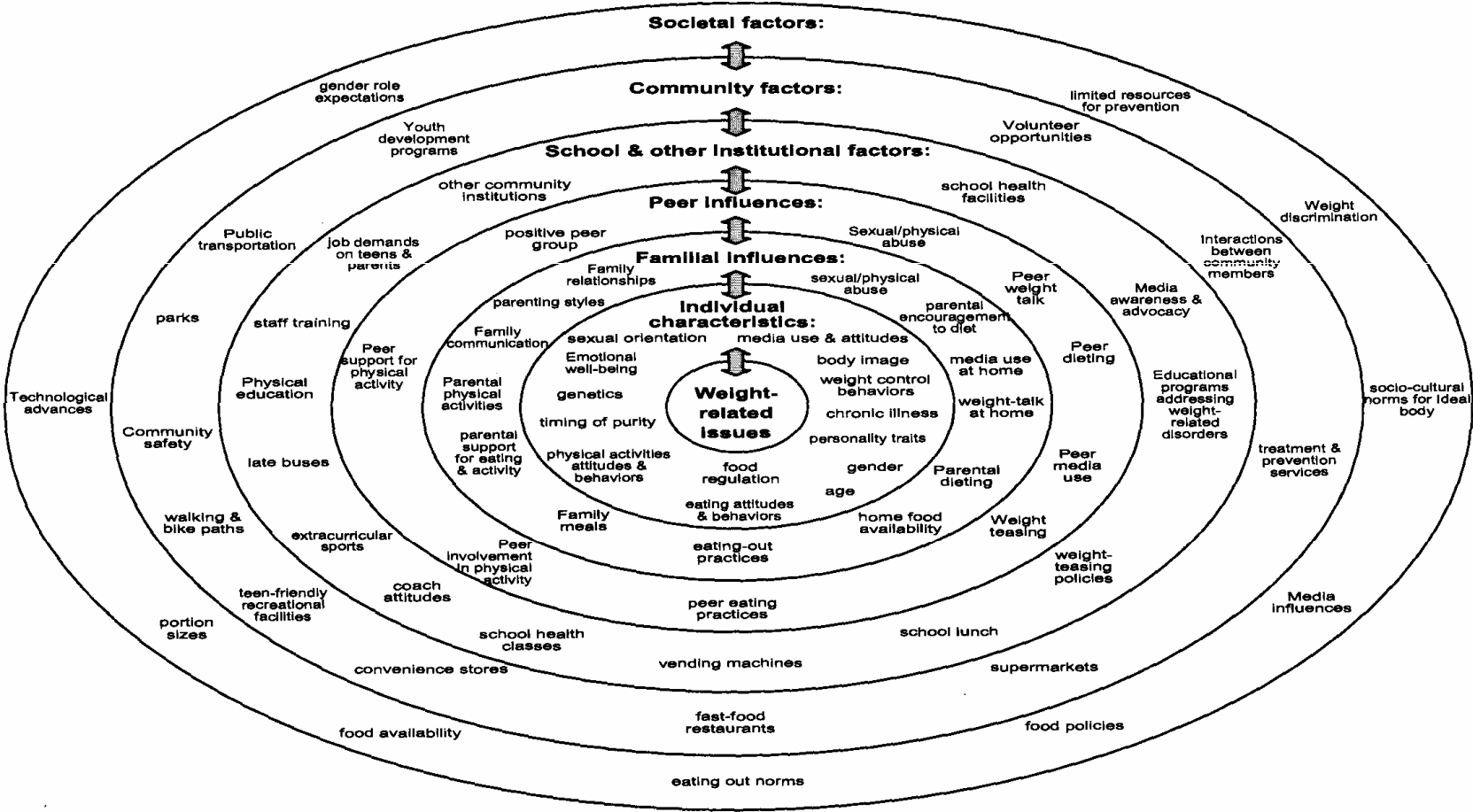
Overall, the conceptual model shows that child characteristics interact with familial and societal characteristics that influence the development of overweight and obesity. The main individual correlates linked with child overweight are: dietary intake, levels of physical activity, and sedentary behaviors. The impact of these risk factors is moderated by socio-demographic child characteristics (age, gender, and susceptibility to weight gain). Finally, the child weight status is influenced mainly by: parenting styles and family characteristics (including peers) and community and societal characteristics (including school system).

All these factors should be considered together to determine the risk to the development of overweight and obesity and to study their determinants. However, studies assessing predictors of childhood overweight generally have adopted approaches that do not reflect the contextual complexity of childhood overweight development and maintenance (Davison, & Birch, 2001).

Even if this framework (Davison, & Birch, 2001) gives an important theoretical framework which is useful to conduct studies on risk factors and development of overweight and obesity, one limitation should be underlined: the framework is not focused specifically on adolescent overweight and obesity. However, as affirmed by Braet (2005, p. 19) “*the development of obesity is identical in children and in adults*”. However, adolescence is also defined as “*one of the most dynamic and complex transitions in the lifespan*” (Story, Neumark-Sztainer, & French, 2002, p. 40). The physical, developmental, and social changes that occur during adolescence can influence eating habits and lifestyles. For example, evidence suggests that dietary quality declines from childhood to adolescence (Morton, & Guthrie, 1998) and the role of physical appearance and body weight become more important for peer relationships and social acceptance (Story et al., 2002).

Another broader conceptual framework has recently been proposed by Neumark-Sztainer (2005). The author presents this framework for understanding factors affecting weight-related problems (including overweight, but also body image, disordered eating, body dissatisfaction and so on). Therefore, the framework is not focused exclusively on obesity and adolescent weight, but it analyzes the factors influencing a broader spectrum of weight-related problems in adolescence.

Figure 4.3. Factors affecting weight-related problems (Neumark-Sztainer, 2005, p. S136, Figure reprinted with the authors permission).



The framework is developed by merging two theoretical theories: the social cognitive theory (SCT) (see Paragraph 4.2.1) to understand the multiple influences that have an impact on food behaviors (Baranowski, Perry, & Parcel, 1997) and the ecological perspective (Bronfenbrenner, 1979) to describe factors influencing eating behaviors. In both these theories the central principle is the reciprocal determinism that means that *“behavior and environment are reciprocal systems and that influence occurs in both directions. The environment shapes, maintains, and constrains behavior, but people can create and change their environment”* (Story et al., 2002, p. 41).

In the model, weight-related problems are reciprocally influenced by six levels: individual influences, familial influences, peer influences, school and other institutional factors, community factors and societal factors. Moreover, the framework emphasizes the interaction and the integration of factors within and across different levels of continual and reciprocal influence.

Even if the ecological and social models could be really useful for obesity prevention (French et al., 2001a) more research is needed to pass the limitations previous described. Although it is well understood that the causes of eating behaviors are multi-factorial, involving cultural, environmental, relational and individual factors (Contento et al., 2006), etiologic research has predominately focused on individual level determinants (e.g. attitude) or on factors within a single domain (e.g. behavioral determinants) (Haines, Neumark-Sztainer, Wall, & Story, 2007). Moreover, the interventions aimed at modifying adolescent eating behaviors and preventing or reducing obesity and overweight have had mixed results and have shown limited effectiveness. This is partly the result of an inadequate understanding of factors and their interrelationship associated with adolescent obesity and overweight (Story et al., 2002).

Based on these limitations and on awareness about the importance of influences at different levels, the next two chapters have the aim of describing the main factors, reported in literature, that at different levels influence these phenomena. The perspective of the last two ecological conceptual models just described (Davison, & Birch, 2001; Neumark-Sztainer, 2005) will be one of the main sources adopted to identify factors which influence obesity and overweight of two studies in the present work.

The next two chapters will be dedicated to describe the most important individual and contextual factors which influence excess of weight problems in adolescence.

CHAPTER 5

OBESITY AND OVERWEIGHT CORRELATES AT THE INDIVIDUAL LEVEL: SOCIO-DEMOGRAPHIC CHARACTERISTICS AND OBESITY-RELATED BEHAVIORS AND LIFESTYLES

As described in the previous chapter, several factors at the individual-, micro- and macro-environmental level can influence obesity and overweight in adolescence (Davison, & Birch, 2001).

This chapter has the aim of describing the main correlates of obesity and overweight in adolescence at the individual level: genetic factors, socio-demographic characteristics, dietary behaviors, physical activity and food-related lifestyle behaviors. This chapter will therefore answer three main questions: What are the nutritional and behavioral factors at the individual level which can promote obesity and overweight in adolescence? Why are these factors related to obesity and overweight? And, how do these individual correlates interact and change in relation to adolescents' gender and age?

Even if, these correlates will be described separately, they interact (see Chapter 4) and are influenced by reciprocal inter-relationships that shape and influence the adolescents' behaviors.

5.1 GENETIC FACTORS

Both height and weight have a heritable component. A review study (Farooqi, 2005) has suggested that genetic variables are able to explain a percentage from 40% to 70% of BMI. Studies on twins found that in childhood the heritability of BMI is about 66% (Reilly & Wilson, 2006). Overall, beyond the specific results, all the findings on genetic components show that genetic factors influence the individual's susceptibility to gain weight (Sweeting, 2008).

Recently, Wisniewski and Chernausek (2009, p. 81) have affirmed that “*the genetic impact on obesity is indisputable, but the genes involved are only beginning to be identified. (...). However, obesity in the vast majority of affected individuals is not caused by a single gene mutation. Rather, excessive weight gain in these individuals is associated with modest variations in the expression of many genes that, when added together, lead to a robust increase in adiposity*”.

Moreover, the alteration in the balance between energy intake and energy expenditure is influenced by several complex molecular and biological factors influencing, for example, the perception of appetite and satiety (Wabitsch, 2005). Some examples of systems involved in the energy-balanced mechanism are the hypothalamus, the sympathetic and parasympathetic nervous system, or the hypothalamo-hypophysio-thyroid axis (Wabitsch, 2005). In addition, several hormones interact to influence the energy balance; some examples are: insulin, leptin, adiponectin, ghrelin.

However, it is not the aim of this work to assess the complex genetic, molecular and biological factors influencing obesity and overweight development⁷. Indeed, the development of obesity and overweight in the majority of the cases is a multifactorial phenomenon in which a genetic predisposition is affected by several environmental factors that are not, at present, fully understood (Wabitsch, 2005). The effects of predisposing genes can be increased or diminished by exposure to relevant behaviors through gene-environment interactions (Bouchard, 2009).

In addition, several authors (Farooqi, 2005; Rennie, Johnson, & Jebb, 2005; Sweeting, 2008) object that a genetic predisposition to gain weight has existed for awhile and it is not possible to explain the increasing rates of obesity and overweight across countries. This demonstrates the central role of contextual and environmental factors (Sweeting, 2008).

5.2 SOCIODEMOGRAPHIC CHARACTERISTICS

Socio-demographic characteristics may be considered as individual factors influencing the risk of developing overweight and obesity. In particular, following the international

⁷ Possible reviews studies to further explore the role of genetic, molecular and biological factors are Barsh, Farooqi, & O’Rahilly, 2000; Bouchard, 2009; Schwartz, Woods, Porte, Seeley, & Baskin, 2000; Wabitsch, 2005.

literature, we will describe hereafter the link between obesity and overweight and the main socio-demographic characteristics: gender, age, ethnicity and socio-economic status.

5.2.1 GENDER

One of the main socio-demographic characteristics included in studies about obesity and overweight in adolescence is gender. Even if this variable is included in almost all the research on this topic, for example as a control variable, very few studies have focused their attention on explaining and understanding gender differences, especially in adolescence (Wisniewski, & Chernausek, 2009).

Males and females show differences at two levels (Sweeting, 2008): biological differences (sex differences) and social and cultural differences (gender differences) (Bird & Rieker, 1999, Krieger, 2003). However, in the insurgence and the maintenance of obesity and overweight these two levels are reciprocally interrelated.

Males and females show differences concerning the distribution of body fat. These differences begin during the pre-pubertal and pubertal age and are partially hormonally controlled (Sweeting, 2007; Sweeting, 2008). For example, with similar weight, in pre-pubertal age girls show more visceral fat stores than boys. In pubertal age, on the other hand, boys have a greater waist circumference than females, and females show greater extremity and hip fat than males (Wisniewski, & Chernausek, 2009). As previous explained, the distribution of body fat, especially abdominal fat, is relevant because it is closely related with health risks. However, the distribution of body fat can be addressed only using direct measures with subsequent problems due to costs, acceptability and handiness (see Paragraph 1.1), especially in population studies.

As far as gender differences are concerned, controversial findings can be found in the literature. On one hand, some recent studies (Lissau et al., 2004; Sweeting, 2008) show no consistent gender differences in the prevalence of obesity and overweight. On other hand the Health Behavior in School Aged Children (HBSC) cross sectional survey, using BMI self-reported values categorized with IOTF cut-off (Cole et al., 2000), found that boys are significantly more likely to be overweight than girls (Currie et al., 2008a; Huang et al., 2009). Involving 41 countries, the study found that males are more likely to be overweight in about half of countries, among 11 year-old adolescents, and in the majority of countries

among 13 and 15 year-old adolescents (Currie et al., 2008a). HBSC findings are in line with other studies underlining a higher prevalence of obesity and overweight among males between 1986-1998 (Strauss, & Pollack, 2001).

Drawing general conclusions is particularly difficult due to different methods employed to assess and define obesity in different studies. However, in consideration of these mixed results, some authors (Reilly, 2005; Sweeting, 2008) have suggested that in this research topic, gender differences should always be addressed.

Finally, beyond the prevalence of obesity and overweight, gender differences can be found in research focusing on other behaviors and obesity-related correlates. Gender differences can be detected, for example, in the accuracy of weight perception or body image (more accurate in females) (Martin, Frisco, & May, 2009) (see Chapter 3), in the susceptibility to family and environmental factor obesity-related (higher in females) (Wisniewski, & Chernausk, 2009), and in the frequency of physical activity (higher in males) confirming the necessity and the importance of testing gender differences in studies on overweight.

5.2.2 AGE AND ETHNICITY

Two other sociodemographic characteristics linked with obesity and overweight in adolescence, even if less studied than gender, are age and ethnicity.

The HBSC cross sectional survey found, in 41 countries, a weak relationship between age and obesity among adolescents aged 11, 13 and 15 years (Currie et al., 2008a). The study only underlined lower levels of overweight and obesity among 15 years old females compared with 11 years old females (Currie et al., 2008a), no other age differences were found. Also other studies (Huang et al., 2009) found few consistent results across countries about the association between age and BMI status among adolescents.

Moreover, beyond the prevalence, BMI is persistent from childhood to adolescence (Johansson, Arngrimsson, Thorsdottir, & Sveinsson, 2006), but also from adolescence to adulthood (Monteiro, & Victora, 2005) (see Chapter 1 and 2).

The prevalence and correlates of overweight and the risk of overweight in children and adolescents from different ethnic groups is a socio-demographic characteristic that has been studied less than gender or age.

However, recent studies suggest that ethnic minorities have a higher risk of obesity and overweight (Adams, Boscarino, & Laraque, 2008; Hass et al., 2003; Kaufman, Popkin, & Gordon-Larsen, 2009). Some authors found that this higher risk is mainly due to disadvantaged socio-economic status (Kaufman et al., 2009), but also in part due to poor or lacking health provision (Hass et al., 2003). However, even if the interaction between ethnic group and socio-economic status is important for explaining disparities in these health behaviors, more studies are needed to confirm this result across different cultural contexts. Moreover, there are mixed findings in the literature because these differences are also influenced by other factors such as lifestyle, acculturation, and cultural beliefs and practices (Hass et al., 2003).

Hass and colleagues (2003) have observed that Asian/Pacific Islanders and Latinos adolescents are significantly more likely than Whites and Afro-American peers to be overweight. A retrospective study (Adams et al., 2008), involving children and adolescents from a US school-based health centre, found that minority ethnic groups are more at risk of being overweight and, among different ethnic groups, Hispanic/Latino children and adolescents show the highest percentage of people who are overweight or at risk for overweight. Another study carried out in London (Taylor et al., 2005) found a higher overweight and obesity prevalence among Black African girls and among Indian boys.

Moreover, ethnic group membership is important in influencing, not only prevalence, but also individual attitudes toward overweight. For example, studies found that African-American people show more positive attitude toward excess of weight (Averett, & Korenman, 1999). This positive attitude is particularly important as it is a protective factor against psychosocial comorbidities and overweight- and obesity-related outcomes, even if this positive attitude is influenced by status attainment (Merten et al., 2008). Another study (Ge, et al., 2001) found that being obese has more negative effects on emotional well-being for White adolescents than for African American or Hispanic peers. However, other studies support these findings only partially. In fact, Merten and colleagues (2008) found that even if African-American people show more positive attitudes toward excess of weight, obesity status is linked with poorer emotional well-being and depressive symptoms for both White and African American females.

Moreover, little is known about the prevalence of obesity and overweight in immigrant populations. A recent study, carried out in the US with a broad sample of children and

adolescents aged 10-17 years, found a variation in the prevalence of obesity and overweight among 12 different ethnic-immigrant sub-groups (Singh, Kogan, & Yu, 2009). In particular, all ethnic-immigrant groups showed a lower prevalence of obesity and overweight than US-born peers. These lower levels of obesity and overweight among immigrant groups seem due to two main factors. First, immigrant sub-groups report lower total calorie and fat intake compared with US-born peer. Second, immigrant sub-groups have healthier obesity-related lifestyles (e.g., more regular physical activity) than US-born peers. Other possible explanations are linked, for example, to higher levels of social support perceived by immigrant sub-groups. However, these differences in the prevalence of obesity and overweight among immigrants' sub-groups are also influenced by generational status. The prevalence of obesity and overweight among immigrant people increases with each successive generation for both white and black people, but not for the Hispanic ethnic group (Singh et al., 2009). Overall, the lower risk of immigrant people for overweight or obesity tends to decrease with the increase of acculturation levels and years of residence (Singh, & Hiatt, 2006).

5.2.3 SOCIO-ECONOMIC STATUS

As far as socio-economic status (SES) is concerned, two different trends should be underlined (Matijasevich et al., 2009). On one hand, in industrialized and rich countries a higher prevalence of obesity and overweight was found among people with low socio-economic status. On the other hand, in poor and developing countries a higher prevalence of obesity and overweight was found among people with high socio-economic status (Lobstein et al., 2004; Wang, 2001). This may be due to the fact that in developing countries people with high SES have more access to globalized and industrialized food (e.g. calorie-dense food) (Sobal, 2001). However, among industrialized and rich countries not all the studies found a higher prevalence of overweight in low SES sub-group populations and mixed results can be found. A recent review (Shrewsbury, & Wardle, 2008), including 45 studies, on the association between SES and adiposity found that SES was inversely associated with adiposity in 19 studies, no association was found in 12 studies and in 14 studies mixed results were found among sub-group populations. These mixed results are partially due to the different methods adopted in the literature to

operationalize socio-economic status (including SES indicators, parental education, parental occupation, indices of family income or neighbourhood SES). HBSC data on 2005/2006 survey also found a relation between SES (conceptualized as family affluence) and overweight in about half of the participant countries (Currie et al., 2008a). Low SES was associated with higher prevalence of obesity and overweight, especially for girls (Currie et al., 2008a).

The association between SES, adiposity and other socio-demographic characteristics in school-aged children is more complicated. As far as gender is concerned, overall, the association between SES and adiposity is significant for both boys and girls (Shrewsbury, & Wardle, 2008). However, some studies found significant associations only for girls (De Spiegelaere, Dramaix, & Hennart, 1998; Mamun, Lawlor, O'Callaghan, Williams, & Najman, 2005; Matijasevich et al., 2009) or only for males (Gnavi et al., 2000; Griffin, Younger, & Flynn, 2004). Some evidence, in contrast, suggests that SES differences about overweight are significant in both genders, but are stronger among females (Wardle, Henning-Brodersen, Cole, Jarvis, & Boniface, 2006).

As far as age is concerned, longitudinal studies found that low SES in early life was not associated with adiposity in childhood, but this association is significant later in adulthood (Parsons et al., 1999). Cross-sectional studies suggest an overall inverse association between SES and adiposity in childhood (Gordon-Larsen, Adair, & Popkin, 2003; Lobstein et al., 2004; see Shrewsbury, & Wardle, 2008 for a review), however, some studies have not found an association (Jansen, & Hazebroek-Kampschreur, 1997; Timperio, Salmon, Telford, & Crawford, 2005).

Moreover, some studies found, using a multidimensional measure of SES, ethnic differences in the relationship between SES and obesity, especially for females (Scharoun-Lee, Adair, Kaufman, & Gordon-Larsen, 2009). Unfortunately, studies on this topic are really lacking, and no general conclusion can be drawn.

Overall, findings underline the importance of studying socio-economic status as a variable that influences adiposity in children and adolescents. Moreover, among the several methods to operationalize SES in literature, the parental education level, and in particular maternal education level (Romon, Duhamel, Collinet, & Weill, 2005; Sallis, Zakarian, Hovell, & Hofstetter, 1996; Shrewsbury, & Wardle, 2008; Sobal, 1991; Vereecken, Keukelier, & Maes, 2004), is the indicator which is more consistently inversely associated

with adiposity in childhood and adolescence. Parental educational may influence adolescents' overweight through several mechanisms. It is possible that educational level is a more stable indicator than occupational level. It is also possible that parental educational level has a greater influence than other indicators because it is directly linked with knowledge, and belief about healthy lifestyles (Sobal, 1991). For example, parents with a lower educational level may be less informed about the importance of nutrition and physical activity (Haas et al., 2003). Finally, the higher importance of maternal education level suggests that mothers have more influence than fathers on children's and adolescents' eating behaviors.

However, Haas and colleagues (2003) found that overweight among adolescents appears less influenced by parental education level than among children. Indeed, adolescents, more than children, are more independent about eating behaviors and can get nutritional advice from other sources such as peers, school or media (Haas et al., 2003).

In conclusion, even if findings are mainly consistent concerning an inversely association between overweight and SES, this association is too complex to attribute and analyze in terms of simple cause-effect and further studies are needed to understand the mechanisms involved in this association (Hill, & Lissau, 2002).

5.3 DIETARY BEHAVIORS, PHYSICAL ACTIVITY AND FOOD-RELATED LIFESTYLES

Weight gain is due to an imbalanced relation between input and output energy: a positive energy balance occurs when energy intake exceeds energy output (Kremers, De Bruijn, Schaalma, & Brug, 2004). Weight gain, in turn, can lead to overweight or obesity. It is important to note that the excessive energy which can lead to overweight may also be really small (about 2% of daily intake) if it is excessive for a long time (Goran, 2001).

As explained in the previous chapter (see Chapter 4), no single factor can be identified as the sole cause of obesity and overweight (Davison, & Birch, 2001; Neumark-Sztainer, 2005): an interaction and co-occurrence of multiple behaviors can lead to a positive energy balance and body fatness (Kremers et al., 2004). For example, in the past few decades several behaviors and consumption have changed: the consumption of soft drinks has increased, like the consumption of candies, pre-prepared meals and the frequency of meals

in fast food restaurants (French et al., 2001a; Janssen, Katzmarzyk, Boyce, King, & Pickett, 2004b). At the same time, the time spent engaging in physical activity has decreased and there has been an increase in the time spent watching television, or using video games and the internet (French et al., 2001a; Janssen et al., 2004b).

As previously explained (see Chapter 4), at the individual level three main factors can summarize the individual characteristics influencing overweight and obesity: dietary behaviors, physical activity and food-related lifestyles. With the words “food-related lifestyles”, we are referring to the lifestyles and behaviors that might cause an excess of energy intake and/or inadequate energy expenditure (Sweeting, 2008) (e.g. sedentary behaviors like television watching, breakfast habits and so on).

Even if, for purposes of clarity, these three topics will be presented separately thereafter, they are partially inter-related. For example, low fruit and vegetable consumption and skipping breakfast are associated with low levels of physical activity (Driskell, Dymont, Mauriello, Castle, & Sherman, 2008; Keski-Rahkonen, Kaprio, Rissanen, Virkkunen, & Rose, 2003; Kremers et al., 2004); high-calorie snack intake increases with hours of television viewing (Epstein, Roemmich, Paluch, & Raynor, 2005) and dietary behaviors are associated with physical activity levels (Schuit, Van Loon, Tijhuis, & Ocké, 2002). Despite these reciprocal inter-relationships among individual weight-related characteristics, the effect size of these associations are often found to be modest or small (Kremers et al., 2004). However, some studies found that a percentage of around 80% of adolescents aged 11-15 years old show more than one risk factor linked with dietary behavior and/or physical activity and/or sedentary behaviors (e.g., Sanchez et al., 2007), however, other studies (e.g., Pearson, MacFarlane, Crawford, & Biddle, 2009) have found a lower percentage (around 54%) of adolescents with clustering risk factors.

5.3.1 DIETARY BEHAVIORS

The need to promote healthy eating habits among adolescents has intensified in recent years due to the growing prevalence of obesity and overweight in many countries (Vereecken, Inchley, Subramanian, Hublet & Maes, 2005b). Indeed, dietary behaviors are considered to be one of the main determinants of body size (Rolland-Chachera, & Bellisle, 2005).

Despite that fact that obesity and overweight continue to rise in children and adolescents population, some studies have found a stable or falling energy intake (Nicklas, Elkasabany, Srinivasan, & Berenson, 2001b; Rolland-Chachera, & Bellisle, 2005; Schnohr, Pedersen, Alcón, Curtis, & Bjerregaard, 2003). Even if findings suggest a stable total energy intake some changes in dietary behaviors have occurred and two main considerations should be addressed to better interpret these results in relation to obesity and overweight:

1. Changes in portion size. Increasingly people consume meals out of home (Nicklas, Baranowski, Cullen, & Berenson et al., 2001a). When eating out, people are consume a greater total amount of food, however package size in supermarkets has also increased (Matthiessen, Fagt, Biloft-Jensen, Beck, & Ovesen, 2003). One significant example is reported by Nicklas and colleagues (2001a, p. 603) “*The average theatre serving of popcorn consisted of three cups in 1957, compared with 16 cups (“medium size”) in 1997*” (Hill, & Peters, 1998). Larger portion sizes have been found both, in the US and in European countries and contribute to the increasing prevalence of overweight (Steenhuis, & Vermeer, 2009). In addition, a recent review underlines that people have a higher energy intake when larger portion sizes are offered (Steenhuis, & Vermeer, 2009).
2. Changes in quality: from 1973 to 1994 an increased in carbohydrate consumption was found (Nicklas et al., 2001b). Moreover, a decrease of total fat consumption coming from fruit and vegetable, fats/oils, mixed meats, pork, eggs, milk and desserts and an increase of cheese, snacks and soft drink have been observed (Nicklas et al., 2001a).

Poor dietary behaviors are characterized by high fat- and sugar-food consumption (e.g., high soft drink, sweets, snacks, candy consumption) and low fruit, vegetable and fiber consumption. Poor dietary behaviors have been associated with weight gain, overweight and obesity in adolescence but also with a higher risk of some diseases during adulthood (e.g., type 2 diabetes, or cardiovascular disease) (McClain, Chappuis, Nguyen-Rodriguez, Yaroch, & Spruijt-Metz, 2009; Nicklas, Yang, Baranowski, Zakeri, & Berenson, 2003).

Despite these benefits several dietary habits are worsening in adolescence and few adolescents meet health-recommendations and guidelines (Pearson et al., 2009; Vereecken et al., 2005b; Verzeletti, Maes, Santinello, Baldassari, & Vereecken, 2009b). For example, even if a diet rich in fruit and vegetables has a positive effect on disease prevention and

weight management, national health surveys indicate that adolescents are not consuming recommended amounts (Larson, Neumark-Sztainer, Hannan, & Story, 2007a, Lowry, Wechsler, Galuska, Fulton, & Kann, 2002, Vereecken et al., 2005b; Vereecken, De Henauw, Maes, 2005a, Verzeletti et al., 2009b; World Health Organization, 2004). Moreover, the consumption of soft drinks has increased (French, Lin, & Guthrie, 2003; Overby, Lillegaard, Johansson, & Andersen, 2004): a higher percentage of soft drink intake (Janssen et al., 2005; Vereecken et al., 2005a; Verzeletti, Maes, Santinello, & Vereecken, 2009a) has been found in adolescence across different countries. Finally, sweets, crisps and chips have been found to be very common and popular among adolescents in several countries (Janssen et al., 2005; Vereecken et al., 2005a).

However, a healthy diet is complex and influenced simultaneously by several dietary behaviors, for example, low consumption of foods like soft drinks, but also a higher consumption of fruits and vegetables (Vereecken et al., 2005b). Indeed, beyond the association between single dietary behaviors and weight status, there is a potential synergistic effect of multiple health behaviors and dietary behaviors on health outcomes and overweight (Pearson, Atkin, Biddle, Gorely, & Edwardson, 2009). However, little is known about the relationship and clustering pattern among dietary behaviors in adolescence (Nicklas et al., 2003; Pearson et al., 2009) because, for pragmatic and methodological reasons, several studies have focused on the study of “key-foods” linked with obesity and overweight (e.g., soft drink, sweet, fruit and vegetable).

Nicklas and colleagues (2003) testing the association between eating patterns and obesity in a sample of 10 year-old children found, among several food groups, that the consumption of sweet and sweetened beverages, meat and consumption of low-quality foods, were positively associated with overweight. Moreover, the association between sweets consumption and overweight is influenced mainly by sweetened beverage consumption, rather than desserts or candies, confirming that sweetened beverage intake is a critical dietary behavior linked with overweight and obesity (Ludwig, Peterson, & Gortmaker, 2001). However, despite these significant associations the model, based on child eating patterns, only explained a small percentage of variance (about 5%) of overweight status (Nicklas et al., 2003). The study confirmed that overweight is influenced by several behaviors and food-related lifestyles, and that dietary behaviors are only one of

these components, given that the variance in overweight status is poorly explained by eating patterns.

Another study of 34 countries found no significant association between overweight and fruit, vegetables and soft drink intake (Janssen et al., 2005). The same study found a negative association between sweet consumption and overweight in adolescence in which an increased sweet intake was associated with a lower probability of being overweight (Janssen et al., 2005).

Moreover, dietary behaviors should be assessed in relation to socio-demographic characteristics. Gender differences in nutrition habits can be found in childhood and adolescence. Studies have found, for example, a higher intake of fruit and vegetables and a lower intake of soft drink among females adolescents, as compared to male adolescents across different countries (e.g., Vereecken et al., 2005b; Verzeletti et al., 2009a). Girls are more likely to follow nutritional guidelines and recommendations and pay more attention to food intake and quality as a means of influencing their health status than males (Sweeting, 2008). Other explanations of gender differences include a greater attention to physical appearance in girls than in boys, but also greater health consciousness and the role that our society attributes for each gender (Vereecken et al., 2005b). As far as the association between age and dietary behaviors is concerned, an overall trend is that with the increase of age, dietary behavior quality decreased. For example, studies found that young adolescents consumed more fruit and vegetable and less soft drink than older adolescents (Vereecken et al., 2005b). This decline in quality could be explained because the increase of age in adolescence is related to greater autonomy concerning food selection and purchase outside the home (Inchley, Todd, Bryce, & Currie, 2001; Vereecken et al., 2005b).

Finally, socio-economic status is also related to dietary behaviors. Higher SES is associated with higher fruit consumption (Vereecken et al., 2005b), and lower soft drink intake (Verzeletti et al., 2009a). The cost of food can influence family purchasing (e.g. fruit has a higher cost than sweet or high-fat food) (Frazao, & Allshouse, 2003). Moreover, studies underline that not only individual and familial SES influence dietary behaviors, but also school SES can influence adolescents consumption pattern (Vereecken et al., 2005b).

Psychosocial characteristics have also been linked with dietary behaviors in adolescence. Some examples included food preferences (Birch, & Sullivan, 1991), self-efficacy, dietary

locus of control (O'Dea, & Wilson, 2006), attitude (Resnicow et al., 1997), and knowledge (Wardle, Parmenter, & Waller, 2000). With respect to the association between psychosocial determinants and dietary behaviors in adolescence, the results are mixed, with few or no associations. For example, a review (Baranowski, Cullen, & Baranowski, 1999) underlined the low predictive power of psychosocial variables on fruit and vegetable consumption.

Taste preference is one of the most important variables influencing dietary intake. Studies found, for example, an association between adolescent's preferences and fruit and vegetable intake (Neumark-Sztainer, Wall, Perry, & Story, 2003a; Resnicow et al., 1997; Vereecken, Van Damme, & Maes, 2005c). Another psychosocial factor studied in relation to dietary behaviors and, more extensively, with regard to fruit and vegetable consumption, is self-efficacy (Neumark-Sztainer et al., 2003a; Resnicow et al., 1997; Reynolds, Hinton, Shewchuk, & Hickey, 1999; Vereecken et al., 2005c). Results regarding self-efficacy are heterogeneous: studies found low correlation between self-efficacy and fruit and vegetable intake (Resnicow et al., 1997), other studies found significant correlation, but only for fruit and not for vegetables (Vereecken et al., 2005c), while other studies found no association between self-efficacy and fruit and vegetables intake (Neumark-Sztainer et al., 2003a). In addition, O'Dea and Wilson (2006) found, against their hypothesis, that high dietary self-efficacy contributes to the risk of overweight and that dietary locus of control is not a predictor of BMI.

Moreover, several studies (O'Dea, & Wilson, 2006; Reinehr, Kersting, Chahda, & Andler, 2003; Thakur, & D'Amico, 1999) have found no relationships between nutritional knowledge and obesity in adolescence. Indeed, similar nutritional knowledge levels were found among obese and non-obese adolescents underlining that obesity is not caused by lack of knowledge in obese people (Reinehr et al., 2003).

In conclusion, a recent review (McClain et al., 2009) analysing psychosocial correlates of several eating behaviors in children and adolescents have underlined that the effect size and the association between psychosocial determinants and dietary behaviors in adolescence rely on the dependent variables considered. For example, psychosocial variables show a weak association with fat intake, stronger associations (e.g., knowledge) were found for fruit, fruit juice and vegetable intake, while attitude and intention are found to be consistently associated with sugar snacking consumption. Overall, total energy intake

has been found to be associated with knowledge, even if few associations or no associations were found for preference or self-efficacy. However, self-efficacy was found to be positively associated with healthy dietary consumption. These complex associations underline the need for further research assessing the psychosocial correlates of dietary behaviors in adolescence, but also the necessity to study patterns of eating behavior associated with weight gain to reduce the inconsistency of these results.

5.3.2 PHYSICAL ACTIVITY

Increased physical activity and a reduction in sedentary behaviors are protective factors against weight gain in adolescence (Must, & Tybor, 2005). High level of physical activity can partially compensate for excessive energy intake and support children and adolescents in the maintenance of healthy weight status (Davison, & Birch, 2001). Beyond overweight, physical activity during adolescence influences the growth and the development of several body tissues like body fat, skeletal muscle and bone (Hills, King, & Armstong, 2007; Meredith, & Dwyer, 1991). Adolescents performing appropriate levels of physical activity are more likely to show a healthy pattern of maturation (Hills et al., 2007). Moreover, people performing regularly physical activity show a reduction in all-cause mortality and a lower incidence rate of cardiovascular diseases, type 2 diabetes, hypertension, some cancer, osteoporosis, anxiety, and depression (Hallal, Victora, Azevedo, & Wells, 2006; Pan et al. 2009). Thus, regular physical activity is linked with short term effects on mental and physical health, on weight management but also it has long term protective effects on health later in life.

Moreover, physical activity persists from childhood to adulthood: the level of physical activity in adolescence influences patterns of physical activity, health and well-being in adulthood (Boreham, & Riddoch, 2001; Hallal et al., 2006; Hasselstrom, Hansen, Froberg, & Andersen, 2002; Malina, 2001; Telama et al., 2005; Yang et al., 2007). Adolescents performing regular physical activity in adolescents are more likely to be active in adulthood. However, physical activity is a complex behavior and the effect size of the direct association between physical activity in adolescence and in adulthood is generally found to be modest (Hallal et al., 2006).

Unfortunately, physical activity levels have reduced in the past few decades, probably due to several modifications of environmental factors that have influenced physical activity patterns among adolescents (Hills et al., 2007; Janssen et al., 2005). The gradual decrease in physical activity levels from childhood to adolescence is a trend that is well recognized in the literature (Sallis, 2000) and it has been speculated that this decrease can partially explain the increasing prevalence of obesity and overweight (Davison, & Birch, 2001). This decrease is the result of a complex interrelation of factors which include an increase amount of time spent watching television and using computer, a decline in opportunities to perform physical activity in schools and communities during free time (French et al., 2001a) and lower levels of perceived safety (Hills et al., 2007).

However, focus the attention on the outcomes of this work, that are obesity and overweight, a reduced physical activity in association with unhealthy dietary behaviors and other individual and environmental determinants (see Chapter 4) contribute to increase the risk of obesity and overweight (Hills et al., 2007) in adolescence. For example, a cross sectional study found a significant association between low physical activity levels and overweight in adolescence (Janssen et al., 2005) in 29 countries of the 33 countries participating in the study, underlining the robustness of this association in different cultural contexts.

US and European health-recommendations and guidelines suggest that adolescents should engage in moderate or vigorous physical activity for at least 30-60 minutes, five days a week (Biddle, Sallis, & Cavill, 1998; Corbin, & Pangrazi, 1998; Strong et al., 2005; U.S. Department of Health and Human Services, 1996). Other guidelines are more restrictive, suggesting that young people should engage in physical activity around 90 minutes on most days of the week (Health Canada, 2002; Janssen et al., 2005). However, beyond the specific guidelines, evidence suggest that adolescents, like adults, do not perform appropriate levels of physical activity, and that the time spent on physical activity is significantly lower than recommended (Hills et al., 2007; Pratt, Macera, & Blanton, 1999; Reilly, & McDowell, 2003; Reilly, et al., 2004).

Moreover, the level of physical activity in adolescence is influenced by socio-demographic characteristics: several studies have found differences for both gender and age. As far as gender is concerned, the level of moderate or vigorous physical activity was found to be higher among males than among females (Cumming, Standage, Gillison, Malin, 2008;

Davison, & Birch, 2001; Kimm et al., 2000; Pearson et al., 2009; Sallis, Prochaska, & Taylor, 2000; Trost et al., 2002). In particular, in early adolescence males are involved in twice-as-much physical activity as females peers (Kohl, & Hobbs, 1998) thus, females comply to a lesser degree with physical activity guidelines (Butcher, Sallis, Mayer, & Woodruff, 2008). As far as age is concerned, higher levels of physical activity were found among younger adolescents and children, as compared to older adolescents, underlining an age-related decrease in physical activity levels (Davison, & Birch, 2001; Kimm et al., 2000; Pearson et al. 2009; Trost et al., 2002). The age-related decline in physical activity levels can be explained with the increase and change of interests during adolescence, but also with the emotional and social changes associated with the body in adolescence (Davison, & Birch, 2001; Goran, Gower, Nagy, & Johnson, 1998). The age-related decrease in physical activity levels in adolescence is greater among females (Kohl, & Hobbs, 1998; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008), suggesting the importance of studying physical activity determinants in this developmental stage, taking into account gender differences, for the implementation of effective physical activity promotion programs.

In conclusion, from a preventive point of view, the amount of physical activity is considered one of the most modifiable behavior obesity-related in adolescence (Rennie et al., 2005) and it is partially able to counterbalance the total energy intake. Moreover, desirable patterns of physical activity are established in childhood and adolescence, configuring, again, these ages groups as critical to the study of obesity-related behaviors and to the contribution of the development of effective prevention programs.

5.3.3. FOOD-RELATED LIFESTYLES

Several studies have found significant associations between BMI and several food-related lifestyles (Nicklas et al., 2003). The most common individual obesity-related lifestyles in adolescence are: sedentary behaviors and television viewing, breakfast consumption, meals in fast food restaurant and snacking behaviors. These lifestyles will now be described.

5.3.3.1 Sedentary behaviors and television viewing

High levels of sedentary behaviors are associated with body composition and body fat: physical inactivity is an important determinant of overweight and obesity (Boreham, & Riddoch, 2001; Epstein, & Roemmich, 2001; Yang et al., 2007).

Sedentary behaviors, like television viewing, playing computer games, or watching videos, can be read in contrast with physical activity. However, it is important to recognise that sedentary behaviors play an independent effect on overweight and obesity: sedentary behaviors are not simply the result of inadequate levels of physical activity (e.g. high sedentary behaviors and adequate levels of physical activity can co-exist) (Davison, & Birch, 2001).

Roberts and colleagues (1999) found that media use (TV/videos, playing video games, computer/internet use, reading books and magazines) take around 5 hours every day of leisure time among youth, of which approximately 50–60% is spent watching television. Adolescents spent more time watching television than any other free time activities (Boynton-Jarrett et al., 2003). Moreover, even if electronic games may have an effect on unhealthy weight gain, they are less related to increased energy intake than television (e.g., computer use is accompanied by fewer food advertisements, which are designed to invoke feelings of hunger) (Swinburn, & Shelly, 2008). Studies found that children and adolescents spend, on average around 3 hours every day watching television (Bryant, Lucove, Evenson, & Marshall; 2007; Davison, & Birch, 2001). Davison and Birch (2001, p. 166) have affirmed that several reasons can explain these higher rates of time spent watching television including “*ready accessibility of televisions, increasingly child-centred nature of programmes, a lack of monitoring by parents, a lack of outdoor play areas, unsafe neighbourhoods, and the planned use of television by parents as an electronic baby-sitter*”.

Moreover, several studies have underlined an association between higher time spent watching television and higher prevalence of overweight (Berkey et al., 2000; Boynton-Jarrett et al., 2003; Dietz, & Gortmaker; 1985; French et al., 2001a; Gable, Chang, & Krull, 2007; Hanley et al., 2000; Hernández et al., 1999; Janssen et al., 2004a; Janssen et al., 2005; McMurray et al., 2000; Robinson, 2001). A cross-sectional study involving 34 countries found in 22 countries higher level of overweight with greater television viewing time among adolescents (Janssen et al., 2005). These findings, consistent across countries,

underline that the time spent watching television is an important factor associated with obesity and overweight in adolescence. Several mechanisms, only partially understood, are involved in this association (Davison, & Birch, 2001; Janssen et al., 2005; Robinson, 2001):

1. Increased caloric intake during viewing (e.g., extra calorie intake due to snacking watching television) (Van Den Bulck, & Van Mierlo, 2004; Vereecken, Todd, Roberts, Mulvihill, Maes, 2006).
2. Overall increased caloric intake due to food advertising. Television viewing can influence the purchase of advertised foods, which are mainly sugary and high-caloric food, negatively influencing adolescents' dietary behaviors. Indeed, studies found that high television viewing behaviors are associated with higher intake of snack food and calories like soft drink, sweets, chips and pizza, a higher frequency of fast food restaurants and a low intake of fruit and vegetables (Boynton-Jarrett et al., 2003; Coon, Goldberg, Rogers, & Tucker, 2001; Muller, Koertringer, Mast, Languix, & Frunch, 1999; Van Den Bulck, & Van Mierlo, 2004; Vereecken et al., 2006; Verzeletti et al., 2009a). Marketing has a strong influence on food preferences and consumption: the time spent watching television increases the consumption of foods commonly advertised that are usually high in fat, sugar and salt (Aktas Arnas, 2006; Maziak, Ward, & Stockton, 2007; McGinnis, Gootman, & Kraak, 2006; Utter, Scragg, & Schaaf, 2006; Wiecha et al., 2006).
3. Reduced energy expenditure: the time spent in sedentary behaviors could be employed for example for physical activity or more energy-heavy activities.
4. A misconception about knowledge of nutritional value and characteristics of foods due to marketing strategies used in the advertising which are more focused on psychological and emotional needs, rather than feelings of hunger or real food characteristics (Boynton-Jarrett et al., 2003; Kotz, & Story, 1994; Lewis, & Hill, 1998; Vereecken et al., 2006). Children aged 2-11 years are exposed to an average of 20,000 commercial messages every year, among which around 56% are for food (Kotz, & Story, 1994). Advertising about food and their marketing strategies are able to shape adolescents' nutritional beliefs, attitudes and consumption pattern (Boynton-Jarrett et al., 2003).

Overall, television advertising promote food-consumption contradicting dietary recommendation (Kotz, & Story, 1994). Moreover, high television exposure may lead to an unrealistic bias about the health consequences of poor dietary behaviors: television protagonists are usually non obese and obesity and dietary behaviors health consequences are not commonly shown on television (Boynton-Jarrett et al., 2003; Gunter, & McAleer, 1990).

As far as the association between television viewing behaviors and socio-demographic characteristics is concerned, a review found that males spend more time watching television and using videogames than females. About 30% of males spend more than four hours every day watching television, while about 25% of females are high television viewers (Marshall, Gorely, & Biddle, 2006). It is possible that females have less sedentary behaviors than males, but it is also possible that females are more involved in different sedentary activities (e.g. talking on the phone, reading) than males usually not measured as sedentary activities (Sweeting, 2008; Marshall et al., 2006). In addition, cross-sectional studies found, across various countries, a higher rate of television watching among males (Vereecken et al., 2006). However, other studies have found opposite results, finding that rates of sedentary behaviors are higher among females (Myers, Strikmiller, Webber, & Berenson, 1996).

As far as age is concerned, time spent watching television decreases during adolescence, even if other sedentary behaviors (e.g. listening to the radio) might increase. Furthermore, people that were considered “high viewers” in young ages are likely to remain so in later adolescence as well (Marshall, Gorely, & Biddle, 2006).

Even if several studies have analyzed the association between television exposure and overweight, the circumstances in which adolescents watch television should also be considered. Watching television during meals is one of the most important television behaviors studied in the literature. Coon and colleagues (2001, p. 2) suggest that “*Because children learn television-viewing habits, as well as eating habits, primarily from parents, the choices parents make about the use of television during meals may be associated with choices that they make regarding the foods they buy and make available to their children, independently of children’s direct requests for advertised foods*”. Moreover, the family daily food routines and food consumption patterns are influenced by television viewing habits at mealtime (Coon et al., 2001). Television during meals was found to be associated

with the use of quick suppers, higher intake of red meats, pizza, salty snacks, soda and lower consumption of fruit and vegetables. This association could be explained because television during meals may be considered as a marker for the families that have incorporated the television as a habitual part of their food cultures, in which there is a relationship between private family food culture and the food culture promoted on television (Coon et al., 2001).

As explained before, studying sedentary behaviors is relevant because they are likely to contribute to obesity and overweight. Moreover, the rate of sedentary behaviors seems to be particularly worrying in our country (Dallago, Santinello, & Davoli, 2005; Patriarca, Di Giuseppe, Albano, Marinelli, & Angelillo, 2009). A recent Italian study (Patriarca, et al., 2009) found that more than 55% of adolescent participants (age mean 13.7 years) ate at least one meal in front of television, around 90% had a television in their bedroom but only 49% reported that parents check the content of what they are watching on television. The mean of hours spent watching television are about 2.8h every day. Finally, high television behaviors are associated with more time spent on other sedentary behaviors, like time playing videogames and using the computer.

5.3.3.2 Breakfast consumption

Breakfast consumption is considered essential for children's and adolescents' nutritional well-being (Matthys, De Henauw, Bellemans, De Maeyer, & De Backer, 2006). Skipping breakfast regularly is linked with health-compromising behaviors in adolescents and adults (Keski-Rahkonen et al., 2003).

Moreover, regularly missing breakfast (O'Dea, & Caputi, 2001), but also a poor quality (O'Dea, & Wilson, 2006) and quantity of breakfast, are associated with overweight and obesity in adolescence (Affenito et al., 2005; Ortega et al., 1996; Pearson et al., 2009a). Eating breakfast may, in fact, lead to more regular eating habits and exercise patterns, reduce dietary fat intake and minimize impulsive snacking (Nicklas et al, 2001a).

Studies found that adolescents consuming breakfast regularly have better overall dietary quality than adolescents who skip breakfast (Nicklas, O'Neil, & Berenson, 1998; Nicklas et al., 2001a). Adolescents who regularly have breakfast show better Healthy Eating Index scores, a higher intake of fruits and micronutrients and a lower intake of fat and soft drinks

(Matthys et al., 2006; Nicklas et al., 2001a; Rampersaud, Pereira, Girard, Adams, & Metz, 2005; Verzeletti et al., 2009a).

Finally, a daily breakfast seems positively associated with cognitive and academic performance and psychosocial functions, even if the findings about this relationship are more controversial and are influenced by several social and educational factors (Matthys et al., 2006; Rampersaud et al., 2005).

Despite the importance of breakfast habits for adolescents, demonstrated in several studies, breakfast is the meal which is more often skipped by adolescents (Matthys et al., 2006; Sjoberg, Hallberg, Hoglund, & Hulthen, 2003). Furthermore, studies have underlined a significant decline in breakfast consumption in childhood and adolescence from 1965 to 1991 (Nicklas et al., 2001a).

With respect to the frequency of breakfast consumption, several studies have underlined that girls are more likely to skip breakfast than boys: missing breakfast may be chosen as a weight control method by girls, on the contrary of evidence suggesting that adolescents who skip breakfast are at greater risk of being overweight (Albertson et al., 2007; Rashidi et al., 2007).

5.3.3.3 Frequency of meals in fast food restaurant

A high frequency of fast food meals could be one of the factors contributing to the epidemic increase of obesity and overweight (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004). For example, studies found that the risk of becoming obese over a 15-year period is around 86% higher among young adults who eat more than two times per week in fast food restaurants, compared with those that eat in fast food restaurants less than once a week (Pereira et al., 2005).

In the period around 1970, US children ate 17% of meals outside of home and around 2% of total energy intake was attributable to fast food restaurants. Then, in a period around 1990 it has been estimated that children ate 30% of their meal outside of home and fast food restaurants contributed to around 10% of their total energy intake (Guthrie, Lin, & Frazao, 2002; Stanton, 2006). Furthermore, the numbers of fast food outlets has dramatically increased: studies report that it more than doubled between the 1970s and the 1990s (Bowman et al., 2004).

Even if evidence underlines that frequent meals in fast food restaurants are associated with overweight, obesity and unhealthy dietary behaviors, nonetheless these restaurants are commonly visited by adolescents. Indeed, while it is true that such food has several adverse dietary effects (high energy intake, large portion size, palatability, high content of saturated and trans fat, high glycemic load, and low content of fiber) (Bowman et al., 2004; Ebbeling, Pawlak, & Ludwig, 2002), they also have a low price, nice packaging, a good taste, and large portion sizes that are appealing factors for adolescents (Maziak et al., 2007).

High frequency consumption of fast food meals also has implications for dietary behaviors outside of fast food: fast food might replace more healthy food options (Bowman et al., 2004), and they are linked with higher total energy intake and poorer diet quality (Bowman et al., 2004; French, Story, Neumark-Sztainer, Fulkerson, & Hannan, 2001b; McNutt et al., 1997). High frequency of fast food consumption is associated with overall poorer dietary habits, such as lower consumption of fruit and vegetables (Bowman et al., 2004) and higher consumption of soft drinks (Bowman et al., 2004; Ludwig, Peterson, & Gortmaker, 2001; Verzeletti et al., 2009a).

Finally, no gender differences were found for the frequency of fast food consumption, while a direct association was found between age and frequency of fast food: the adolescence is the period of autonomy and adolescents can purchase more fast food meals with their money than younger adolescents (Bowman et al., 2004). Other individual correlates associated with higher frequency of fast food restaurants are: less concern about healthy eating, more perceived barriers to healthy eating (e.g., poor taste of healthier foods), and lower perceptions of maternal concern for healthy eating (French et al., 2001b).

5.3.3.4 Snacking behaviors

Studies have found a decline in the traditional habit of eating three meals per day and at the same time an increase in 'snacking' behaviors (Kerr et al., 2009; Zizza, Siega-Riz & Popkin, 2001). This change in meal patterns has coincided with the increasing prevalence of obesity and overweight among children and adolescents, thus, studies have investigated a causal link between obesity, overweight and snack food intake (Kerr et al., 2009). Indeed, the energy intake attributable to snack consumption has increased around 30% in US children and adolescents in the past few decades (Jahns, Siega-Riz, & Popkin, 2001)

and studies reported that people do not do anything to compensate the increased energy intake (de Graaf, 2006). Moreover, studies underline that the snacks have higher energy density compared with food normally consumed at meals (Ovaskainen et al., 2006). Even if large quantities of energy intake are consumed outside of mealtimes as snacks (Rolland-Cachera, & Bellisle, 2002), other lifestyle behaviors are associated with snacking. For example, several hours watching television are associated with higher consumption of snack and junk food in adolescence (Rolland-Cachera, & Bellisle, 2002). Finally, snack consumption decreases from adolescence to young adulthood (Kerr et al., 2009).

All these individual characteristics, behaviors and food-related lifestyles are not only an individual choice, they are also influenced by micro- and macro- environmental factors. So, what environmental factors influence obesity and overweight in adolescence? How do these environmental factors interact with individual determinants? We will answer these questions in the next chapter.

CHAPTER 6

FAMILIAL AND ENVIRONMENTAL CORRELATES OF OBESITY, OVERWEIGHT AND FOOD-RELATED BEHAVIORS AND LIFESTYLES

Both individual and environmental correlates influence the onset and the maintenance of overweight and obesity in adolescence (see Chapter 4). Indeed, as well as individual characteristics and behaviors, weight-related behaviors and lifestyles are influenced by family, peers, school, institutional and community factors, and societal factors (Neumark-Sztainer, 2005).

While the previous chapter was devoted to describing the individual correlates of obesity and overweight, in this chapter we will describe the main micro- and macro-environmental factors associated with obesity and overweight in adolescence that, in turn, influence individual behaviors and lifestyles. Although several proximal and distal factors have been found to be associated with these phenomena and to contribute an “obesogenic environment” (Lobstein et al., 2004), in this work we will focus our attention primarily on family environment.

Indeed, the role of the family environment in childhood and adolescence overweight onset and maintenance is a growing field of interest in the literature (Golan & Weizman, 2001) for several reasons. Firstly, although several factors within the adolescent’s environment may have an impact on adolescents’ dietary behaviors and food-related lifestyles, studies on excess of weight problems suggest that family influences play a very important role (Neumark-Sztainer, 2006). Secondly, it has been argued that, in order for obesity treatment to be successful, the primary agent of change should be the parents because family environment plays a key and critical role in the development and reduction of obesity (Golan & Weizman, 2001; Gruber, & Hadelman, 2009). Thirdly, the role played by parents on overweight-related behaviors and lifestyles has been mainly studied in childhood and to a lesser extent in adolescence. Fourthly, the family is the primary socialization context in

the development of eating behaviors (Birch, & Fisher, 1998) that, as explained in the previous chapter, represent some of the most important factors associated with obesity and overweight.

Furthermore, starting with early infancy and breastfeeding, parents can influence and shape children's eating behaviors and dietary beliefs and also, subsequently, the onset of obesity and overweight (Lazarou, Kalavana, & Matalas, 2008). Parents can, for example, influence children's natural self-regulation of energy intake through different parental control practices and ways of feeding (Sweeting, 2008). The family can shape children's tolerance of hunger and self-regulation skills that are gradually acquired through education and learning (Braet, 2005).

However, focusing on adolescence, the age target of the present work, some authors suggest that, in this developmental period, parents can make a significant difference to weight-related problems (Neumark-Sztainer, 2005). Indeed, families can filter out the unhealthy messages about food, overweight and related matters that adolescents may receive from other distal levels of influence such as peers or the media (Neumark-Sztainer, 2005). Moreover, adolescence is a critical stage for the development and the stabilization of several food-related behaviors and lifestyles (see Paragraph 1.4). For example, eating patterns established during adolescence may track into adulthood (Kelder, Perry, Klepp, & Lytle, 1994). At the same time, adolescence is characterized by important changes in the relationships with the family system including, for example, more conflict with parents, dissatisfaction with the relationships and communication with them, and a desire for greater autonomy (e.g., Burgess-Champoux, Larson, Neumark-Sztainer, Hannan, & Story, 2009; Palmonari, 1997).

Moreover, from a preventive point of view, a family approach appears relevant and effective: studies show that behaviors and obesity- and overweight-related lifestyles improved most when families are involved in the process of change (e.g., Golan, Fainaru, & Weizman, 1998a; Lobstein et al., 2004).

Despite the important role played by parents in obesity- and overweight-related behaviors and lifestyles in adolescence, the role of the family context has been mainly studied in childhood.

Overall, there are several family factors, across multiple domains, which can influence adolescents' obesity and overweight. Physical (e.g., availability of food), normative and

educational (e.g., parenting practices), and socio-relational characteristics (e.g., parenting style, family communication and social support) of the family may influence the onset and maintenance of overweight and food-related behaviors and lifestyles (Gruber, & Hadelman, 2009; Lobstein et al., 2004; Neumark-Sztainer, 2005; Parsons et al., 1999).

In this chapter we will firstly describe the family factors influencing the adolescents' risk of overweight and obesity followed by other environmental factors (e.g., peers, school) that may influence obesity- and overweight- related behaviors and lifestyles.

6.1 PARENTS' WEIGHT STATUS AND DIETARY BEHAVIORS

Parental obesity is a risk factors for excess of weight problems among children and adolescents (Lobstein et al., 2004). Indeed, children of obese parents are more likely to be obese in adulthood themselves (Lake, Power, & Cole, 1997). In particular, having an overweight mother has been linked with a higher risk of obesity and overweight for children and adolescents (Gibson et al., 2007; Hui, Nelson, Yu, Li, & Fok, 2003; Langanse, Mast, & Muller, 2002; Moens, Braet, Bosmans, & Rosseel, 2009).

Moreover, studies on monozygotic twins underline that the BMI shows a high heritability of about 85%, while families and adoption studies found that BMI heritability ranged from 25% to 50% (Allison, Matz, Pietrobelli, Zannolli, & Faith, 1999; Lobstein et al., 2004). However, as suggested by Lobstein and colleagues (2004), it is likely that the important role of family on adolescents' overweight and obesity is partly due to genetic factors and partly due to shared lifestyles, behaviors and environment (e.g., similar dietary behaviors). In fact, as affirmed by Branca et al. (2007, p. 78) "*Children share with their parents not only the genetic background but also the environment in which they live and behave*".

In fact, beyond genetic factors, studies underline similar patterns in several dietary behaviors between parents and adolescents (e.g., Campbell et al., 2007; Feunekes, de Graaf, Meyboom, & van Staveren, 1998; Stanton, Fries, & Danish, 2003; Sweeting, 2008). Furthermore, similarities between parent and children dietary behaviors reflect the role of environmental factors more than genetic factors (Davison, & Birch, 2001).

As far as exercise is concerned, studies have found that families with overweight parents show lower levels of physical activity and greater unhealthy dietary behaviors compared to

families with normal weight parents (Davison & Birch, 2002; Wardle, Guthrie, Sanderson, Birch, & Plomin, 2001).

Moreover, obese parents report less concern and awareness about the excess of weight problems of their children (Lobstein et al., 2004). In these family cultures, obesity and overweight seem to be quite normal (Lobstein et al., 2004) underlining, once again, the importance of involving the parents in preventive intervention aimed at reducing obesity and overweight among adolescents. Indeed, lack of parental concern and attention concerning adolescents' obesity and overweight are likely to lead to less individual and familial attempts to reduce and manage overweight and obesity (Lobstein et al., 2004).

Finally, even if both parents play an important role, some studies suggest that maternal overweight has a stronger association with child overweight than father overweight (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). This differing influence may be explained by the fact that in our society it is mainly mothers who take care of food and nutrition at home (e.g., Bonino et al., 2003). For example, overweight mothers are more likely to give their children snacks and high-energy foods (Davinson, & Birch, 2001).

The parental influence on obesity- and overweight-related behaviors and lifestyles is so strong that some authors (Davison, & Birch, 2001) suggests that obesogenic family clusters can be identified on the base of parents' dietary and activity patterns and that parental behaviors and lifestyles may predict the risk of overweight in children. Indeed, parents act as role models at home and through their food-related behaviors and lifestyles, can influence and shape children's and adolescents' overweight-related behaviors and beliefs.

6.2 FAMILY SOCIO-ENVIRONMENTAL FACTORS

Beyond the influence of socio-economic status, already discussed in chapter 4, other family socio-environmental factors may influence obesity and overweight in adolescence. In particular, the family structure and the availability of food at home have been investigated in the literature in association with obesity- and overweight-related behaviors.

In the last decades family characteristics have changed: more women are working and the number of children and adolescents living in single-parents families has grown (e.g., Cattelino, Calandri, & Bonino, 2001; Burgess-Champoux et al., 2009; Patrick, & Nicklas, 2005). For this reason some authors have speculated that family structure may have an influence on adolescents' eating behaviors and food-related lifestyles.

Family structure (e.g., traditional families, single parent families, number of siblings) has been mainly studied in association with adolescents' and children's dietary behaviors like fruit and vegetable consumption, rather than directly in association with weight status. For example, a review study on fruit and vegetable intake underlined that in the majority of studies there was an association between single parents families and lower fruit and vegetable consumption among children and adolescents compared with traditional (two-parents) families (Rasmussen et al., 2006). However, the same review also reports some studies which reveal no association between family structure and fruit and vegetable intake.

Unfortunately, very few studies have assessed the role of family structure in association with BMI, thus, it is difficult to draw a general conclusion. On the one hand, some studies have found that living in a single parent family is linked with a higher risk to be overweight for adolescents and children (Gibson et al., 2007; Hesketh, Crawford, Salmon, Jackson, & Campbell, 2007). On the other hand, review studies (Parsons et al., 1999) underlined that the association between family structure and obesity and overweight is generally inconsistent. Finally, some studies suggest that children with siblings are less likely to be overweight compared to children without siblings (Hesketh et al., 2007; Moens et al., 2009)

Another socio-environmental family factor influencing overweight and obesity is home availability of food. Home availability has mainly been studied in childhood (Story et al., 2002). Moreover, studies assessing the association between food availability at home in adolescence are mainly focused on adolescents' food intake rather than directly on adolescents' weight status (see McClain et al., 2009 for a review).

Home availability has been found to be one of the most important factors associated with fruit and vegetable intake among adolescents (Bere, & Klepp, 2004; Neumark-Sztainer et al., 2003a). In turn, the correlates of fruit and vegetable home availability included social support for healthy eating, family meal patterns, family food security, and family socioeconomic status (Neumark-Sztainer et al., 2003a).

Other studies that have analyzed the association between availability of unhealthy foods and adolescents' intake found that availability of unhealthy foods and conflict among family members were associated with a higher intake of sweet snacks among girls, while no significant association were found for males (Campbell et al., 2007). Moreover,

analyzing the home accessibility of fruit and vegetables reported by parents and their children, studies found that parents perceive their children's accessibility to be better than those reported by their children (Bere, & Klepp, 2004).

Finally, home availability interacts with children's and adolescents' individual characteristics, like taste preference. For this reason, some authors have suggested that family socio-environmental factors should not be read in isolation when attempting to explain adolescents' food-related behaviors (Neumark-Sztainer et al., 2003a), but taking into account the ecological and reciprocal inter-relationships with individual characteristics.

6.3 FAMILY INFLUENCES ON ADOLESCENTS' DIETARY BEHAVIORS AND PHYSICAL ACTIVITY

As previous explained in chapter five, dietary behaviors are an important determinant of overweight and obesity among adolescents (Hill, & Peters, 1998; Swinburn, Gill, & Kumanyika, 2005). The influence of parents and home environment are critical in the development and maintenance of healthy dietary behaviors and eating patterns (Branca et al., 2007; De Bourdeaudhuij, & Van Oost, 2000; Kumanyika, 2001). Indeed, some authors sustain that "*Children's dietary patterns evolve within the context of the family*" (Davison, & Birch, 2001, p. 164).

Children's and adolescents' dietary behaviors and beliefs are associated with parental modelling and parental dietary behaviors (Lazarou et al., 2008, Patrick, & Nicklas, 2005). Similar dietary patterns and intake of different foods has been found between parents and children (Bere, & Klepp, 2004; Davison, & Birch, 2001; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Vauthier, Lluch, Lecomte, Artur, & Herberth, 1996). Indeed, with both modelling and different levels of pressure on child feeding, parents may influence children dietary behaviors (Bere, & Klepp, 2004; Fisher et al., 2002). For example, child fruit and vegetable intake is positively associated with parents' fruit and vegetable intake.

Moreover, similar food preferences have been found between children and their parents. (Benton, 2004; Borah-Giddens, & Falciglia, 1993; Branca et al., 2007; Contento, Williams, Michela, & Franklin, 2006; Davison, & Birch, 2001; Skinner, Carruth, Wendy, & Ziegler, 2002). Mothers, especially, seem to play an important role in shaping children's food

preferences through influencing the foods available at home and through modelling (Branca et al., 2007; Skinner et al., 2002).

There are several mechanisms through which parents may influence child dietary behaviors and food preferences including: nutritional knowledge, availability of foods at home, parental modelling about specific eating behaviors, educational strategies and parenting practices (which will be described in paragraph 6.5). The parental level of knowledge on healthy dietary behaviors is positively associated with healthier dietary patterns at home such as higher fruit and vegetable intake (Gibson, Wardle, & Watts, 1998; McClain, et al., 2009). In particular, parental knowledge concerning healthy dietary behaviors is linked with more appropriate portion sizes, purchase of healthier food (e.g., fruit and vegetables) and higher accessibility of these foods for children and adolescents, thereby lowering risk of overweight and obesity (Davison, & Birch, 2001). Finally, as previously explained, parents act as role models, and through repeated exposure may influence children food intake and preferences (McClain, et al., 2009).

Like dietary behaviors, physical activity may also be influenced by parents. Parents can influence their adolescent to carry out regularly physical activity in two main ways: through parental modelling and through parental encouragement to perform physical activity (Wisniewski et al., 2009).

Moreover, parental participation in physical activities is positively related to physical activity among adolescents, especially for girls (Anderssen, & Wold, 1992; Vilhjalmsson, & Thorlindsson, 1998). As above, this association reflects the important role of parents as social models for their adolescents (Davison, & Birch, 2001).

Finally, parents who perform regularly physical activity are more likely to communicate and believe in the positive health and emotional benefits of exercise with their children and are also more likely to create a positive environment that promotes and encourages children and adolescents to be active themselves (Davison, & Birch, 2001; Sallis, Alcaraz, McKenzie, & Hovell, 1999). Indeed, findings underline that children show higher levels of physical activity if parents encourage them to perform sport, active play and exercise (Arredondo et al., 2006).

6.4 FAMILY INFLUENCE ON ADOLESCENTS' FOOD-RELATED LIFESTYLES

As explained in chapter 5, as well as dietary behaviors and physical activity, food-related lifestyles also have an impact on adolescents' obesity and overweight and may be influenced by family environment. Like other correlates of these health outcomes, studies suggest that families may also influence food-related lifestyles behaviors.

Family meals may play a relevant role in the prevention and change of childhood overweight (Sen, 2006). Several studies, in fact, underline an association between frequency of family meals and quality of dietary behaviors (e.g., higher fruit and vegetable intake), quality of diet and psychosocial well-being among adolescents (Burgess-Champoux et al., 2009; Fulkerson, Strauss, Neumark-Sztainer, Story, & Boutelle, 2007; Gillman et al., 2000; McClain, et al., 2009; Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003; Videon, & Manning, 2003; Verzeletti et al., 2009b).

Regular and high frequency family meals (at least 5 meals weekly) are associated with a better quality of diet characterized, for example, by a lower consumption of saturated fat, fried food and soft drinks and higher consumption of fruit and vegetables (Gillman et al., 2000; Neumark-Sztainer et al., 2003; Videon, & Manning, 2003; Verzeletti et al., 2009b). This association may be partially explained by the lower consumption of ready-made dinners and quick meals (Gillman et al., 2000; Neumark-Sztainer, Story, Perry, & Casey, 1999b) and lower frequency of meals consumed outside of home in places such as fast food restaurants (Nielsen, Siega-Riz, Popkin, 2002).

Moreover, the frequency of meals with parents may be read as an opportunity to share a meal together, to monitor and limit adolescents' intake, for parents to be role models for healthy eating behaviors, to establish a daily moment to communicate, to improve family relationships, to increase family connectedness and to enhanced adolescent well-being (Burgess-Champoux et al., 2009; Contento et al., 2006; Sen, 2006).

These results suggest that parental influence on weight-related behaviors and lifestyles is extended beyond childhood. In adolescence, parents also act as role models, can provide knowledge and support, and make available a healthy food environment at home, thereby influencing adolescents' behaviors and lifestyles. More generally, parents may influence the future health and overall well-being of their adolescent, improving communication with

them and reducing possible feelings of isolation and depression (e.g., Burgess-Champoux et al., 2009; Sen, 2006; Calandri, Borca, Begotti, & Cattelino, 2004; Marta, 1997).

Indeed, beyond the association with eating behaviors and BMI, the frequency of family meals is associated with positive adolescents' psychosocial outcomes. The frequency of family meals is positively associated with adolescents' adjustment, academic achievement and reduced drug use, and negatively associated with low self-esteem, depressive symptoms, premature sexual activity and suicide ideation (Eisenberg, Olson, Neumark-Sztainer, Story, & Bearinger, 2004; Neumark-Sztainer, Wall, Story, & Fulkerson, 2004; Sen, 2006). In addition, the frequency of family meals may also be a protective factor influencing adolescents' eating behaviors and choices during meals consumed outside of the home (Sen, 2006).

Despite these benefits few studies have investigated the long term effects linked with a high frequency of family meals (Burgess-Champoux et al., 2009; Larson, Neumark-Sztainer, Hannan, & Story, 2007b; Sen, 2006; Taveras et al., 2005) and studies conducted in the US over a 21-year period reported a significant decrease in the frequency of family meals at home in our society (Nicklas et al., 2004). However, the few longitudinal studies available found that adolescents having regular meals with parents in adolescence also show a better quality of diet and eating patterns years later compared with adolescents who report no regular or less frequent meals with their families, underlining the long term benefits of this habit (Burgess-Champoux et al., 2009).

Even if studies have found an association between frequency of family meals and healthier dietary behaviors among adolescents that, in turn, should have an impact on adolescents' BMI, few studies have investigated the direct association between family meals and adolescents' weight status. The few studies available assessing this association found, in cross-sectional analyses, that the frequency of family dinner is inversely associated with the prevalence of overweight, however, this association was no longer significant in a longitudinal analysis (Taveras et al., 2005). Other studies found longitudinal associations between high frequency of family dinner and both a lower risk of becoming overweight and a higher chance of not being overweight anymore, even if with some ethnic differences (Sen, 2006). These associations were found for white adolescents, while no significant associations were found for black and Hispanic adolescents, underlining that, beyond the frequency of meals, the types and the portions of food consumed during family meals also

play a role that can partially explain these ethnic differences (Sen, 2006). However, due to the lack of studies which have investigated the association between BMI and frequency of family meals, and the complex results found by the longitudinal studies available, this association should be interpreted with caution.

Moreover, among different meals during the day, the frequency of evening meals with parents was found to be higher compared with the frequency of breakfast or lunch in adolescence (Burgess-Champoux et al., 2009; Verzeletti et al., 2009a). However, like evening meals, eating breakfast with parents may be an important marker of more organized family routines that are indicative of greater family health behaviors (Lobstein et al., 2004). Indeed, some studies (e.g. Burgess-Champoux et al., 2009) suggest that the health benefits of dinner and breakfast with parents for adolescents' dietary behaviors should be similar. The low frequency of breakfast with parents compared with evening meals may simply be linked with practical and organizational family aspects, such as different working hours among family members (Burgess-Champoux et al., 2009).

Although the frequency of family meals is associated with healthier dietary behaviors and lower BMI status, the circumstances in which they are consumed also play an important role (Branca et al., 2007). For example, as explained in chapter 5 the use of television during meals is associated with a worse quality of diet and a higher risk of obesity and overweight. Thus, more than just the frequency of family meals should be considered. Parents, in fact, can monitor adolescents' television behaviors and make rules about the use of television at home both during meals and free time. Even if few studies are available about the role of parents in regulating sedentary behaviors, findings suggest that in this case parental behaviors (e.g., modelling), and monitoring of adolescents' sedentary behaviors, can also improve these unhealthy lifestyles among adolescents (Davison, & Birch, 2001).

6.5 PARENTING PRACTICES AND PARENTING STYLE

Parenting style refers to general patterns of parenting and the general emotional climate in which parents' behaviors are expressed (van der Horst et al., 2007). Parenting practices, on the other hand, are directly concerned with limiting or encouraging specific child and adolescent behaviors (van der Horst et al., 2007). Thus, parenting style refers to overall parent-offspring interactions, while parenting practices are related to specific child and

adolescent behaviors (e.g., in this research topic family food rules) (Darling, & Steinberg, 1993). In other words, “*parenting practices operate in the context of parenting style*” (van der Horst et al., 2007, p. 296).

Parenting practices are mainly studied with infant and preschool children (see Faith, Scanlon, Birch, Francis, & Sherry, 2004 for a review) and often in association with the infant skills needed to regulate their energy requirements and to recognize feelings of hunger and satiety (Birch, McPhee, Shoba, Steinberg, & Krehbiel, 1987). It is worth noting that the association between parenting practices and dietary behaviors in adolescence is less well studied, so that, the debate in the literature about the role of parenting practices in adolescence is still open and controversial results can be found among studies.

Birch and colleagues (2001) underlined two main food-related parenting practices: “restriction of intake” and “pressure to eat”. Pressure to eat refers to parents’ attempts to increase healthy food intake (e.g., fruit and vegetables intake) (Francis, Hofer, & Birch, 2001; Vereecken et al., 2004). Parental restriction refers to the extent to which parents restrict children’s and adolescents’ access to unhealthy foods, in terms of type and amount of food intake (Francis, Hofer, & Birch, 2001; Vereecken et al., 2004), that can influence dietary behaviors and subsequently adolescents’ weight (Wisniewski et al., 2009). Overall, studies suggest that parental restriction may influence in childhood several dietary behaviors, food consumption patterns and food preferences (Wisniewski et al., 2009; Fisher, & Birch, 2002).

Moreover, food is often used by parents as an educational instrument to reinforce desired or undesired behaviors. In this way, children can learn to eat in association with external stimuli and not based on internal cues such as hunger and satiety, with the consequence of reducing children’s skills of self-regulation of their eating behaviors (Branca et al., 2007). In addition, parents who reinforce their children with foods may increase the child’s attraction for the food used as a reinforce (Braet, 2005).

Furthermore, parents can encourage their children to eat more healthy foods (e.g., fruit and vegetables). However, as affirmed by Birch (1999, p. 10) “*although these practices can induce children to eat more vegetables in the short run, evidence from our research suggests that in the long run parental control attempts may have negative effects on the quality of children's diets by reducing their preferences for those foods*”.

Finally, parents may restrict the consumption of certain foods (e.g., unhealthy foods). In this regard, experimental studies (e.g., Fisher, & Birch, 1999a) have found that restricting access to palatable foods is linked with an increase of children's desire for the restricted foods and attempts to obtain them. In children, high maternal restrictions of unhealthy food has been found to promote their over-consumption and are associated with poor energy regulation, especially in girls (Birch, & Fisher; 1998; Sweeting, 2008). These studies confirm that some parenting practices often adopted by parents to prevent and reduce their offspring's overweight, like restriction to palatable foods, can promote the intake of these foods in unrestrictive circumstances, for example when parents are absent (Fisher, & Birch, 1999b). Given that foods restricted by parents are usually "unhealthy foods" (e.g., snack food), these parenting behaviors may increase the risk of overweight among children promoting overconsumption of restricted foods (Davison, & Birch, 2001).

However, it is important to recognize that the studies of Fisher and Birch were mainly carried out in experimental settings and involving samples of children. Other studies, on the other hand, suggest that permissiveness is associated with more frequent soft drink and sweet intake among children (Vereecken et al., 2004) and restriction rules with healthier eating habits (De Bourdeaudhuij, 1997).

Focus the attention on adolescent population, studies on parenting practices have found mixed results underlining both positive and negative effects on adolescents' dietary behaviors (de Bruijn et al., 2007). On the one hand, some studies have found that restrictive parenting practices may increase children's food intake and preference of restricted foods (Birch, & Fisher, 1998; Brown, & Ogden, 2004). On the other hand, studies have found that restrictive parenting practices are associated with healthier adolescent dietary behaviors (De Bourdeaudhuij, & Van Oost, 2000, de Bruijn et al., 2007; Hearens et al., 2008; van Horst et al., 2007; Verzeletti et al., 2009a; Verzeletti et al., 2009b).

In particular, studies have found that children and adolescents whose parents reported higher levels of control on their diet reported eating more healthy and unhealthy snack foods and that a greater use of food to control adolescents' behavior was associated with higher levels of body dissatisfaction (Brown & Ogden, 2004). On the other hand, as has just been reported, other studies have found a positive association between restriction rules and healthier food intake among adolescents. Zabinski and colleagues (2006) found that

family food rules related to healthy food were associated with adolescents' food choice. A positive association was found for fruit and vegetable intake and a negative association was found for the percentage of energy intake from total fat in boys, but not in girls. Besides, household food rules are particularly relevant for food choice in younger adolescents as opposed to older adolescents. Restrictive parenting practices have also been found to be associated with a lower frequency of unhealthy food intake (De Bourdeaudhuij, & Van Oost, 2000). For example, restriction rules have been found to be associated with less adolescent soft drink consumption (de Bruijn et al., 2007; van der Horst et al., 2007; Verzeletti et al., 2009a). Furthermore, studies found that this association was moderated by the personality dimension of agreeableness in adolescents (de Bruijn et al., 2007). Other studies that have found a positive association between family food rules and dietary behaviors among adolescents underlined gender differences (e.g., Hearens et al., 2008). For example, among adolescent boys, fewer family food rules were associated with higher fat intake, while no significant association was found for girls (Hearens et al., 2008).

Finally, studies have found that the impact of family food rules on adolescents' dietary behavior is influenced by dietary outcome variables and by the specific parenting practices considered (e.g., pressure, permissiveness and so on). Indeed, both being too permissive and being too strict may result in less healthy dietary behaviors (Vereecken, Legiest, De Bourdeaudhuij, & Maes, 2009). These authors conclude that in nutrition education programs parents should be trained in firm but, not coercive food parenting skills to have a positive impact on children's dietary behaviors (Vereecken et al., 2009).

Even if they have been investigated less than adolescents' dietary behaviors, parenting practices may also influence adolescents' weight status. In fact, studies suggest that *"improving relationships among family members and providing education about the adverse effects of restrictive feeding practices may be expected to ameliorate overweight and obesity"* (Wisniewski et al., 2009, p. 78).

Unfortunately, regarding overweight and obesity, no clear conclusions can be drawn about the role of parenting practices. Studies suggest that parental restrictions are linked to higher weight status (Fisher, & Birch, 1999a). Other studies confirm these findings by suggesting that maternal restrictive strategies are associated with children's increased BMI (Moen, Braet, & Soetens, 2007).

On the contrary, Robinson and colleagues (2001) found that parents who reported greater control on food intake had daughters who were less likely to be overweight, while no association was found for males. Finally, other studies found no association between parental feeding practices and children's weight (Wardle, Sanderson, Guthrie, Rapoport, & Plomin, 2002).

Overall, few studies have used a longitudinal design and methods adopted to assess parenting practices tend to be very heterogeneous (e.g., by questionnaire, observation, experiments and so on). For these reasons it is not possible to draw firm conclusions about the association between parenting practices and adolescents' overweight.

Beyond parenting practices, some studies have found an association between parenting style⁸ and eating behaviors. Studies have found that an authoritative parenting style (highly strict and highly involved) was linked with higher fruit and vegetable intake among adolescents (Kremers, Brug, de Vries, & Engels, 2003; Lytle et al., 2003). Moreover, in contrast to authoritarian (highly strict and low involved) and permissive parenting style, an authoritative parenting style is associated with the development of young children's self-control and healthier eating habits (Nicklas et al., 2001). On the contrary, permissive parenting style has been associated with a higher intake of fat, sweets and snacks, and fewer healthy food choices (De Bourdeaudhuij, 1997; De Bourdeaudhuij, & Van Oost, 2000). However, a recent study found that general parenting style does not have any impact on dietary behavior in early adolescents (Vereecken et al., 2009).

In addition, observational studies at mealtime have shown that, in families with young overweight children, the permissive and authoritative styles were equally prevalent, while the authoritarian parenting style was less present. In families with normal weight children, the authoritative parenting style was most prevalent, followed by the permissive and the authoritarian parenting style (Moens et al., 2007). Furthermore, an authoritarian style, characterized by high restriction and monitoring, has been associated with higher body mass (Fisher, & Birch, 2000; Lee, & Birch, 2002).

Finally, in the light of the controversial results on restrictive parenting practices, some studies have tested the moderation effect of a general parenting style on the association between parenting practice and adolescents' food intake. Van der Horst and colleagues

⁸ Is not aim of this work to describe the classification of parenting styles reported in the literature, see for example Baumrind, 1991; Maccoby, & Martin, 1983.

(2007) found that the effect of parenting practices was greater in the families characterized by parents who adopted a highly involved and moderately strict parenting style.

6.6 FAMILY FUNCTIONING: SOCIAL SUPPORT AND COMMUNICATION WITH PARENTS

Several authors suggest the importance of focusing on parent–offspring relationships in adolescence (e.g., Marta, 1997; Noller, 1994; Scabini, 1995). Adolescence is an important stage of change in terms of the relationship with parents that may include, for example, a decline in intimacy and an increase in conflict (e.g., Grotevant, 1998; Marta, 1997; Palmonari, 1997).

Moreover, several physical, social, and cognitive changes occur during adolescence. For these reasons, feelings of closeness with parents, the communication with them and perceived support from family are relevant factors in protecting adolescents from the rising rates of adjustment problems linked with their body and, more generally, adjustment difficulties that may begin in adolescence (Grotevant, 1998; May, Kim, McHale, & Crouter, 2006). In fact, family communication, climate, cohesion, emotional bonding and organization may influence several adolescents' health behaviors, with food-related behaviors being among them (De Bourdeaudhuij, & Van Oost, 2000).

Family functioning and relationships with parents have been investigated less than food-related behaviors and lifestyles in association with obesity and overweight and their psychosocial consequences (De Bourdeaudhuij, & Van Oost, 2000; Lobstein et al., 2004). This is quite surprising considering the importance of family for children's and adolescents' obesity and overweight and the implication of this shortfall in terms of clinical and preventive interventions. Indeed, even if very few studies assessed these variables, the psychosocial family functioning and the relationships with parents may play a more relevant role than some socio-environmental family' characteristics.

First, studies on family functioning were mainly focused on the role of mothers in early childhood (Bruch, 1973). Food may be viewed by mothers as an instrument in response to the child's signals of discomfort. Thus, starting from the early years of life children learn to interpret negative feelings as a need of food (Bosch, Stradmeijer, & Seidell, 2004; Burch, 1973). These preliminary studies were focused on a dominant maternal role

compared with weaker fathers (Valtolina, & Ragazzoni, 1995). Other studies have suggested that families with obese children are characterized by higher marital conflicts (Mendelson, White, & Schliecker, 1995). However, a more recent review study on family functioning (Bosch et al., 2004) underlined that these hypotheses are not empirically confirmed in clinical and non-clinical samples and are characterized by several limitations, the small sample size being one of the most common critical of these aspects.

Other studies suggest that perceived parental stress is an important variable in considering studying family functioning in relation to body weight status (Abidin, Jenkins, & McGaughey, 1992; Moens et al., 2009). Indeed, a recent study (Moens et al., 2009) carried out with children aged from 6 to 14 years old, found that parents of overweight children perceived more parenting stress. However, despite this difference in perceived parenting stress the same study found that parenting stress does not contribute to the prediction of children's and adolescents' weight status.

Moreover, among family functioning variables, longitudinal studies found that parental neglect and low parental support in childhood is linked with a higher risk of developing obesity and overweight in early adulthood (Lissau, & Sorensen, 1994).

Beyond overweight, a higher perceived social support from parents and an adequate communication with them have also been found to be positively associated with individual and social adjustment and well-being in adolescence (e.g., self-esteem), and negatively associated with deviant and risky behaviors (e.g., Boutelle, Eisenberg, Gregory, & Neumark-Sztainer, 2009; Cristini, Santinello, & Dallago, 2007; Graziano, Bonino, & Cattelino, 2009; Hess, 1995; Marta, 1997; Noller, 1994; Vieno et al., 2007). In addition, the quality of the relationship with parents in adolescence also influences the behaviors and social relationships outside of the family (e.g., school adjustment) (Marta, 1997; Palmonari, 1997).

Moreover, even if the lack of studies that investigate the role of family social support in this research topic, higher perceived family social support is considered to be an important key factor for promoting and supporting health behavioral changes (e.g., dietary change) (Gruber, & Hadelman, 2009; Kelsey, Earp, & Kirkley, 1997; Mulvaney-Day, Alegria, & Scribney, 2007; Verheijden, Bakx, van Weel, Koelen, & van Stavem, 2005; Wilson, & Ampey-Thornhill, 2001). Indeed, these studies underline that parental support is an

important component influencing the success of intervention programs aimed at reducing behaviors and lifestyles linked with obesity and overweight.

Moreover, perceived social support from parents is positively correlated with physical activity levels (Gruber, & Hadelman, 2009; Horn, & Horn, 2007; Sallis et al., 2000; Shields et al., 2008; Trost et al., 2003). Furthermore, qualitative studies suggest that the quality of communication and interactions with parents surrounding food is perceived by adolescents as important and it is associated with the frequency of family meals and adolescents' quality of diet (Contento et al., 2006).

Parental support was also found to be associated with adolescents' dietary behaviors (De Bourdeaudhuij, & Van Oost, 2000). Finally, family cohesion and family interactions have been found to be associated with higher healthy food consumption by parents and higher vegetable consumption by adolescents (De Bourdeaudhuij, & Van Oost, 2000), while family connectedness was found to be positively associated with fruit or vegetable intake among adolescents (Neumark-Sztainer, Story, Resnick, & Blum, 1996; van der Horst et al., 2007).

Unfortunately, family functioning variables have not been extensively investigated in association with weight status, dietary behaviors and food-related lifestyles, and, overall, it is important to note the associations just described, if and when present, are modest (McClain, et al., 2009). For example De Bourdeaudhuij, & Van Oost (2000), who assessed several family characteristics in relation with dietary behaviors in adolescence, underlined that family relationship variables explained a very low variance of dietary behaviors.

Beyond the influence of family relational variables on overweight-related behaviors, in adolescence the relationships, the communication and the perceived social support from parents has been linked with poor body image, body dissatisfaction and weight concern (Jones, 2004; May et al., 2006; Barker, & Galambos, 2003; Prsenall, Bearman, & Stice, 2004; Stice, & Whintenton, 2002; Stice, Presnell, & Spangler, 2002; Swarr, & Richards, 1996). Moreover, longitudinal and cross-sectional studies found that BMI and excess of weight problems (overweight and obesity) are strongly associated with and predictive of these variables (Al Sabbah et al., 2009; Barker, & Galambos, 2003; Paxton, Eisenberg, & Neumark-Sztainer, 2006; Presnell et al., 2004; Stice, & Whintenton, 2002). In turn, body image, body dissatisfaction, and weight concern may be associated with a higher risk of eating disorders, depression and the use of unhealthy dietary practices in order to lose

weight (Jones, 2004; Rodgers, & Chabrol, 2009; Neumark-Sztainer et al., 2006a; Stice et al., 2002; Stice, & Whitenton, 2002).

Relationships with parents characterized by higher conflicts and less warmth and support are predictive of increased dieting behaviors and poor body image (Archibald, Graber, & Brooks-Gunn, 1999; Ata, Ludden, & Lally, 2007). In particular, conflicts and a lack of closeness in the relationship between mother and daughter were associated with more weight concern in adolescence (May et al., 2006).

Unfortunately, studies involving both parents and male and female adolescents in this regard are lacking. The most studies on body image and body dissatisfaction have focused their attention only on female adolescents and on the role of mother, fewer studies also involve male participants and less is known about the role of the father (Ata et al., 2007). However, a study found that only conflicts in the relationship with the father are associated with weight concerns in adolescence in both genders (May et al., 2006). Moreover, in a cross-sectional study (Al Sabbah et al., 2009) involving 24 countries, difficulty in talking with father was more common than difficulty in talking with mother in all countries among adolescents. In addition, difficulty in talking with father was associated with weight dissatisfaction among both boys and girl adolescents in most countries, while difficulty in talking with mother was associated with body weight dissatisfaction for girls in most countries and rarely for males (Al Sabbah et al., 2009).

Overall, studies suggest that family social support may play the role of a buffer against negative social and cultural influences, sustaining adolescents in the development of a positive body image and body dissatisfaction (Ata et al., 2007; Barcker, & Galambos, 2003; Bearman, Presnell, Martinez, & Stice, 2006; Ricciardelli, McCabe, & Banfield, 2000; Stice and Whitenton, 2002). Thus, improving relationships and communication between parents and adolescents may have a positive impact on adolescents' food-related health behaviors, body dissatisfaction and adolescents' psychosocial well-being (Al Sabbah et al., 2009; Mellin, Neumark-Sztainer, Story, Ireland, & Resnick, 2002).

Finally, several studies on this topic have underlined gender differences that should always be taken into account. For example, gender was found to moderate the effect of BMI on body dissatisfaction (Presnell et al., 2004), while other studies found a greater impact of BMI on body dissatisfaction in adolescent girls, as compared with boys (Stice, & Whintenton, 2002; Jones, 2004).

6.7 GENERAL CONCLUSION ON THE ROLE OF THE FAMILY

As has been described above, parents can influence onset and maintenance of children's and adolescents' overweight and obesity in two main ways (Ritchie, Welk, Styne, Gerstein, & Crawford, 2005). Firstly, in a direct way, building and determining the physical and social environment in which adolescents live. Secondly, in an indirect way, through socialization, relational processes and modelling.

Previous studies, mainly assessing a few family correlates of obesity and overweight, have concluded that familial factors have a limited effect on adolescents' overweight.

However, some gaps in the literature have been underlined in the previous paragraphs, thus, examining multiple indicators of familial relationships and their associations with adolescents' overweight and obesity in population studies may represent a promising approach to better explaining the role of family in the development of adolescents' overweight and obesity (Moens et al., 2009).

Finally, it is important to recognize that family-based intervention programs that aim to reduce obesity and overweight are more effective in preventing and reducing these problems than individual-centered interventions (Gruber, & Hadelman, 2009). The involvement of the family may, in fact, result in positive change for both parents and adolescents, with greater and longer term results (Gruber, & Hadelman, 2009).

In conclusion, as explained in chapter 4, family characteristics cannot alone explain the increasing prevalence of obesity and overweight among adolescents, and to explain these phenomena only referring to individual and family variables would be an error (Neumark-Sztainer, 2005).

Other micro- and macro-contexts of life may influence the excess of weight problems and overweight-related behaviors and lifestyles in adolescence. In the next paragraphs we will mostly describe some of the other environmental settings that contribute to build the "obesogenic environment" in which adolescents live (Lobstein et al., 2004).

6.8 THE ROLE OF PEERS ON ADOLESCENT OVERWEIGHT

During adolescence, peers become more important and the need of friends' support and approval increases significantly (Ata et al., 2007). In addition, adolescents spend a lot of

time socializing, performing physical activity and eating with peers, all of which represent important forms of socialization (Story et al., 2002).

Moreover, as is the case for the family, peers and social network contexts may promote and support exercise and healthy eating behaviors. In interventions aimed at reducing excess weight, perceived support from peers is linked with higher adherence to dieting and exercise programs (Felton & Parsons, 1994; Wing & Jeffrey, 1999). Indeed, peer social support represents an important source of motivational strength in adolescence, which is able to promote and support diet and healthy eating behaviors (Backman, Haddad, Lee, Johnston, & Hodgkin, 2002; Contento et al., 2006; Huon, Lim, & Gunewardene, 2000; Gruber, 2008), physical activity (Coumeya, & McAuley, 1995; Motl, Dishman, Saunders, Dowda, & Pate, 2007), leisure time exercise participation (Okun, Ruehlman, Karoly, Lutz, Fairholme, & Schaub; 2003) and weight control behaviors (Neumark-Sztainer, Wall, Story, & Perry, 2003b).

Moreover, peer physical activity patterns may influence adolescents' physical activity patterns by promoting sport participation (Vilhjalmsson, & Thorlindsson, 1998; Wold, & Anderssen, 1992).

As far as dietary behaviors are concerned, friends may influence adolescents' food choice. In fact, in adolescence the importance of peer approval is well recognized as a determinant of adolescents' food selection (Story et al., 2002). Unfortunately, very few studies have examined the role of peers in adolescents' food choice and those few studies which are available found no strong association (Story et al., 2002).

Some studies have found that perceived friend fruit and vegetable intake is positively associated with adolescents' fruit and vegetable intake (Rasmussen et al., 2006; De Bourdeauj, & van Oost, 2000; Woodward et al., 1996). However, other studies have found that early adolescents were not encouraged to eat fruit and vegetables by peers and they did not expect that fruit and vegetable consumption would make them more physically attractive or popular (Vereecken et al., 2005c). The same study showed significant correlations between perceived peer behavior and fruit and vegetables consumption among early adolescents (Vereecken et al., 2005c), in contrast with the study of Cullen and colleagues (2001b) which found no association between fruit and vegetable consumption, peer modelling and peer perceived norms.

Moreover, Contento and colleagues (2006), through individual interview conducted with adolescents, found that to manage the conflict between the need to eat with peers and individuals' dietary behaviors, adolescents chose to eat with peers who have similar values concerning food.

Finally, as far as peer relationships are concerned, perceived peer social support is an important factor in promoting positive health behaviors and influencing weight-related behaviors and lifestyles (Gruber, 2008). Lower peer acceptance, perceived social support, and friendship intimacy have been found to predict poor body image among female adolescents (Ata et al., 2007; Gerner and Wilson, 2005). Stice and colleagues (2002) suggest that in adolescence, perceived social support from peers predicts negative and unhealthy dietary behaviors to a greater degree than perceived support from parents. However, friends' social support not always has a positive effect on adolescents' feelings about their bodies and related behaviors (Ata et al., 2007). For example, friends' body image concerns and eating behaviors predicted adolescents' body image concerns and behaviors (Paxton, Schutz, Wertheim, & Muir, 1999). The worst instance, in this regard, may happen when peers encourage extreme weight loss strategies (Paxton, 1996).

6.9 OTHER ENVIRONMENTAL CORRELATES RELATED TO OVERWEIGHT AND OBESITY IN ADOLESCENCE: AN OVERVIEW

As described in chapter 4, organizational, community and societal environments may also influence adolescents' overweight-related behaviors and lifestyles. A detailed description of macro-environmental correlates related to dietary behaviors, physical activity and food-related lifestyles remains outside of the aim of this thesis. However, we recognize the importance of reporting a brief overview of some environmental factors related with obesity and overweight in adolescence.

As far as dietary behaviors are concerned, the school environment is an important context in the development of children's and adolescents' dietary behaviors and food choice, especially for people consuming lunch at school (Story et al., 2002; Wolfe, & Campbell, 1993). However, apart from lunch, almost all schools have vending machines or snack bars

which mainly offer available snack food and soft drinks (Story et al., 2002) that negatively influence adolescents' dietary behaviors.

Moreover, more macro-level correlates, such as the SES of local areas, may also influence individual dietary behaviors. Studies found, for example, that large supermarkets with fresher foods and lower prices are more likely to be located in middle-class neighbourhoods (Morland, Wing, Roux, & Poole, 2002) than in poor neighbourhoods and the availability of food in local markets has been found to be related to resident dietary consumption patterns (Baranowsky et al., 2003; Cheadle et al., 1991; Edmonds, Baranowski, Baranowski, Cullen, & Myres, 2001). Thus, local food availability may influence people's dietary behaviors and overweight (Baranowsky et al., 2003).

Finally, even if we have already examined the role of media exposure in the previous chapter, in order to describe individual lifestyle behaviors linked with obesity, it is also important to consider media advertising and media as relevant societal influences on adolescent eating behaviors (Story et al., 2002).

As far as physical activity is concerned, several environmental variables may influence exercise patterns. The principal macro-environmental factors linked with performing physical activity are: home equipment, availability of recreational areas for outdoor activities, neighborhood safety and esthetics, convenience of facilities groups, amount of daily free time and school physical education programs (Baranowski et al., 2003; Davison, & Birch, 2001; Giles-Corti, & Donovan, 2002; Sallis et al., 1997). Indeed, as underlined by Davison and Birch (2001, p. 168) *"the ability for parents to use sport as a form of family recreation has declined. Access to walking and bicycling paths, parks, and general recreational facilities has decreased due to urban sprawl and greater distances of such facilities from the home"*.

Also organizational and social changes exert an influence on adolescents' exercise level. For example, low school budgets can lead to few opportunities to perform different kinds of physical activity with no, or low, costs for families. In fact, participation in physical education classes has been associated with higher levels of physical activity among adolescents (Gordon-Larsen, McMurray, & Popkin, 2000).

Finally, the relatively inexpensive and appealing nature of television, videos, and computer games as a form of entertainment, and the higher rates of crime in low SES neighborhoods, have increased the amount of time that adolescents spend in sedentary behaviors (see

Chapter 5). For example, in neighborhoods with high rates of crime, parents may view sedentary behaviors at home as protective and as a way of avoiding danger and not as an unhealthy lifestyle (Davison, & Birch, 2001).

In conclusion, it should be underlined that results from ecological studies are often complex. For example, complex results concerning weight-related environmental correlates can be found in different population sub-groups (e.g., gender, SES) (Baranowski et al., 2003; Romero et al., 2001; Sallis et al., 2001; Sallis et al., 2003). A detailed description of macro-environmental correlates and their reciprocal interactions is beyond the aims of the present work. However, it is important to recognize the role of macro-environmental variables in terms of research, in order to better understand the factors and the mechanisms involved in the onset and maintenance of excess of weight problems and, in terms of intervention, to better identify and evaluate effective strategies with regard to overweight prevention among adolescents. As affirmed by Baranowski and colleagues (2003, p. 38S) “*Behavior- and ecology-based problems require behavior- and ecology-based solutions*”.

CHAPTER 7

RESEARCH DESIGN AND GENERAL AIMS

7.1 Health Behavior in School-aged Children cross-national survey

The present thesis is based on the data from the Health Behavior in School-Aged Children (HBSC) survey of the Veneto Region of Italy.

HBSC is a cross-national survey carried out every four years in collaboration with the World Health Organization (WHO) Regional Office for Europe⁹ to provide and increase understanding of young people's health, well-being and their social context. The survey originated in 1982 when researchers from three countries (Norway, Finland and England) met to discuss research difficulties concerning the comparability of data across different countries. The first HBSC survey (1983/1984) involved five countries (Norway, Finland and England, Denmark and Austria). Already, in 1985/1986, the HBSC survey involved thirteen participant countries (Currie, Gabhainn, Godeau, & International HBSC Network Coordinating Committee, 2009)¹⁰. From this starting point, the HBSC study has gradually and constantly grown to involve more countries in each subsequent survey (see Figure 7.1). In the last survey (2005/2006) 41 countries were involved. At present, the study is still growing and in the survey 2009/2010 43 countries will be involved.

Italy was involved in the HBSC network for the first time for the 2001/2002 survey. However, a first pilot survey, a fundamental step for inclusion in the international research group, was carried out in 2000/2001. Thus, three Italian surveys are presently available: 2000/2001 (pilot survey); 2001/2002 and 2005/2006 (official surveys). Moreover, in parallel with the national survey, in Italy three regions participated in the HBSC survey: the Veneto region, the Piemonte region and the Toscana region.

⁹ The partnership with the WHO Regional Office for Europe and HBSC has been described in Currie et al., 2009, p. 134.

¹⁰ International research report on HBSC results can be found at www.euro.who.int.

The survey involves the administration of a self-report questionnaire. The questionnaire consists of a number of mandatory and optional questions (see Paragraph 7.4 for a full description).

In the 2005/2006¹¹ Veneto survey several optional questions on overweight- and obesity-related behaviors and lifestyles were added, chosen among HBSC optional questions packages. For this reason the present work only used data from the Veneto Region.

Figure 7.1. Growth of HBSC study: countries by survey year (Downloaded from www.hbsc.org).

1983/84	1985/86	1989/90	1993/94	1997/98	2001/02	2005/06
1. England	1. Finland	1. Finland	1. Finland	1. Finland	1. Finland	1. Finland
2. Finland	2. Norway	2. Norway	2. Norway	2. Norway	2. Norway	2. Norway
3. Norway	3. Austria	3. Austria	3. Austria	3. Austria	3. Austria	3. Austria
4. Austria	4. Denmark	4. Belgium (Fr)	4. Belgium (Fr)	4. Belgium (Fr)	4. Belgium (Fr)	4. Belgium (Fr)
5. Denmark	5. Belgium	5. Hungary	5. Hungary	5. Hungary	5. Hungary	5. Hungary
	6. Hungary	6. Scotland	6. Israel	6. Israel	6. Israel	6. Israel
	7. Israel	7. Spain	7. Scotland	7. Scotland	7. Scotland	7. Scotland
	8. Scotland	8. Sweden	8. Spain	8. Sweden	8. Spain	8. Spain
	9. Spain	9. Switzerland	9. Sweden	9. Switzerland	9. Sweden	9. Sweden
	10. Sweden	10. Wales	10. Switzerland	10. Wales	10. Switzerland	10. Switzerland
	11. Switzerland	11. Denmark	11. Wales	11. Denmark	11. Wales	11. Wales
	12. Wales	12. Netherlands	12. Denmark	12. Canada	12. Denmark	12. Denmark
	13. Netherlands	13. Canada	13. Canada	13. Latvia	13. Canada	13. Canada
		14. Latvia	14. Latvia	14. N. Ireland	14. Latvia	14. Latvia
		15. N. Ireland	15. N. Ireland	15. Poland	15. Poland	15. Poland
		16. Poland	16. Poland	16. Belgium (Fl)	16. Belgium (Fl)	16. Belgium (Fl)
			17. Belgium (Fl)	17. Czech Republic	17. Czech Republic	17. Czech Republic
			18. Czech Republic	18. Estonia	18. Estonia	18. Estonia
			19. Estonia	19. France	19. France	19. France
			20. France	20. Germany	20. Germany	20. Germany
			21. Germany	21. Greenland	21. Greenland	21. Greenland
			22. Greenland	22. Lithuania	22. Lithuania	22. Lithuania
			23. Lithuania	23. Russia	23. Russia	23. Russia
			24. Russia	24. Slovakia	24. England	24. England
			25. Slovakia	25. England	25. Greece	25. Greece
				26. Greece	26. Portugal	26. Portugal
				27. Portugal	27. Ireland	27. Ireland
				28. Ireland	28. USA	28. USA
				29. USA	29. tfyr Macedonia	29. tfyr Macedonia
					30. Netherlands	30. Netherlands
					31. Italy	31. Italy
					32. Croatia	32. Croatia
					33. Malta	33. Malta
					34. Slovenia	34. Slovenia
					35. Ukraine	35. Ukraine
						36. Luxembourg
						37. Turkey
						38. Slovakia
						39. Romania
						40. Iceland
						41. Bulgaria

¹¹ Data from Veneto Region (Italy) are funded by Veneto Region (D.G.R. no 812 of March, 21, 2006).

7.2 Conceptual framework and aims of the HBSC survey

In line with the World Health Organization (1998), the HBSC survey conceptualized health not merely as the absence of illness or disease, but also in terms of physical and psychological well-being. The basic idea in the HBSC study is that adolescents' health-related behaviors were "*part of young people's broader lifestyle and health was viewed in its social context. HBSC was not to be a standard epidemiological study nor one in which smoking was seen simply as a health damaging risk behaviour. Instead, health related behaviours, such as smoking, were conceptualised as forming a set of interconnected patterns within adolescent lifestyles*" (Currie et al., 2009, p. 132).

Subsequently, the understanding of micro- and macro-contexts in which young people live, society and adolescents' perception of social domains, and their psychosocial well-being were considered as relevant topics that are associated and inter-related with adolescents' health-related behaviors and lifestyles (Currie et al., 2009).

In other words, different sets of health-related behaviors and related psychosocial aspects (e.g., well-being) are the outcome variables of interest in the HBSC, while personal, micro- and macro-environmental and sociodemographic characteristics are considered as relevant aspects associated with these outcome variables (Currie et al., 2009). Indeed, family, peers and school are, for example, important settings that may influence and promote health behaviors, health-related lifestyles and psychosocial well-being.

The survey assumes a flexible and broad concept of "health". This broad and flexible approach has allowed the collaboration of several researchers across different disciplines (e.g., public health, medicine, psychology and so on). In fact, this interdisciplinary is one of the most important peculiarities and strengths of the HBSC network (Currie et al., 2009).

The overall aim of the HBSC study is to provide and to increase the understanding of young people's health, well-being and social context. From a pragmatic point of view, insight and findings from the HBSC study can be adopted to divulge information concerning adolescents' health behaviors and to influence health promotion and educational policies and practices at national and international levels.

Moreover, the study has several sub-aims (taken from the international HBSC study website: www.hbsc.org):

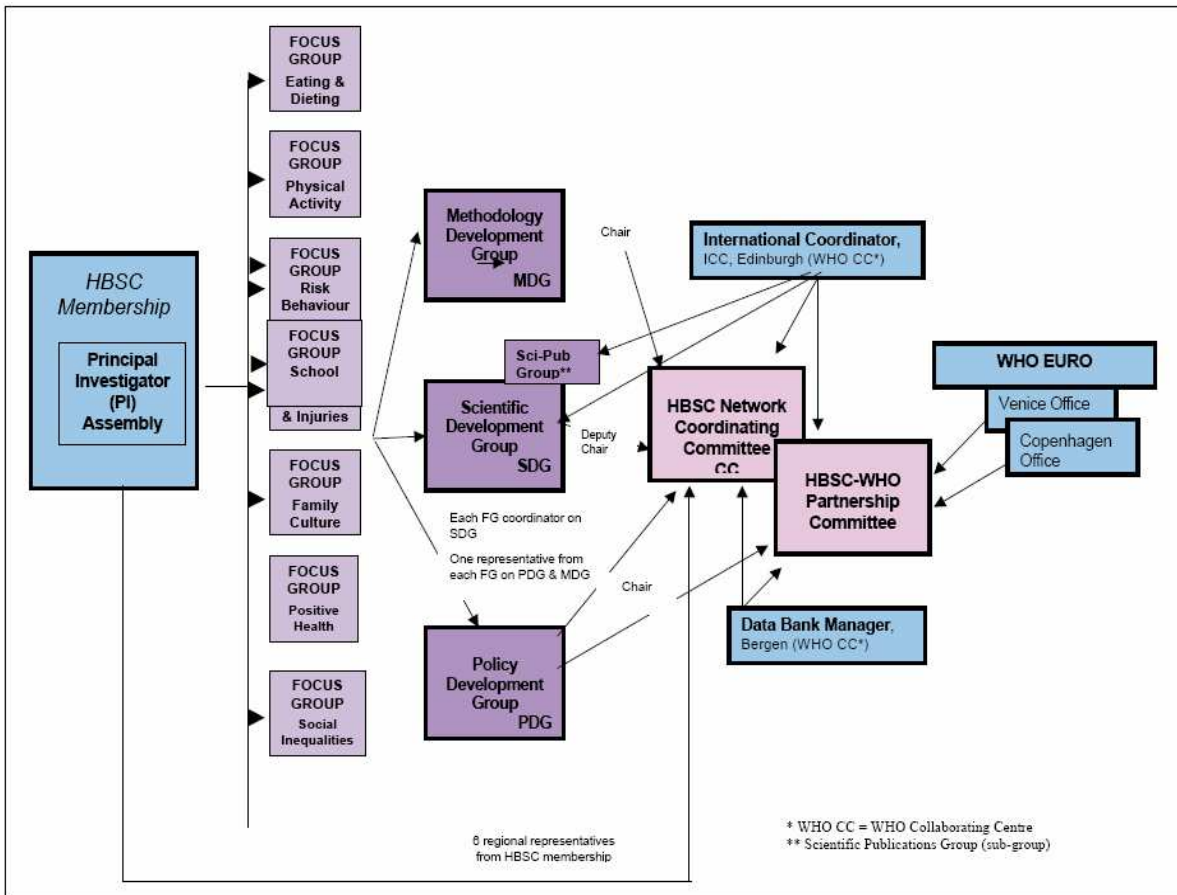
- to sustain national and international research on health behavior, health and well-being and their social contexts in school-aged children;
- to contribute to theoretical, conceptual, and methodological development in this research area;
- to monitor and to compare health perceptions, health behaviors and different social contexts of school-aged children over time and at national and international levels;
- to disseminate findings to relevant audiences including researchers, health and education policy makers, health promotion practitioners, teachers, parents and young people;
- to develop partnerships with relevant external agencies in relation to adolescent health to support the development of health promotion interventions and programs with school-aged children;
- to establish a multi-disciplinary international network of experts in this field to provide an international source of expertise on adolescent health for public health and health education.

HBSC considers health to be an important resource for every day living (WHO, 1998). Indeed, from the beginning, the survey has tried to fill a gap in the research on adolescents' well-being and health, recognizing that young people are an integral part of several life contexts and of a broad society framework which cannot be neglected in this study field.

7.3 INTERNATIONAL NETWORK ORGANIZATION

The feasibility of the HBSC survey, the maintenance of high quality standards and the continuous improvements of the study in terms of contents and methodological issues, are guaranteed by a complex international organization. A detailed description of HBSC organizational structure, function, and aims is beyond the aim of this work and can be found in recent paper (Currie et al., 2009).

Figure 7.2. HBSC Organizational structure. (Source: Currie et al., 2009).



To warrant relationships and scientific comparison and discussion among countries, the HBSC international group organizes two meetings every year for the network members. One meeting is a kind of conference in which different researchers present their scientific works and research questions, in contrast, the second meeting is dedicated to working groups that discuss and work on specific research topics (e.g., eating habits focus group, social inequalities focus group).

The international network organization is quite complex (Figure 7.2). The survey is supported by an International Coordinating Centre (Child and Adolescent Health Research Unit, University of Edinburgh); and by an International Databank (Centre for Health Promotion, University of Bergen). Each member country has a national team. A national Principal Investigator (PI), who is formally accepted by the study assembly, leads each national team. The national team is selected by the PI.

Moreover, an elected Coordinating Committee monitors the study's progress, supports internal organization and internal policy and so on (a comprehensive description of

network organization can be found in Currie et al., 2009). The Coordinating Committee involves people from different organisational sub-groups that work on three main topics: Scientific Development Group, Policy Development Group and Methodology Development Group. Moreover, each network member works with other international members on a topic-specific Focus Group (FG) that concentrates on specific issues or areas of scientific interest included in the HBSC core questionnaire (Currie et al., 2009). Finally, an elected International Databank Manager manages the process of producing the international data file.

7.4 PARTICIPANTS AND SAMPLING PROCEDURE

The target populations of the HBSC study are early adolescents and adolescents attending school, aged 11, 13 and 15 years old. In terms of the developmental perspective, these age groups represent periods in which maturational processes influence cognitive function, self-perception and psychological processes (Currie et al., 2009). In particular, as recently explained by Currie and colleagues (2009), the early years represent the onset of adolescence and the time in which people start important physical and emotional changes; while the middle years represent the stage in which young people start to consider important life and career decisions. These stages are also characterized by an increased degree of autonomy and choice concerning patterns of consumption and health behaviors. Moreover, social influence (e.g., from peers or family) and expectations also vary according to age.

The survey has to be carried out on a nationally representative sample of adolescents aged 11 13 15 years old in each participating country. The sample should be made up of approximately 1,500 participants from each age group so that there is a final sample involving at least a total of 4,500 participants from each participating country.

This criterion is established based on “*The calculation assuming a 95 % confidence interval of +/- 3 % around a proportion of 50 % and design factor of 1.2, based on analyses of existing HBSC data*” (Roberts et al., 2009; p. 143).

The participants are selected using a cluster sampling procedure (Thompson, 2002). The primary sampling unit is the school class (or school in the absence of a sampling frame of

classes) that is randomly selected, taking into account adolescents' gender and grade as suggested by international protocol (Roberts et al., 2009).

In addition, the sample of the Veneto Region (2005/2006) is also stratified for:

- School: the sampling procedure takes into account the educational level of schools (e.g., general, technical and vocational) and the size of the school.
- Geography: the sample was selected to be representative of the Veneto region's provinces in all surveys (geographical Italian unit). Moreover, since the 2001/2002 survey the sample has been stratified for ULSS (an administrative Italian unit linked with territorial health care services).

Thus, in each data survey for Italian Veneto Region a sample was obtained of middle (first grade, 11–12 years old and third grade, 13–14 years old) and high schools (second grade 15–16 years old). The schools are randomly selected (following the criteria just explained) from the school list provided by the Regional School Office's database. In each participating school, 2 classes (about 40 pupils) were randomly selected.

For clearness of exposure, response rate and sample characteristics will be described separately in each research chapter.

7.5 THE QUESTIONNAIRE

HBSC is a school-based survey in which the data are collected through self-report questionnaires administered in the classroom by teacher.

For each HBSC survey an international research protocol is produced that allows the questionnaire preparation and administration (e.g., see for example Currie, Samdal, Boyce, & Smith, 2001). The international research protocol includes detailed information for the participant countries on rationale, concepts, methods, questionnaire and survey administration. Each survey protocol includes an overall rationale and a rationale for each specialist area based on the purpose and conceptual framework of the study. Protocols, a fundamental instrument to ensure the comparability of data across countries, are available on request on the international HBSC website¹². Each new survey's protocol is based on the previous one. In fact, the HBSC questionnaire is constituted by some mandatory parts, which have remained the same in each survey so as to allow monitoring activities,

¹² www.hbsc.org

comparability of data across survey and time trends. However, each new protocol includes new areas of development. These are new instruments (item or scale) which are part of the optional sections that each country can choose to include in their questionnaire (Currie et al., 2009). The protocol also includes the instructions for the questionnaire administration (layout, question ordering, translation guidelines and do on), data collection procedures and instructions concerning how to build the national data file (Roberts et al., 2009). Further and more detailed methodological issues related to the HBSC survey are discussed in recent papers by Roberts and colleagues (Roberts et al., 2007b; Roberts et al., 2009).

The international standard questionnaire for each survey is consisted by three different levels of questions (Roberts et al., 2009):

1. core questions that have to be included in the questionnaire by all the participating countries;
2. optional packages of questions on specific research topics that each country can choose to include;
3. country-specific questions related to specific issues of the country's interest.

The survey questions regard several sets of health indicators, health behaviors and adolescents' context of life. The core questionnaire provides information about different health-related topics (Roberts et al., 2009):

1. demographic factors (e. g., gender, age, and state of maturation);
2. social background (e. g., family structure and socio-economic status);
3. social context (e. g., family, peer, school environment);
4. health outcomes (e. g., self-rated health, injuries, overweight and obesity);
5. health behaviors (e. g., eating and dieting, physical activity and weight reduction behavior);
6. risk behaviors (e. g., smoking, alcohol use, cannabis use, sexual behavior, bullying).

In the 2005/2006 Veneto region survey several optional questions on overweight- and obesity-related behaviors and lifestyles were added that were not included in the mandatory questionnaire (e.g., measured height and weight; food-related lifestyles). For this reason in the present thesis only data from the Veneto Region are used.

For the sake of clarity, the instruments adopted in each research study of this work will be described separately. In fact, due to a certain degree of overlap between instruments of

each research study, we chosen to explain the measures used in each research study's chapter. Overall, this work includes measures assessing the following topics:

- socio-demographic characteristics;
- body mass index,
- body image and body dissatisfaction;
- eating behaviors and physical activity;
- adolescent and family food-related lifestyles;
- food-related parenting practice;
- perceived family social support and communication with parents.

Before its official administration, the questionnaire was piloted on a small adolescent sample to check the time required for completion of the questionnaire, possible adolescents' comprehension difficulties, clearness of instructions and so on.

7.6 PROCEDURE

As previously explained, HBSC is a school-based survey. Selected schools were invited to participate in the survey via fax and email (where available). Afterward a few days all the schools were contacted by phone to better explain the research and to answer possible questions.

The data were collected through self-report questionnaires administered in the classroom by a teacher. For all the school agreed to participate, teachers were trained with provincial formative meetings held by researchers on how to administer the questionnaire (procedure, instructions, ethic issues and so on).

Before the questionnaire administration three kinds of consent were requested:

- A written consensus of agreement to participate from the schools;
- A written consensus of agreement to participate from parents;
- A verbal consensus of agreement to participate from adolescents.

Parents were sent a letter including a short explanation of the study and a written request for consent. Students without parental written consensus were excluded from the survey administration and did not complete the questionnaire. Student participation was voluntary and the students were assured of the confidentiality of their answers with written and verbal instructions. The questionnaire was completed during the school hours and it took about one class hour (40-60 minutes). The Italian Veneto Region HBSC survey was

approved by the ethics board of the University of Padua. After the survey, all the schools participating received a written research report describing the main findings (divided regional, provincial and ULSS) achieved by the study¹³.

7.7 GENERAL AIMS

This thesis is subdivided into three studies which focus on overweight and obesity among adolescents from the Veneto Region. The general aims of these studies are:

1. to determine the validity of self-reported height and weight with regard to adolescents' gender and age and to adjust self-reported anthropometric values on the strength of measured values (*Chapter 8*);
2. to assess the prevalence of obesity and overweight in the Veneto Region from 2000 to 2006 (*Chapter 8*);
3. to study the association between BMI status (normal weight, overweight and obesity) and dietary patterns, physical activity and food-related lifestyles (*Chapter 9*);
4. to examine the association between BMI, body image and body dissatisfaction and family food-related lifestyles, food-related parenting practice and relationships with parents (communication with parents and perceived family social support) (*Chapter 10*).

The next chapters will describe these studies. All the chapters will have the same structure: a brief introduction to underline the reasons behind the study, aims and hypothesis; a method section describing participants, measures and statistical analyses; a description and discussion of the study's findings; and finally, a section on the limitations and conclusions of the study.

¹³ Research reports on HBSC Veneto region are available at <http://www.crrps.org>.

CHAPTER 8

THE PREVALENCE OF OBESITY AND OVERWEIGHT FROM 2000 TO 2006 AMONG ADOLESCENTS FROM THE VENETO REGION: HOW TO IMPROVE THE VALIDITY OF SELF-REPORTED HEIGHT AND WEIGHT?

8.1. INTRODUCTION

The prevalence of obesity has tripled among adolescents over the past two decades (see Chapter 2), underlying the need for effective obesity prevention strategies (Hedley et al., 2004; Johannsson et al., 2006; Kohn & Booth, 2003, Lobstein et al., 2004; Ogden et al., 2006; Peneau et al., 2009; Wang, & Lobstein, 2006). Increasing rates of adolescents' obesity has become a major public and psychosocial health concern. Young people's obesity, indeed, is linked with several short and long term health and psychosocial problems (Braet, 2005; Burniat, Cole, Lissau, & Poskitt, 2002; Engeland et al., 2003; Gortmaker et al., 1993; Hughes et al., 2007; Kolotkin et al., 2001; Lobstein et al., 2004). For example, adolescent obesity is associated with social difficulties and problems concerning self-esteem and body image, and higher risks for adult chronic diseases such as cardiovascular disease, type 2 diabetes and premature death (see Chapter 3 for a detailed description).

Therefore, the identification and the accurate monitoring of overweight and obesity in adolescence constitutes one of the major issues in this research topic and are essential to the implementation of health policies and effective strategies to prevent obesity and overweight.

The measure most commonly used to identify overweight and obese subjects in population studies is the body mass index (BMI), defined as body weight divided by height squared (kg/m^2) (see Chapter 1 for a detailed description). BMI is not a perfect measure of adiposity in adolescence, however, it is a valid measure of relative adiposity

(Pietrobelli et al., 1998) and it is recognised as being appropriate for the indirect assessment of adiposity in childhood and adolescence (Frontini et al., 2001; Lobstein et al., 2004; Rosner et al., 1998). For this reason, BMI is the main measure, in terms of validity and diffusion, employed to assess overweight and obesity in childhood and adolescence.

Moreover, for practical and economical reasons, self-reported weight and height are frequently adopted in place of objective anthropometric value measurements (Tsigilis, 2006). Self-report measures are more feasible, especially for population studies, are undemanding for participants and have fewer costs compared with measured anthropometric values (McAdams, Van Dam, & Hu, 2007).

Several studies have examined the accuracy of self-reported anthropometric values in adolescence, underlining some bias linked with their use. Overall, most studies confirm that adolescents tend to underestimate their weight and to overestimate their height (Abraham et al., 2004; Brener et al., 2003; Himes, & Faricy, 2001; Lee et al., 2006; Tsigilis, 2006).

This bias in self-reported anthropometric values has an important implication on this research topic: an underestimation of weight and an overestimation of height will be linked with an underestimation of BMI and subsequently with a lower prevalence of obesity and overweight. For this reason the prevalence of obesity and overweight reported in studies using self-report anthropometric values is lower than the real prevalence. Moreover, this bias causes important consequences for the comprehension of these phenomena and for the identification of effective prevention strategies and intervention actions (e.g., difficulties in the identification of sub-group populations with higher BMI or geographical areas with a higher prevalence of obesity and overweight) (Boström, & Diderichsen, 1997; Jeffery, 1996; Nyholm et al., 2007).

In addition, studies testing the accuracy of self-reported anthropometric values in relation to socio-demographic characteristics in children and adolescents have found ambiguous results. Some studies (Morrisey et al., 2006; Tokmakidis et al., 2007) concluded that gender did not influence bias in self-report measures, but other studies reported gender difference findings that girls tend to underreport their weight to a greater degree than boys due to the social emphasis on thinness for females in our society (Brener et al., 2003; Davis, & Gergen, 1994; Giacchi et al., 1998; Nieto-Garcia, Bush, & Keyl, 1990; Rosner et

al., 1998; Tsigilis, 2006). Furthermore, studies showed that young adolescents are more accurate in reporting their height and weight (Brenner et al., 2003; Himes, Hannan, Wall, & Neumark-Sztainer, 2005; Tokmakidis et al., 2007).

Overall, the comparison of several studies suggest that bias in self-reported height and weight are influenced by demographic, cultural and social factors of a specific population at a particular time because there is a different social acceptance of excess of weight problems across different countries (Nyholm et al., 2007; Paeratakul, White, Williamson, Ryan, & Bray, 2002).

These different findings across countries and population sub-groups (e.g., gender) are one of the main reasons why there is no agreement concerning the validity of self-report measures applied in different cultural contexts, the population's sub-groups most at risk of bias in self-reported height and weight and the potential predictors of this bias.

Given that many studies use self-reported height and weight for their ease of use and lower economic costs, and in the light of the differences between measured and self-reported BMI values found in many studies, it would be appropriate to identify new methodological strategies to improve the validity of self-reported anthropometric values in adolescent populations in order to determine more carefully the prevalence of obesity and overweight. Moreover, as far we know the validity of self-reported BMI and the prevalence of obesity and overweight across different years have not been reported recently in Italian adolescent populations even if large between-country differences in terms of prevalence of excess of weight problems have been found (Janssen et al., 2005; Lobstein & Frelut, 2003).

Thus, the purposes of this study are (1) to assess the validity of self-reported BMI through a comparison between self-reported height and weight and measured height and weight; (2) to study the differences between self-reported and measured BMI with respect to gender and age; (3) to develop a calibration equation to adjust self-reported anthropometric values on the strength of measured values to assess the prevalence of obesity and overweight using self-reported information more accurately; (4) to determine the prevalence of overweight and obesity among adolescents from the Veneto region from 2000 to 2006.

We hypothesized that there would be significant differences between self-reported and measured height and weight with the expectation that adolescents tend to underreport their weight and overreport their height. Moreover, we hypothesized that there would be greater differences between self-reported and measured anthropometric values in girls as

compared with boys and in older adolescents as compared with younger adolescents. Finally, we expected that there has been an increase in the prevalence of obesity and overweight from 2000 to 2006 in the Veneto region.

8.2 METHODS

8.2.1 PARTICIPANTS

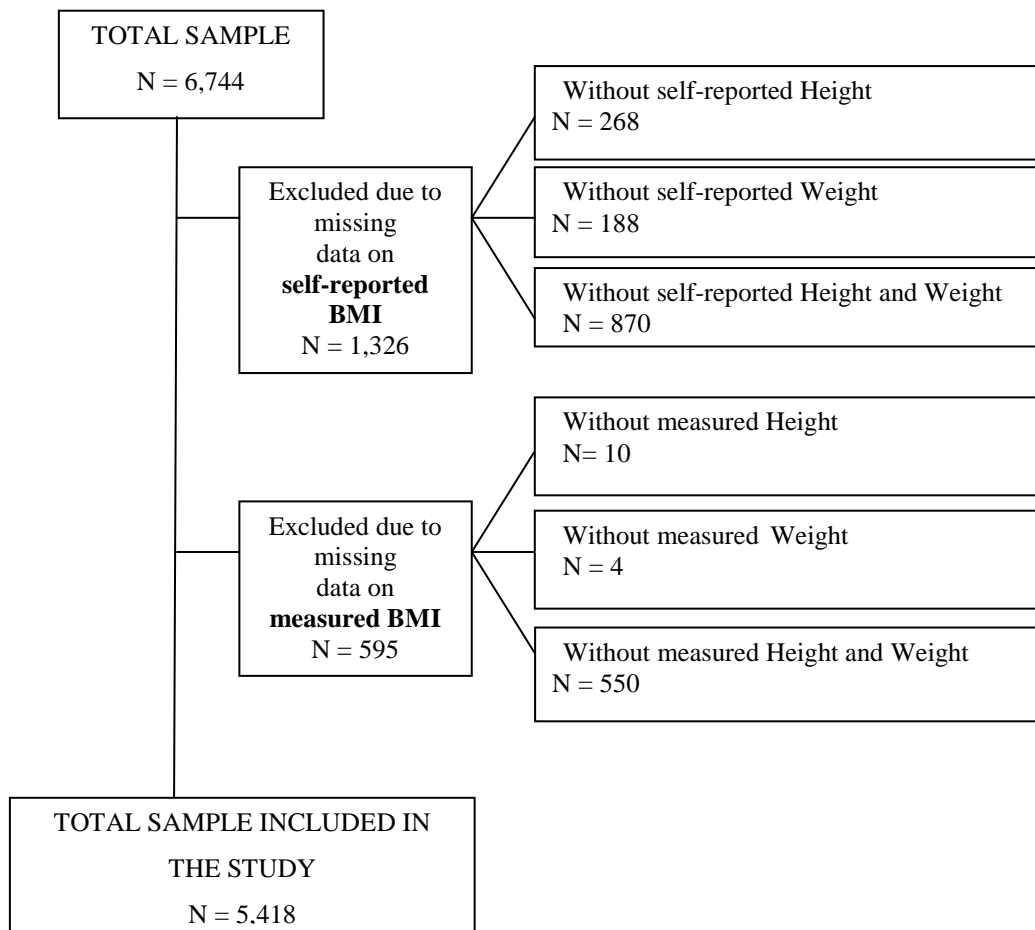
The present data are part of the Veneto Region HBSC survey. The present work may be subdivided into two steps. In the first step we analyze the validity of self-reported height and weight using data from the 2005-2006 (HBSC) survey which includes both self-reported and measured anthropometric values. In the second step we determine the prevalence of overweight and obesity among adolescents from the Veneto region from 2000 to 2006, thus, three surveys are used in this step (2000-2001; 2001-2002; 2005-2006)¹⁴. The sample was selected using a cluster sampling procedure (see Paragraph 7.4 for a description of sampling procedure).

1. **Sample characteristics of step one.** Of the 244 schools selected for study participation, 240 schools (98% response) agreed to participate. In each participating school, 2 classes (about 40 pupils) were randomly selected. Of all pupils approached, 3% did not get consent from their parents and 6.6% of the pupils were absent on the day of testing. Data were collected in May 2006 through a self-report questionnaire, followed by the measurement of objective anthropometrics values (assessed only in the Veneto region 2005/2006 survey). The questionnaire was completed by a total of 6,744 students. However, in order to reach our aim, we include in this study only adolescents without missing data on both self-reported height and weight and measured height and weight (see Figure 8.1). From the original sample 19.6% (N=1,326) subjects were excluded from missing data on self-reported BMI and 8.8% (N=595) participants were excluded

¹⁴ Data are from the regional administration of the World Health Organization “Health Behaviour in School-Aged Children” survey in Veneto, Italy. Surveys 2000-2001, 2001-2002 were funded by Regione Veneto (D.G.R. n° 203 of April, 4, 2000). Survey 2005-2006 was funded by Regione Veneto (D.G.R. n° 812 of March, 21, 2006). The International coordinator for all three surveys was Candace Currie, Edinburgh University; Data Bank Manager: Bente Wold, Bergen University; National coordinator (PI): Franco Cavallo, University of Turin.

because of missing data on measured BMI. Given the high number of missing data on self-reported and objective BMI values it is possible that the youth included in the analysis differ systematically from the original sample participants. For this reason, we used Chi-squared to compare the original study participants with students who were included in this study. We did not find any differences in terms of gender ($\chi^2_{(1)} = 1.34$, n.s.), but we found grade differences ($\chi^2_{(2)} = 1.64$, $p < .001$). Younger adolescents show higher percentage of missing data than older adolescents (40.4% of the excluded sample were aged $\pm 11-12$ years old; 36,6% were aged $\pm 13-14$ years old and 23.1% were aged $\pm 15-16$ years old) especially on self-reported height and weight. It is possible that young people have low levels of knowledge about their anthropometric values than older adolescents resulting in a higher rate of missing data.

Figure 8.1. Participants included in step one of the study.



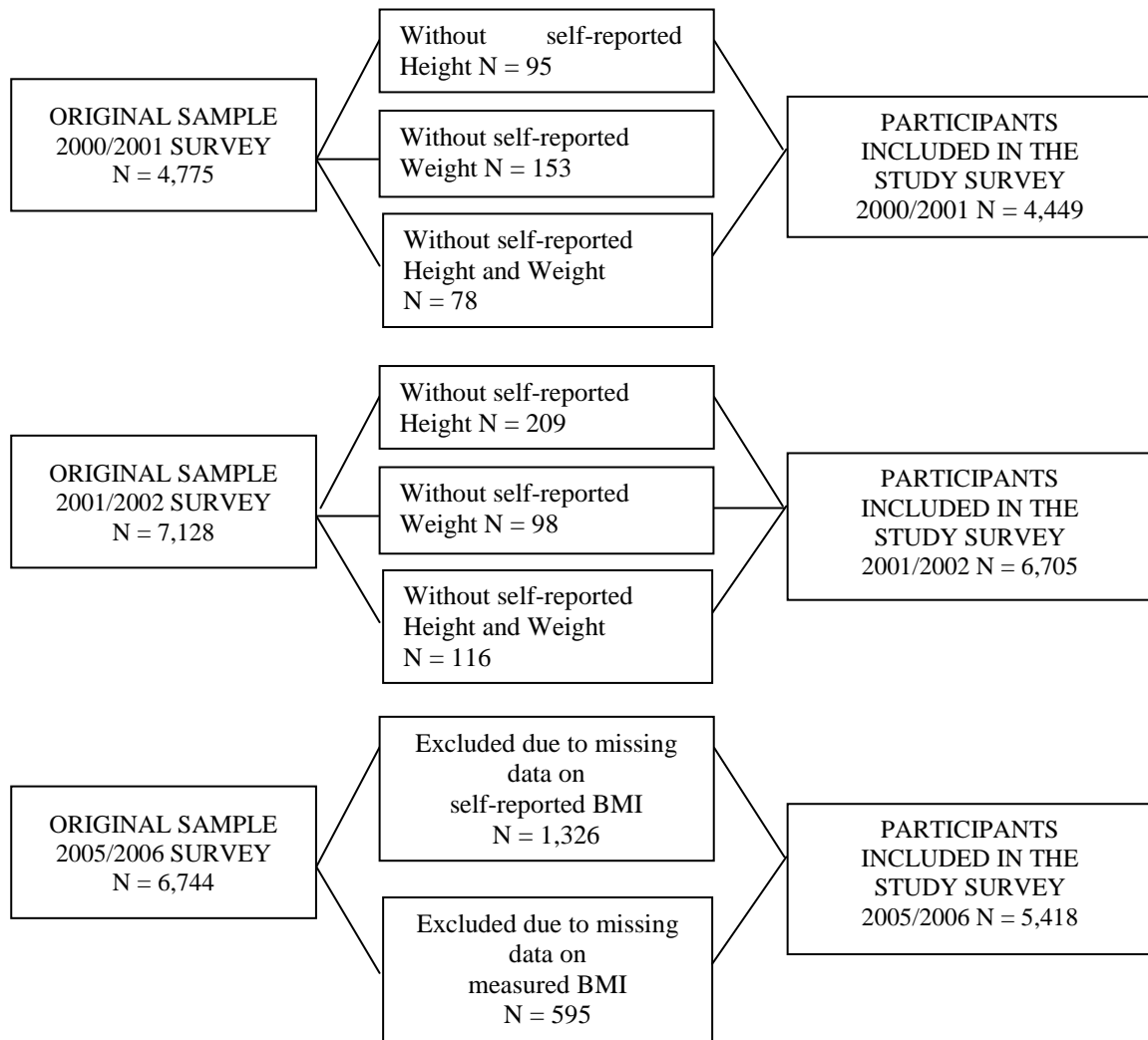
The final sample included in step one of the study was constituted by 5,418 adolescents: 2,711 (50%) were males, 1,561 (28.8%) were attending the first grade of middle school ($M=11.91$, $SD=0.39$), 1,583 (29.2%) were attending the third grade of middle school ($M=13.98$, $SD=0.46$) and 2,274 (42%) were attending the second grade of high school ($M=15.98$, $SD=0.59$).

2. **Sample characteristics of step two.** Three HBSC surveys were included in step 2. Survey 2000-2001, 2001-2002 and 2005-2006 (see Figure 8.2). Sample characteristics of the 2005-2006 study have just been described (Figure 8.1). For the 2000-2001 survey of the 169 schools selected for participation, 162 schools (95.9% response) agreed to participate. Among schools participating, 82 were middle schools while 80 were high schools. In each participating school, 2 classes (about 40 pupils) were randomly selected. The questionnaire was completed by a total of 4,775 students. However, in order to reach our aim, we include only adolescents in this study without missing data on self-reported height and weight. Thus, from the original sample, 6.8% ($N=326$) of subjects were excluded because of missing data on self-reported BMI.

For the 2001-2002 HBSC survey of the 218 schools selected for participation, 205 schools (98.6% response) agreed to participate. Among schools participating, 96 were middle schools while 109 were high schools. In each participating school, 2 classes (about 40 pupils) were randomly selected. The questionnaire was completed by a total of 7,128 students. However, from the original sample, 5.9% ($N=423$) of subjects were excluded because of missing data on self-reported BMI.

The final sample of step two of the study was constituted by 16,572 participants. The sample included 4,449 participants of the 2000-2001 survey: 2,206 (49.6%) were males, 1,503 (33.8%) were attending the first grade of middle school ($M=12.00$, $SD=0.43$), 1,438 (32.3%) were attending the third grade of middle school ($M=14.07$, $SD=0.48$) and 1,508 (33.9%) were attending the second grade of high school ($M=15.60$, $SD=0.74$).

Figure 8.2. Participants included in the step two of the study.



Moreover, the sample includes 6,705 adolescents of the 2001-2002 survey: 3463 (51.6%) were males, 2,031 (30.3%) were attending the first grade of middle school ($M=11.68$, $SD=0.39$), 2,129 (31.8%) were attending the third grade of middle school ($M=13.74$, $SD=0.43$) and 2,545 (38.0%) were attending the second grade of high school ($M=15.88$, $SD=0.66$)

Finally, 5,418 adolescents were included from the 2005/5006 survey: 2,711 (50%) were males, 1,561 (28.8%) were attending the first grade of middle school ($M=11.91$, $SD=0.39$), 1,583 (29.2%) were attending the third grade of middle school ($M=13.98$, $SD=0.46$) and 2,274 (42%) were attending the second grade of high school ($M=15.98$, $SD=0.59$).

8.2.2 MEASURES AND PROCEDURE

Two measures of Body Mass Index (BMI) were used in this study:

- First, self-reported BMI was assessed by asking “*How much do you weigh without clothes?*” and “*How tall are you without shoes?*” Afterwards, these values were adopted to calculate self-reported BMI (Kg/m^2).
- Second, BMI was measured. The data collector of anthropometric values (Operators of the Food Hygiene and Nutrition Service)¹⁵ were trained to use a standard protocol to measure students’ height and weight. After completing the questionnaire, students were asked to go into the school nurse’s room individually. Before being measured, students were asked to remove their shoes, belt, outer clothing (such as jackets), any removable air accessories and personal items from their pockets. Each student was weighed more than once: the final reported weight was the one that didn’t change for three consecutive measurements. Each SIAN operator went into each school with their own calibrated balance and meter. Errors in measured BMI were minimized by rigorous adherence to the standard procedure and calibration of the weighing scale and meter. Moreover, in order to minimize weight differences through the course of day (Brenner et al., 2003) all students were weighed during the morning, before lunch. Afterwards, using objectively measured weight and height values, BMI (Kg/m^2) was calculated.

For both self-reported and objective BMI, overweight and obesity were identified using age and gender specific international cut-off points (Cole et al., 2000, see Chapter 1 for a detailed description) based on the average centile estimates that pass through BMI values of 25 and 30 $\text{kg}\cdot\text{m}^2$ respectively, at the age of 18 years.

8.2.3 STATISTICAL ANALYSIS

Statistical analyses were completed in a two step procedure which will be separately described.

¹⁵ Measured weight and height were obtained in collaboration with the Operators the Food Hygiene and Nutrition Service (SIAN) from Veneto Region

Step one. SPSS version 14.0 for Windows and R 2.4.1 was used for data management and statistical analyses. Descriptive analysis and partial correlation were performed. A Student paired *t*-test was used to determine differences between continuous variables: self-report and objective values of height, weight and BMI.

Moreover, an analysis of variance (ANOVA), with delta BMI (self-reported BMI - measured BMI) as a dependent variable was carried out to examine whether the bias and errors in self-reported BMI were influenced by gender and age category. Post-hoc testing with Bonferroni's correction was used to determine differences between age category groups.

Finally, linear regression analysis with Akaike Information Criterion (AIC) and BMI measured as a dependent variable was used to estimate a calibration equation, to improve the accuracy of self-reported values starting from self-reported BMI. All presented *p* values are two-tailed.

Step two. Data on adjusted height and weight (achieved from the calibration equation identified in step one) were adopted to assess the prevalence (%) of obesity and overweight in the three HBSC Veneto Region surveys (2000-2001; 2001-2002; 2005-2006). Adjusted BMI status was calculated using adjusted anthropometric values recoded with international standard cut-off values (Cole et al., 2000).

In order to assess whether the prevalence rates of overweight and obesity increased from 2000 to 2006, a log-linear model was performed using BMDP software (1992). This software has many applications (e.g., analysis of repeated measures with imbalanced data) and it is also appropriate to describe the association between categorical variables (Christensen, 1990; Cristante, Robusto, Mannarini, 2002; Jennrich and Schlucher, 1986; Kreft, de Leeuw, & van der Leeden, 1994; Mannarini 1999; Robusto, & Cristante, 2001). We analysed a four-way log-linear model (BMI X Gender X Age Category X Year of the survey collection). We tested a saturated model in which all factors are treated as predictors and including all possible main effects and interactions between them. We start with the description of two-way interactions and after three- and four-way interactions. Likelihood ratio tests (Y^2), linked with χ^2 distribution, were used to determine *p* values (Cristante, Robusto, Mannarini, 2002; Robusto, & Cristante, 2001).

8.3 RESULTS

The main aim of the first step of this study was to assess the validity of self-reported height and weight by adolescents through a comparison between self-reported anthropometric values and measured height and weight in the 2005-2006 HBSC survey of the Veneto region.

Partial correlations controlling for gender and age were conducted between self-reported and measured anthropometric values: $r = .88$ for height, $r = .94$ for weight and $r = .85$ for BMI, $p < 0.01$. These high correlations are consistent with previous studies (Brener et al., 2003; Himes, & Faricy, 2001; Tokmakidis et al., 2007).

However, paired t-tests showed significant differences, in our sample, between self-reported and objective height and weight measures, even if the magnitude of the effect size (d) is medium-small (Cohen, 1988). We found significant differences between self-reported and measured values for height ($t_{(5417)}=12.67$; $d=0.18$), weight ($t_{(5417)}=-19.08$; $d=0.27$) and BMI ($t_{(5417)}=-22.68$; $d=0.32$), $p < 0.001$.

Table 8.1. Mean (Standard Deviation) for measured BMI, self-reported BMI and delta BMI separated for gender and age.

	Measured BMI	Self-reported BMI	Delta BMI	F (Delta BMI)
<i>Gender</i>				
Female	20.85 (3.54)	20.26 (3.39)	-0.59 (1.77)	19.65*
Male	21.16 (3.82)	20.77 (3.69)	-0.39 (1.75)	
<i>Age</i>				
11-12 years	19.75 (3.56)	19.30 (3.65)	-0.45 (2.16)	3.52**
a			a,c	
13-14 years	20.89 (3.38)	20.36 (3.38)	-0.53 (1.62)	
b				
15-16 years	22.14 (3.70)	21.47 (3.33)	-0.67 (1.52)	
c			c,a	

a,b,c indicate differences between groups (Post-hoc test with Bonferroni's correction).

* $p < 0.001$, ** $p < 0.05$

Analysis of variance (ANOVA), with Delta BMI (self-reported BMI - measured BMI) as a dependent variable, was conducted to examine whether differences in Delta BMI scores varied by gender and age categories. Descriptive characteristics (mean and standard deviation) and significant differences were reported in Table 8.1.

We found significant sub-group differences on Delta BMI for gender and age category. The results showed that gender influences the bias in self-reported BMI ($F_{(1, 5417)}=19.65$; $p<0.001$): girls under-report their BMI to a greater degree than boys. In addition, age category was positively associated with Delta BMI ($F_{(2, 5417)}=3.52$, $p<0.05$): the bias in self-reported BMI increased with age. In particular, we found a significant difference on Delta BMI between young adolescents (11 years old) and older adolescents (15 years old): older participants showed higher bias in self-reported BMI as compared with younger participants.

Because of these differences between self-reported and objective BMI, the prevalence of overweight and obese students was higher using measured BMI than using self-report BMI. Specifically, 15.61% of students were classified as overweight based on self-reported values, compared with 19.44% of students based on measured values. Similarly, 3.27% of students were considered obese using self-reported BMI and 4.77% based on measured BMI. Thus, the use of self-reported anthropometric values was associated in our sample with an underestimation of the prevalence of obesity and overweight. Indeed, the percentage of participants that were not correctly identified as overweight or obese using self-reported anthropometric values was 5.33%.

Taking into account this difference and the frequent use of self-reported BMI values in many studies, linear regression analysis was used to find a calibration equation to improve the accuracy of self-reported height and weight using measured BMI as a dependent variable (see Table 8.2).

Table 8.2. Results of linear regression model with BMI measured as a dependent variable: B, SE, t values and η^2 were reported.

	B	SE	t	η^2
Intercept	6.04	1.45	4.16**	
Gender (Female)	2.62	0.90	2.90*	0.01
13-14 years old	5.70	1.15	4.96**	0.03
15-16 years old	5.46	1.44	3.78**	0.03
Self-reported weight	0.72	0.03	21.68**	0.50
Self-reported height	-1.66	0.90	-1.84	0.03
Female * 13-14 years old	0.55	0.13	4.33**	0.02
Female * 15-16 years old	0.75	0.15	4.85**	0.02
Female * Self-reported weight	0.02	0.01	4.38**	0.02
Female * Self-reported height	-2.50	0.66	-3.76**	0.01
13-14 years old * Self-reported height	-4.15	0.72	-5.80**	0.04
15-16 years old * Self-reported height	-4.14	0.87	-4.76**	0.04
Self-reported weight * Self-reported height	-0.23	0.019	-11.86**	0.14

* $p < 0.01$, ** $p < 0.001$.

$R^2 = 79\%$, AIC = 3392.33

As shown in the regression model, gender, age category and self-reported weight were significantly associated with measured BMI. Moreover, self-reported weight was the strongest variable associated with our outcome variable ($\eta^2 = 0.50$), while self-reported height was not significant in the model.

The calibration equation to adjust self-reported values on the strength of measured values was calculated by multiplying each independent variable for the respective B coefficient plus the intercept value. The portion of variance explained by model was high ($R^2 = 79\%$). The calibration equation for BMI is reported below for the total sample:

6.04 + 2.62 (Female) + 5.70 (13-14 years) + 5.46 (15-16 years) + 0.72 (Self-reported weight) + [-1.66 (Self-reported height)] + 0.55 (Female aged 13-14 years) + 0.75 (Female aged 15-16 years) + 0.02 (Self-reported weight for female) + [-2.50 (Self-reported height for female)] + [-4.15 (Self-reported height for 13-14 years)] + [-4.14 (Self-reported height for 15-16 years)] + [-0.23 (Self-reported weight x Self-reported height)].

The adjustment of self-reported BMI allows the more accurate assessment of the prevalence of subjects with excess of weight problems (overweight and obesity) than the use of the raw self-reported anthropometric values reported by adolescents (Table 8.3).

Table 8.3. Percentage of normal weight, overweight and obese participants for self-reported, measured and adjusted BMI values recoded.

	Self-Reported BMI (%)	Measured BMI (%)	Adjusted BMI (%)
Normal weight	81.12	75.79	76.69
Overweight	15.61	19.44	19.12
Obesity	3.27	4.77	4.19

The percentage of normal weight adolescents was 81.12% using self-reported BMI, this percentage is lower using measured BMI (75.79%) and adjusted BMI (76.69%). In reverse, the use of adjusted BMI, in line with measured BMI, showed a higher prevalence of overweight and obese adolescents than the use of self-reported BMI. The percentage of overweight adolescents was only 15.61% using self-reported BMI, compared with 19.44% using measured BMI and 19.12% using adjusted BMI. The prevalence of obesity was 3.27% using self-reported BMI while it was 4.77% using measured BMI and 4.19% using adjusted BMI.

Finally, the underestimation of the prevalence of overweight and obesity, was 5.33% using self-reported BMI and 0.90% using adjusted BMI compared with measured BMI, underlying that the calibration equation improved the accuracy of self-reported BMI and subsequently the accuracy of the prevalence rate of overweight and obesity in our sample.

The main aim of the second step of this study was to assess if the prevalence of overweight and obesity increased in the Veneto region from 2000 to 2006. Taking into account the differences between self-reported and measured values already described, adjusted BMI values (achieved with step one of the calibration equation) were adopted to assess the prevalence of excess of weight problem in three HBSC surveys from the Veneto region. The results of the four-way log-linear model (BMI X Gender X Age Category X Year of the survey collection) were reported in Table 8.4.

In order to perform the model we had to test a saturated model in which all variables were treated as predictors and all possible main effects and interactions among variables were included. However, in line with the aim of this work, we are interested in the analysis of only the interactions that include the variable “Year of the survey collection”.¹⁶

Table 8.4. Results of multivariate log-linear model: Likelihood ratio tests (Y^2) and p values.

	Y^2	D.F.	p
BMI	15376.46	2	<.0001
Gender	4.03	1	<0.05
Age Category	147.01	2	<.0001
Year of survey	417.90	2	<.0001
BMI x Gender	157.87	2	<.0001
BMI x Age category	21.55	4	<.001
BMI x Year of survey	69.70	4	<.0001
BMI x Gender x Age category	4.71	4	n.s.
BMI x Gender x Year of survey	1.62	4	n.s.
BMI x Age category x Year of survey	7.11	8	n.s.
BMI x Gender x Age category x Year of survey	14.78	8	n.s.

Our findings showed a significant interaction between BMI and Year of the survey collection underlining that in the three HBSC surveys some changes in the prevalence of obesity and overweight have occurred. Moreover, we explored whether these changes are also associated with participants’ gender or age. No three- or four-way interactions were significant. Thus, the changes in the rates of obesity and overweight in the three HBSC surveys were common across gender and age sub-groups.

The percentage and standardized interaction parameters of the interaction between BMI and Year of the survey collection are reported in Table 8.5.

¹⁶ To obtain the model, in line with our aims, we had to insert all the interactions between variables. However, our data do not have a longitudinal design, thus, it is appropriate to read only the interactions including the effect of “years of the survey”. Nonetheless, we chose to report the full model for the sake of accuracy.

Table 8.5. Percentage and standardized interaction parameters of the saturated log-linear model regarding the observed frequencies of the interaction between BMI and Year of the survey collection.

	Normal weight		Overweight		Obesity	
	%	Observed z-score	%	Observed z-score	%	Observed z-score
2000-2001 (N=4,449)	81.9	3.07*	16.3	-0.46	1.9	-1.38
2001-2002 (N=6,705)	81.6	2.80*	16.2	-0.45	2.2	-1.24
2005-2006 (N=5,418)	76.2	-6.39*	20.1	0.99	3.6	2.88*

Critical z-value (bidirectional)= ± 2.49 (d.f. = 4, $\alpha=.05$)

*Observed z-score > Critical z-value.

Overall, our findings showed an increasing prevalence of obesity and a decreasing rate of normal weight participants from 2000-2001 to 2005-2006 survey.

A significant decrease of the percentage of normal weight participants was found across the surveys: 81.9% in 2000-2001; 81.6% 2001-2002; 76.2% 2005-2006. Moreover, a significant increase of obesity prevalence was found in the 2005-2006 survey (3.6% compared with 1.9% in 2000-2001 and 2.2% in 2001-2002).

Finally, we found no significant increase in the rate of overweight in our sample. However, from a descriptive point of view an increasing percentage of adolescent overweight began to emerge in 2005-2006: the percentage of overweight adolescents was 16.3% in 2000-2001, 16.2% in 2001-2002 and 20.1% in 2005-2006.

8.4 DISCUSSION

The main aims of this study were: to assess whether self-reported anthropometrics values measured with a standard questionnaire were a valid tool to determine the prevalence of overweight and obesity among adolescents, to find a calibration equation to adjust self-reported values on the strength of measured values and to determine the prevalence of obesity and overweight in the Veneto region from 2000 to 2006.

Our findings show, in line with previous studies, that self-reported height and weight correlated highly with anthropometric measured values in adolescence (Elgar, Roberts, Tudor-Smith, & Moore, 2005; Goodman, Hinden, & Khandelwal, 2000; Morrisey et al., 2006). However, the only analysis of correlation may conceal bias caused by variance

method or social desirability (Bland & Altman, 1986; Elgar et al., 2005) and it is not sufficient to establish the validity and the accuracy of the self-reported anthropometric values among adolescents. In fact, comparing self-reported and objective anthropometric values among a broad sample of adolescents we found significant differences: adolescents tend to overestimate their height and underestimate their weight with a subsequent underestimation of BMI value (Abraham et al., 2004; Brener et al., 2003; Himes, & Faricy, 2001; Lee et al., 2006; Tsigilis, 2006).

Furthermore, our results showed that the differences between self-reported BMI and measured BMI are systematically related to selected characteristics of youth: gender and age were important variables influencing bias in self-reported height and weight. In line with previous studies we found that girls tend to underestimate their BMI to a greater degree than boys. Similar gender differences have been found in previous studies (Brener et al., 2003; Davis, & Gergen, 1994; Giacchi et al., 1998; Rosner et al., 1998; Tsigilis, 2006), even if some studies did not report gender differences (Morrisey et al., 2006; Tokmakidis et al., 2007). Moreover, the underestimation of BMI tends to increase with age: the bias in self-reported values was greater for adolescents aged 15 years old than for younger adolescents aged 11 years old. Previous studies showed similar patterns, underlining that younger adolescents were more accurate in reporting their height and weight (Brener et al., 2003; Himes, Hannan, Wall, & Neumark-Sztainer, 2005; Tokmakidis et al., 2007).

The bias in self-reported height and weight values by adolescents may be influenced by many factors. First, given that body weight tends to fluctuate slightly from day to day (Himes, & Faricy, 2001), the finding that adolescents do not always estimate their weight correctly is not unexpected, especially for little bias. Second, the bias in self-reported height can be partially explained because adolescents have few opportunities to measure their height, and therefore they have less information about their height compared with their weight. Third, bias in self-reported BMI (including both, height and weight) may be related to social desirability among adolescence, indeed in children socially desirable responding is considered part of normal development (Klesges et al., 2004). This hypothesis is confirmed also by Elgar and colleagues who found that body size and perceived body size contributed to the underreporting of body weight: overweight and obese early adolescents tended to underreport their weight to a greater degree than their

normal weight peers. Finally, the underestimation of self-reported BMI may be expected because of the ideal body in western cultures is to be thin and the social pressure may lead to negative attitudes regarding big body sizes (Nyholm et al., 2007; Wardle, & Watters, 2004). This hypothesis could explain why girls showed bias in BMI to a greater degree than male adolescents, because there is greater emphasis on thinness for females in our society (Field et al., 1999).

In line with previous studies on child, adolescent and adult population (Jeffery, 1996; Nyholm et al., 2007) we found that the use of self-reported anthropometric values is linked with an underestimation of the prevalence of obesity and overweight of 5.33% compared with measured data.

This study showed that exclusive use of self-reported anthropometrics values in adolescence can lead to erroneous prevalence estimates of overweight and obesity, but also that it is possible to adjust this bias to improve the accuracy of self-reported height and weight values. Indeed, we found that the underestimation of obesity and overweight prevalence was smaller when the calibration equation of BMI, based on the measured height and weight, was used to correct self-reported BMI. In some studies with adult populations, the calibration methods have been debated, because it is difficult to use and does not completely correct the systematic bias in self-reported weight and height (Bolton-Smith, Woodward, Tunstall-Pedoe, & Morrison, 2000; Plankey, Stevens, Flegal, & Rust, 1997). However, the low validity of self-reported BMI has negative implications for population studies and preventive interventions (Nyholm et al., 2007) and can lead to significant distortion of the prevalence of obesity and overweight in adult and adolescent populations.

At present, very few studies have contributed to the improvement of the validity of self-reported anthropometric values and the identification of accurate calibration equations have been conducted regarding early adolescents and adolescents. In this study, the calibration equation has a simple applicability, and the adjusted BMI values are more reliable and accurate compared with self-report data. In fact, the bias in the prevalence of overweight and obesity, compared with measured BMI, was 5.33% for self-reported BMI and 0.90% for adjusted BMI. The calibration equation is an accurate and practical tool which is useful to improve the validity of self-reported anthropometric values in adolescence, it can be helpful for both psychological and epidemiological studies to

estimate the prevalence of obesity and overweight, because it allows the categorization of adolescents as being obese or not, more carefully. Moreover, this tool can also be applied to adjust self-reported BMI in sub-group populations (for example for separate gender or age groups).

Using the adjusted BMI values we found, in line with previous studies (Johannsson et al., 2006; Kohn & Booth, 2003; Lobstein et al., 2004, Peneau et al., 2009; Wang & Lobstein, 2006), changes in the prevalence of excess of weight problems. Our findings showed an increase in the portion of obesity and a decrease in the portion of normal weight adolescents in the Veneto region from 2000 to 2006. These changes in prevalence are common across gender and age sub-groups. No significant increase in the portion of overweight was found, however, a trend in this direction seems to be emerging. Thus, future HBSC surveys could confirm or disconfirm this trend.

Unfortunately, due to the nature of our research design we are not able to establish if the decrease in normal weight prevalence is attributable to a shift in the entire population or to an increase in the upper distribution of BMI (Guillaume, & Lissau, 2002). However, we are able to identify an overall increased percentage of obesity (especially in 2005-2006) and a decreasing rate of normal weight subjects in a broad sample of adolescents representative of the Veneto region: the global prevalence of obesity and overweight was 18.2% in 2000-2001 and 23.7% in 2005-2006. These results suggest that overweight and obesity are very common problems among adolescents (around a quarter of the sample fell into one of the two categories) and that among excess of weight problems is the increase of the most severe condition (obesity) to be worrying.

8.5 LIMITATIONS

This study has several limitations that should be underlined. Firstly, the cross-sectional design limits the study's impact. It is not possible to establish, for example, whether the increasing prevalence of obesity concerns all adolescents or mainly adolescents who were already overweight in the past. Moreover, further longitudinal studies may explain the differences over time of the bias in self-reported height and weight and may validate the calibration equation of self-reported BMI at different points of time.

Secondly, we found a higher percentage of missing data, especially in 2005-2006 survey concerning self-reported BMI (around 19%). This percentage is somewhat higher

compared with the percentage of missing data on self-reported BMI reported in other studies (Janssen et al., 2005; Sabbe et al., 2008). However, this study involved a broad sample of adolescents and we found that body image was similar in young people who reported their height and weight vs. those who did not report their height and weight. This suggests that the degree of adiposity should be similar in the two groups (youth with self-reported BMI and youth without self-reported BMI) (Janssen et al., 2005). Moreover, adolescent participants know that after the questionnaire there was an objective measurement of their weight and height that may be a deterrent in reporting their anthropometric values. This hypothesis is confirmed by the fact that in 2000-2001 and 2001-2002 surveys the percentage of missing data on self-reported values was much lower (around 6%) compared to 2005-2006 survey (around 19%).

Thirdly, the calibration equation may be applied for studies on the Italian adolescent population, but further studies are needed to replicate this work in different socio-cultural contexts in order to improve its generalization. However, despite this limitation, the way in which the calibration equation has been identified constitutes a valid methodological tool which is easy to apply and that can be adopted in other studies.

Fourthly, the age of the sample limits the generalization of our findings. Finally, because of the low percentage of non-Italian adolescents in our sample, we did not examine ethnic differences in the validity of self-reported height and weight, despite the fact that previous studies suggested that this variable may influence the bias in self-reported anthropometric values (Brener et al., 2003; Morrisey et al., 2006).

8.6 CONCLUSION

The present findings indicate a discrepancy between self-reported BMI and measured BMI in adolescents, but also that through a calibration equation it is possible to improve the validity of self-reported weight and height. Accurate and cheap screening of overweight and obesity are essential to monitor the development of these phenomena and their psychosocial and physical consequences. Moreover, continuing to study the prevalence of obesity and overweight may help to understand the history of these phenomena in order to have information concerning the general distribution and the development its prevalence over time (Guillaume, & Lissau, 2002).

From a more operative point of view the increased validity of self-reported weight and

height may support the evaluation and the monitoring of community- and school-based prevention programs aimed at reducing obesity and overweight among adolescents.

Furthermore, the study of the prevalence of obesity and overweight through the adjusted BMI values may allow the more careful identification of the territorial areas which are more at risk for weight problems (e.g., health districts - ULSS - with a higher prevalence of obesity and overweight and the concomitant higher increase of excess of weight problems over time). These territorial areas could be the starting point for the implementation of effective prevention programs regarding obesity and overweight and health promotion programs which promote healthy lifestyles, eating habits and physical activity.

Finally, because of the decrease of normal weight adolescents and the increase of excess of weight problems in this geographical area, this study underlines the importance of continuing the monitoring of the prevalence of obesity and overweight, of studying their individual, micro- and macro-environmental correlates, of indentifying effective strategies to improve the effectiveness of the interventions aimed at reducing and of recognizing obesity and overweight among adolescents.

CHAPTER 9

DIETARY PATTERNS, PHYSICAL ACTIVITY AND FOOD-RELATED LIFESTYLES: ARE THEY RELATED WITH OBESITY AND OVERWEIGHT IN ADOLESCENCE?

9.1 INTRODUCTION

Many factors at the individual-, micro- and macro-environmental level may influence obesity and overweight in adolescence (see Chapters 4, 5 and 6).

Overall, weight gain is due to an imbalanced relationship between energy intake and output: a positive energy balance occurs when energy intake exceeds energy output (Kremers et al., 2004). Any single factor alone can be identified as the main cause of obesity and overweight but an interaction and co-occurrence of multiple behaviors can lead to a positive energy balance and body fatness (Boone-Heinonen, Gordon-Larsen & Adair, 2008; Davison, & Birch, 2001; Hill, Wyatt, & Melanson, 2000; Kremers et al., 2004).

Although several factors have probably contributed to the present high prevalence of obesity and overweight among adolescents, successful prevention strategies should be focused on the etiologic components that it is most possible to change. From this perspective, at the individual level, three main modifiable domains can influence an excess of energy intake and/or inadequate energy expenditure and can place the adolescents at risk of being overweight or obese (Davinson, & Birch, 2001; Huang et al., 2009): dietary behaviors, physical activity and food-related lifestyles¹⁷ (see Chapter 5 for a detailed description).

Poor dietary behaviors (e.g., characterized by high fat- and sugary-food consumption and low intake of fruit and vegetables) have been linked with overweight and obesity and with a higher risk of chronic disease in adulthood (e.g., type 2 diabetes, or cardiovascular disease) (McClain et al., 2009; Nicklas et al., 2003). However, even if several studies have

¹⁷ For a definition and description of food-related lifestyles see Paragraph 5.3.

found a stable or falling energy intake (Nicklas et al., 2001b; Rolland-Chachera, & Bellisle, 2005; Schnohr et al., 2003) changes in quality of eating behaviors (e.g., a decrease of fruit and vegetable consumption) (Nicklas et al., 2001a) should be addressed in explaining the increase in adolescents' obesity and overweight.

Moreover, adequate levels of physical activity can partially compensate the excessive energy intake and support the adolescents in the maintenance of healthy weight status (Davison, & Birch, 2001). Adolescents performing regular physical activity also show a lower incidence rate of some physical and mental-health problems such as, for example, cardiovascular diseases, anxiety, and depression (Hallal et al., 2006; Pan et al. 2009).

In addition, a significant association between BMI and several food-related lifestyles (e.g., sedentary behaviors) has been underlined in several studies (Bowman et al., 2004; Kerr et al., 2009; Nicklas et al., 2003; Pearson et al., 2009a; Yang et al., 2007).

Finally, the risk factors for the development of overweight and obesity are influenced by adolescents' socio-demographic characteristics such as gender (Currie et al., 2008a; Huang et al., 2009; Sweeting, 2008); age (Currie et al., 2008a); socio-economic status (Shrewsbury, & Wardle, 2008; Vereecken et al., 2005b) and ethnicity (Adams et al., 2008; Kaufman et al., 2009).

Despite the growth in studies concerning the relationship between eating behaviors, physical activity and food-related lifestyles, some issues remain unclear and further research are necessary to develop more effective interventions and to understand their reciprocal inter-relationships.

First, a healthy diet is a complex outcome, influenced simultaneously by several dietary behaviors because different foods are usually not eaten in isolation (Nicklas et al., 2001a). Despite this, most studies have assessed the association between single dietary behavior or specific food intake and BMI (e.g., soft drink intake) (Forshee, Anderson, & Storey, 2008; Malik, Schulze, & Hu, 2006) and less is known about the relationships between dietary patterns¹⁸ and overweight and obesity in adolescence. Beyond the association between single dietary behavior and weight status, there is a potential synergistic effect of multiple dietary behaviors and overweight because various behaviors exert a combinative effect on health outcome (Boone-Heinonen et al., 2008; Pearson et al., 2009). As suggested by Nicklas and colleagues (2003, p. 9) "*While individual nutrients have been implicated in*

¹⁸ In line with Togo et al., 2001 (p. 1742) dietary patterns can be defined as "*the frequency distribution of food in the habitual diet*".

obesity, few attempts have been made to identify eating patterns in this regard". Thus, in the light of the complexity of dietary behaviors, it is likely that dietary patterns may have a greater cumulative effect on adolescents' obesity and overweight rather than single food consumption studies in isolation (Nicklas et al., 2001; Vereecken et al., 2005a).

Second, studies investigating dietary patterns on obesity, overweight or health outcomes are more often carried out with adult populations, while fewer studies address the relationship between dietary patterns and overweight and obesity with children and adolescents (Nicklas et al., 2003).

Third, although from a theoretical point of view multiple domains and correlates, at the individual level, influence obesity and overweight in adolescence, most studies have assessed only the effect of a specific domain (e.g., physical activity) on overweight and obesity, missing out the co-occurrent role of other domains (e.g., dietary patterns). Therefore, less is known about the simultaneous association between adolescents' overweight and obesity, dietary behaviors, physical activity and several food-related lifestyles (Kremers et al., 2004). Studying these three domains separately may be linked with the risk of overestimating the role of each domain in contributing to the development and maintenance of overweight and obesity status in adolescence. For this reason, studying different domains simultaneously in relation to overweight and obesity may be an important step towards better understanding adolescents' overweight and obesity by taking into account the complexity of the factors implicated in these phenomena rather than studying each domain in isolation or one behavior at a time (Kremers et al., 2004).

Moreover, studying several correlates of obesity and overweight simultaneously across multiple domains may allow us to better assess the complexity of obesity-related behaviors among adolescents (Boone-Heinonen et al., 2008) Furthermore, it may help, in terms of preventive intervention, to determine a set of correlates linked with obesity and overweight but also it may support the identification of more effective intervention priorities and strategies (Kremers et al., 2004).

Fourthly, despite the fact that previous studies have shown large country differences in terms of obesity and overweight prevalence, dietary habits, physical activity and food-related lifestyles across countries (Huang et al., 2009; Janssen et al., 2005; Vereecken et al., 2005a; Verzeletti et al., 2009a), as far as we know there are no studies in Italy which

have investigated dietary behaviors, physical activity and food-related lifestyles simultaneously in relation to obesity and overweight.

Understanding the contribution of dietary patterns, physical activity and food-related lifestyle factors influencing adolescents' weight status may help in the development of relevant and effective interventions and prevention programs for adolescents which take into account the complex multi-factorial nature of obesity and overweight. As suggested by Vereecken and colleagues (2005a, p. 425) including several lifestyles and dietary behaviors *“increases the value of the research initiatives: it offers the possibility to move beyond examining isolated risk behaviours so that broader, tailored, more effective and integrated interventions and strategies could be developed focusing on different lifestyle behaviours and/or targeting specific population groups”*.

Thus, the purpose of the present study is to study the association between BMI status (normal weight, overweight and obesity) and dietary patterns, physical activity and food-related lifestyles variables in a broad sample of adolescents from the Veneto region.

We hypothesized that less healthy dietary patterns and low levels of moderate or vigorous physical activity are positively associated with overweight and obesity. Moreover, we hypothesized that skipping breakfast, frequent television viewing behaviors (during meals and during free time), snacking while watching television and using the computer are positively associated with overweight and obesity.

Finally, even if some studies suggest a possible moderation effect of gender on these health behaviors (Boone-Heinonen et al., 2008; Nicklas et al., 2003) there is a lack of international studies testing the moderation effect of gender in the relation between dietary pattern, physical activity, food-related lifestyle variables and BMI status in adolescence. For this reason we explored whether gender acted as a moderator of the impact of these risk factors on adolescents' obesity and overweight.

9.2 METHOD

9.2.1 PARTICIPANTS

The present data are part of the 2005-2006 (HBSC) survey. Data for the Italian Veneto Region were obtained from a sample of middle (first grade, ±11-12 years old and third grade, ±13-14 years old) and high schools (second grade ±15-16 years old) randomly

selected from the school list provided by the Regional School Office's database. Of the 244 schools selected for participation, 240 schools (98% response) agreed to participate. In each participating school, 2 classes (about 40 pupils) were randomly selected. Of all pupils approached, 3% did not get consent from their parents; 6.6% of the pupils were absent on the day of testing. In total, 6,744 pupils completed the questionnaire.

For the current study only adolescents with no missing data on measured BMI were included, resulting in a final sample of 6,149 participants (52% males). Thus, with respect to the original sample we have 8.8% of missing data on measured BMI. This percentage of missing data is somewhat lower than the rate found in other studies using self-reported BMI (Janssen et al., 2005). However, since the number of missing data in objective BMI it is possible that the young people included in the analysis may differ from the original sample. For this reason, a chi-squared test was used to compare the original study's participants with students who were included in this study (without BMI missing data). The sub-sample which was excluded from the current study differed significantly from the original sample in terms of gender ($\chi^2_{(1)}=71.97$; $p<.001$) and age category ($\chi^2_{(2)}=18.30$; $p<.001$) distribution. These differences can be linked with greater difficulties with participating in the measurement of weight and height for girls (66% of the excluded participants were girls) and older adolescents (44.2% of the excluded participants was aged 15-year-old). Socio-demographic characteristics of participants and their association with BMI status are shown in Table 8.1.

Among 6,194 participants, 52% of adolescents were males. Regarding age, 32.1% of participants were aged 11-12 years ($M=11.92$, $DS=0.41$), 31.2% 13-14 years ($M=13.98$, $DS=0.47$) and 36.7% 15-16 years ($M=15.99$, $DS=0.61$). Almost all the participants were born in Italy (92.9%) and reported a medium (50.4%) or high family affluence (43.6%).

Significant associations were found for almost all socio-demographic characteristics and BMI status (Chi-squared tests). In line with previous studies (Currie et al., 2008a; Huang et al., 2009; Strauss, & Pollack, 1998) a higher percentage of overweight or obese adolescents were found among males, while, in turn, a higher percentage of normal weight participants were found among females.

Table 8.1. Percentage of total sample, normal weight, overweight, and obesity^o participants by socio-demographic characteristics (gender, age, FAS and born in Italy).

	Total Sample (n=6149)	Normal Weight (n=4596)	Overweight (n=1231)	Obesity (n=322)
Gender	%	%	%	%
Male	52.0	70.5	23.0	6.5
Female	48.0	79.3	16.8	3.9
χ^2		61.57***	35.94***	20.57***
Age Category				
11-12	32.1	71.1	22.8	6.1
13-14	31.2	76.9	19.1	3.9
15-16	36.7	76.5	18.2	5.3
χ^2		21.62***	14.40***	9.30**
Family wealth (FAS)				
Low	5.9	71.2	21.1	7.8
Medium	50.4	74.4	19.9	5.7
High	43.6	75.8	19.9	4.3
χ^2		4.14	0.30	10.39**
Born in Italy				
Yes	92.9	74.2	20.5	5.4
No	7.1	82.2	14.6	3.2
χ^2		13.89***	8.66**	3.93*

^oBMI status based on measured height and weight.

* p < .05; ** p < .01; *** p < .001.

Moreover, significant differences were found between age and BMI status: young adolescents are more often overweight or obese compared with older adolescents (Currie et al., 2008a). No significant associations were found between family affluence and normal weight and overweight status. Only obesity status was linked with family affluence underlining an association between lower family affluence and obesity among adolescents. In line with the mixed findings reported in the literature concerning the association between the excess of weight problems and SES (Currie et al., 2008a; Shrewsbury, & Wardle, 2008), our results suggest a relation between BMI and SES (operationalized in this study in terms of family affluence) only for high BMI status (obesity), underlying the complexity of this association. Finally, significant associations were found among adolescents' country of birth and BMI. A higher percentage of overweight and obese adolescents were found among participants born in Italy, while a higher percentage of normal weight people were found among adolescents who were not born in Italy.

9.2.2 MEASURES

Body Mass Index (BMI). BMI was obtained by objective measurement of height and weight (see Paragraph 8.2.2 for the detailed procedure). Overweight and obesity were identified using age and gender specific international cut-off points (Cole et al., 2000), based on the average centile estimates to pass through BMI values of 25 and 30 kg*m² respectively, at the age of 18 years.

Family Wealth is assessed with the “*Family affluence scale*” (FAS). The FAS is a proxy four-item measure of socio-economic status developed in the HBSC Study (Boyce, Torsheim, Currie, & Zambon, 2006; Currie et al., 2008b). The items addressed different family conditions that indicated wealth. “*Does your family own a car, van or truck?*” Responses options were: (0)= No; (1)= Yes, one; (2)= Two or more. “*Do you have your own bedroom for yourself?*” Responses options were (0)= No, (1)=Yes. “*During the past 12 months, how many times did you travel away on holiday with your family?*” Responses options were: (0)= Not at all; (1)= Once; (2)= Twice; (3)= More than twice. “*How many computers does your family own?*” Responses options were: (0)= None; (1)= One; (2)= Two; (3)= More than two.

Responses were scored on a 0-9 scale and then divided into three groups using the cut-off points recommended by previous FAS validation studies (Boyce et al., 2006; Currie et al., 2008b): (1) Low FAS (score 0-2); (2) Medium FAS (score 3-5); and (3) High FAS (score 6-9).

Country of birth was assessed asking “*Were you born in Italy?*” The possible responses options were: (1) Yes; (2) No.

Dieting Status was assessed asking: “*At present are you on a diet or doing something else to lose weight?*”. There were four response categories: (1) No, my weight is fine; (2) No, but I should lose some weight; (3) No, because I need to put on weight; (4) Yes. To distinguish among people who are doing something to reduce their weight and those not the response options were categorized into: (1) Currently dieting; (2) Not currently dieting.

Adolescent’s **dietary patterns** were investigated using the Food Frequency Questionnaire (FFQ). The aim of the FFQ is not to provide a quantitative precise estimates of nutrient intake, but to provide raw information concerning the frequency of dietary intake on a list of food items (Vereecken et al., 2005a). Food intake was assessed by asking: “*How many times a week do you usually eat or drink.....?*” followed by a list of foods with seven response options: (1) Never; (2) Less than once a week; (3) Once a week; (4) 2-4 days a week; (5) 5-6 days a week; (6) Once a day, every day; (7) Every day, more than once. Studies on reliability and relative validity of FFQ questionnaire has been previously published (Vereecken, & Maes, 2003; Vereecken, Rossi, Giacchi, & Maes, 2008).

The food items proposed by HBSC core questionnaires are: fruit, vegetables, non-diet soft drinks and sweets (candies and chocolates). Additional (optional) items proposed by international HBSC group and inserted into the Veneto Region questionnaire are: white bread, brown bread, cereals (as source of dietary fibre); low fat/semi skimmed milk, whole fat milk, cheese, other milk products like yoghurt (as source of calcium); light soft drinks, crisps and chips (as popular food of youth food culture); fish and vitamin & supplements. Moreover, in the Veneto Region Survey 2005/2006 four further items were added as common foods of Italian and Mediterranean diet: pasta, rice, meat and eggs. Thus, 20 items were included in our questionnaire. To identify adolescents’ dietary patterns we chose to reduce the number of items computing the consumption average of similar foods. Brown

bread, light soft drinks, vitamin & supplement were deleted from this study due to their distribution. These foods are not commonly consumed by Italian adolescents, in fact, more than 50% of participants reported never having eaten these foods in previous weeks. Recoding the food items just listed (Nicklas et al., 2003), we were left with eight food categories: (1) Fruit, (2) Vegetables, (3) Non-diet soft drinks, (4) Sweets, (5) Chips (chips and crisps), (6) Milk and derived (low fat/semi skimmed milk, whole fat milk, cheese, other milk products like yoghurt), (7) Cereals and derived (cereals, white bread, pasta, rice), (8) Protein derived from meats, fish and eggs.

Physical Activity. Moderate to vigorous physical activity (MVPA) were assessed with one item. MVPA provides a picture of total activity, with a focus on the physical and healthy aspects of physical activity. The measure of MVPA adopted in this study was developed by Prochaska, Sallis and Long (2001). This measure represents a reliable and valid physical activity screening measure for surveys involving children and adolescents taking into account the overall frequency and the intensity of physical activity.

Before the item, a brief description of what is meant with “Physical Activity” was reported in the questionnaire. The definition, established by international HBSC protocol was: *“Physical activity is any activity that increases your heart rate and makes you get out of breath some of the time. Physical activity can be done in sports, school activities, playing with friends, or walking to school. Some examples of physical activity are running, brisk walking, rollerblading, biking, dancing, skateboarding, swimming, soccer, basketball, football, & surfing”*. After this definition was asked to students: *“For this next question, add up all the time you spent in physical activity each day. Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?”* The possible responses were ranged on a Likert scale from (0) 0 days to (7) 7 days (Prochaska et al., 2001).

Validation studies of this item were previously published showing acceptable reliability of the measure (Booth et al., 2001; Prochaska et al., 2001; Roberts et al., 2007a). However, it is important to recognize that self-reported data on physical activity compared to objective measures, tends to results in underreporting MVPA and over-reporting VPA (Vigorous Physical Activity) (Riddoch et al., 2004).

The 60-minute MVPA measure provides a reasonable and easy method to assess participation in overall physical activity and to assess achievement of current international guidelines. As explained in Chapter 5, international guidelines (Biddle et al., 1998; Corbin, & Pangrazi, 1998; Strong et al., 2005) suggest that “*youth should participate daily in 60 minutes or more of moderate to vigorous physical activity that is developmentally appropriate, enjoyable, and involves a variety of activities*” (Strong et al., 2005, p.732).

In line with the international guidelines (see Chapter 5) and previous HBSC studies (Huang et al., 2009) the item was recoded into: (1) Not daily MVPA (<5 Times/Week) (2) Daily MVPA (\geq 5 Times/Week).

Food related lifestyles. A set of food-related lifestyles were included in this study. The items about food-related lifestyles (e.g., breakfast consumption) were only recently introduced into HBSC international study (Vereecken, 2007). Validation studies on this items were done in 2004-2005 in three countries: Belgium (Flanders) (112 pupils), Italy (114 pupils) and Finland (252 pupils) and have been reported in the HBSC international research protocol (Vereecken, 2007). The food-related lifestyles variables included in this study are:

- **Breakfast Consumption.** Breakfast consumption was measured using the questions: “*How often do you usually have breakfast during weekdays?*” Response categories were: (1) I never have breakfast during the week; (2) One day; (3) Two days, (4) Three days; (5) Four days and (6) Five days. In line with previous HBSC studies (Verzeletti et al., 2009a) the responses options were categorized into: (1) Skipping breakfast weekdays (not daily breakfast) and (2) Not skipping breakfast weekdays (daily breakfast).

Validation studies for breakfast during weekdays item (Vereecken, 2007) found a good test-retest reliability of daily consumers versus less than daily consumers in different country (Belgium-Flanders: 0.71; for Italy: 0.71; for Finland: 0.78). Kappa statistics comparing the daily consumption of breakfast, according to the diaries, in the Flemish population were fair for the weekend (0.34) and moderate for the weekdays (0.47) (Vereecken, 2007).

- **Snacking.** Snacking habits were investigated with two items adapted from the Van den Bulck and Van Mierlo (2004). Snack consumption was measured using the

following questions: “*How often do you eat a snack while you (1) watch TV (including videos and DVDs) (2) work or play on a computer or games console?*” The response options were: (1) Never; (2) Less than once a week; (3) 1-2 days a week; (4) 3-4 days a week; (5) 5-6 days a week; (6) Every day. The item was piloted in Belgium Flanders and in Italy (Vereecken, 2007). The test-retest Spearman’s correlations for the variable assessing eating while watching TV or using a computer, varied from 0.44-0.82. The items were categorized in line with a previous study (Verzeletti et al., 2009a) into: (1) Daily snack while watching TV/using PC (≥ 5 days every week); (2) No daily snack while watching TV/using PC (<5 days every week).

- **Television behaviors.** Two different aspects concerning television habits were assessed: the habit of watching television during meals and free time spent watching television by adolescents. *Television during meal* was assessed by asking: “*How often do you watch TV while having a meal?*” with six response options: (1) Never; (2) Less than once a week; (3) 1-2 days a week; (4) 3-4 days a week; (5) 5-6 days a week; (6) Every day. The responses options were categorized into: (1) Daily TV during meal; (2) Not daily.

The adolescent’s *free time spent watching television* was measured by asking: “*About how many hours a day do you usually watch television (including DVDs and videos) in your free time?*” with a Likert scale with 9 response options ranging from (1) None at all, to (9) 7 or more hours a day (Vereecken et al., 2006). Test-retest reliability and relative validity of the items were previously published (Vereecken et al., 2006). The American Academy of Pediatrics (2001) recommend that less than 2 hours each day should be spent watching television, however, no specific guidelines exist for adolescents. Moreover, in our sample this cut-off is not really useful to distinguish those young people watching high television hours because more than 46% of our sample report spending more than 2 hours every day watching television. Thus, based on the mean hours of our sample ($M=4.06$, $SD=1.73$) for TV viewing and previous HBSC studies (Vereecken et al., 2006, Verzeletti et al., 2009a,b), the responses were categorized into: (1) Heavy TV viewing behavior or Heavy viewers (≥ 4 hours); (2) Not heavy TV viewing behavior or not heavy viewer (< 4 hours).

9.2.3 STATISTICAL ANALYSIS

Statistical analyses were completed in a three step procedure which will be described separately.

1. Cluster Analysis. Cluster analysis allows the identification and description of individual or group cases defined by similarities along multiple dimensions of interest simultaneously (Henry, Tolan, & Gorman-Smith, 2005). Cluster analysis has been defined by Kaufman and Rousseeuw (1990, p. 1) as “*the classification of similar objects into groups, where the number of groups, as well as their forms, may be unknown*”. This approach allows the classification of the variables “*according to their similarity on one or more dimensions and producing groups that maximize within-group similarity and minimize between-group similarity*” (Henry et al., 2005, p. 121). Non-hierarchical clustering method has been chosen for our study. Non-hierarchical clustering differs from hierarchical clustering because it not produce a nested structure of the data (Henry et al., 2005). *K-means* algorithm (MacQueen, 1967) with SPSS 16 was used to identify dietary patterns (clusters). Thus, in the final cluster solution, each case is allocated to one cluster.

Standardized variables have been entered in the cluster analysis (Aldenderfer, & Blashfield, 1984) given the unequal scaling of our variables (singular items or composed food groups). In fact, as suggested by Henry and colleagues (2005), unequal scaling can influence the variable weight: variables with greater ranges or larger variances may have greater influence in the algorithm that determines the clusters.

To validate our cluster solution (De Bourdeaudhuij, & van Oost, 1999; Mandara, 2003; Sabbe, De Boudeaudhuij, Legiest, & Maes, 2008), given our large sample size, the sample has been randomly split into two sub-samples. Then, each half sample was analysed separately with the same clustering procedure and the two solutions were compared. Following this procedure, a three-cluster solution was chosen as the most adequate and reliable representation of our food intake variables. Finally, a multivariate analysis of variance (MANOVA), inserting the standardised variables as dependent variables and the clusters as independent variables, was carried out to check cluster differences on each index.

2. Descriptive analysis. Frequency and percentages were used to describe the sample for all the dependent and independent variables. Moreover, chi-square tests were performed to determine gender differences (Table 8.3).

3. Multinomial Logistic Regression analysis. SPSS version 16.0 for Windows was used for data analyses. Multinomial logistic regression was conducted, which is appropriate for variables characterized by more than two categories. Several sets of Multinomial Binary Logistic Regression were carried out to test the association between BMI status and three different domains: dietary pattern, physical activity and food-related lifestyles, controlling for socio-demographic characteristics and dieting status. This was done in two steps. First, by regressing BMI status consumption separately for each domain (Singular Models, Table 8.4) and including interactions between all the independent variables and gender to address whether gender acts as a moderator of the effect of dietary patterns, physical activity and food-related lifestyles on BMI status. As only one borderline interaction was found, all singular models were rerun without the interaction terms.

Secondly, including all the variables of the three domains in one final model to see if these variables remained significant in the full model (controlling the effect of other domains) (Model not shown). After this step, the variables not significant in the singular models were deleted one by one controlling the AIC and R^2 values (Nagelkerke R^2 , a pseudo- R^2) to identify the more explanatory and parsimonious final model (Full Model, Table 8.4).

The dependent variable (measured BMI) was categorized into “normal weight”, “overweight” and “obesity” (Cole et al., 2000) and the normal weight status was the reference category in the multinomial regression.

All the independent variables are presented as dummy indicators contrasted against a base category. This allows us to compare adolescents who have habitually healthy lifestyles (e.g. usually not having meals while watching television) versus those who in general have less healthy lifestyles (e.g. having daily meals while watching television).

All the models were adjusted for socio-demographic characteristics (gender, age, FAS and country of birth) and dieting status.

Significant associations were evaluated in two steps. First, overall model fitting information and Likelihood ratio tests were addressed (Table 8.4). Model fitting information underlined the presence of a relationship between the dependent variable and a

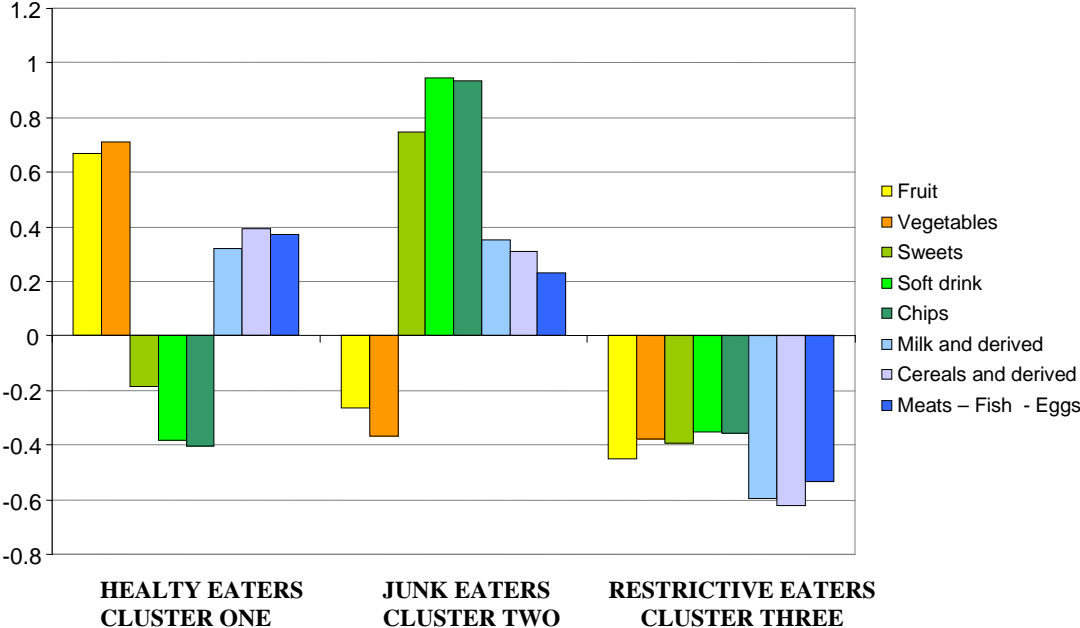
combination of independent variables. Instead, the likelihood ratio test evaluates the overall relationship between each independent variables included in the model and the dependent variable. Secondly, addressing the regression model parameter estimates relative to the reference group “normal weight” (Table 8.5). Adjusted B, standards errors, odd ratios and 95% confidence intervals are reported; *p* values are two-tailed; the significance was defined as $p < 0.05$.

9.3 RESULTS

The final cluster solution, obtained by cluster analysis on several food consumption variables is represented in Figure 8.1. Three-cluster solution was identified as the most adequate representation of our food groups. Distinguishing characteristics of each cluster were indicated by high or low standardized scores of each food variable.

To validate the three-cluster solution and to check that this solution was not dependent of sample’s characteristics, the sample was randomly split in two sub-samples (De Bourdeaudhuij, & van Oost, 1999; Mandara, 2003; Sabbe et al., 2008). Then, each half sample was analysed separately repeating the same clustering procedure. Very comparable and similar results were found, thus, the three clusters solution were accepted.

Figure 8.1. Clusters standard scores on food groups.



The labels of the clusters reflected the main characteristics of participants' food pattern. Each cluster included a similar rate of participants: 34.87% in cluster one (Healthy Eaters), 28.14% in cluster 2 (Junk Eaters) and 36.99% in cluster three (Restrictive Eaters). The characteristics of each cluster were represented and described in Figure 8.2 on the based on standardized scores. Each plot represents a single cluster and each ray represents a single food group.

Moreover, cluster differences on each food group were tested with a multivariate analysis of variance (MANOVA) (Table 8.2).

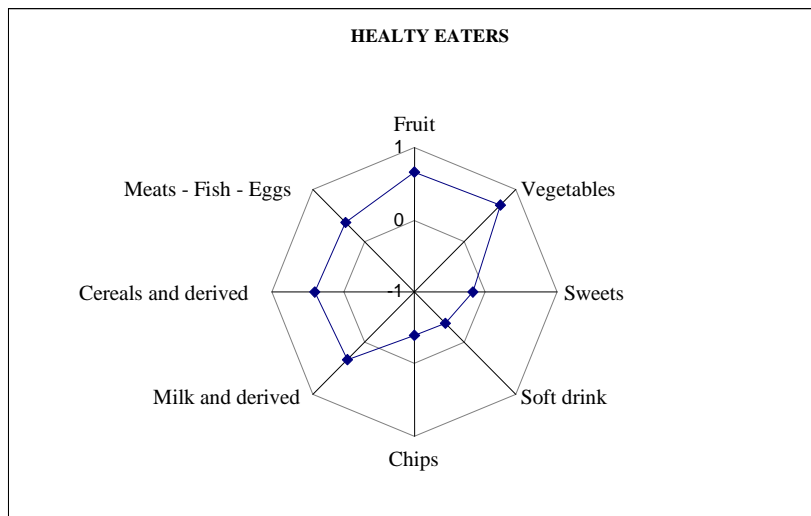
Table 8.2. Standardized scores of final cluster solution and MANOVA results.

	Healty Eaters (n=2160)	Junk Eaters (n=1743)	Restrictive Eaters (n=2291)	F*	η^2
Fruit	0.67	-0.26	-0.45	1037.04	.251
Vegetables	0.71	-0.37	-0.38	1144.03	.270
Sweets	-0.19	0.74	-0.39	913.19	.228
Soft drink	-0.38	0.94	-0.35	1645.61	.347
Chips	-0.41	0.94	-0.36	1724.87	.358
Milk and derived	0.32	0.35	-0.60	803.00	.206
Cereals and derived	0.39	0.31	-0.62	897.03	.225
Meats - Fish – Eggs	0.37	0.23	-0.54	643.76	.172

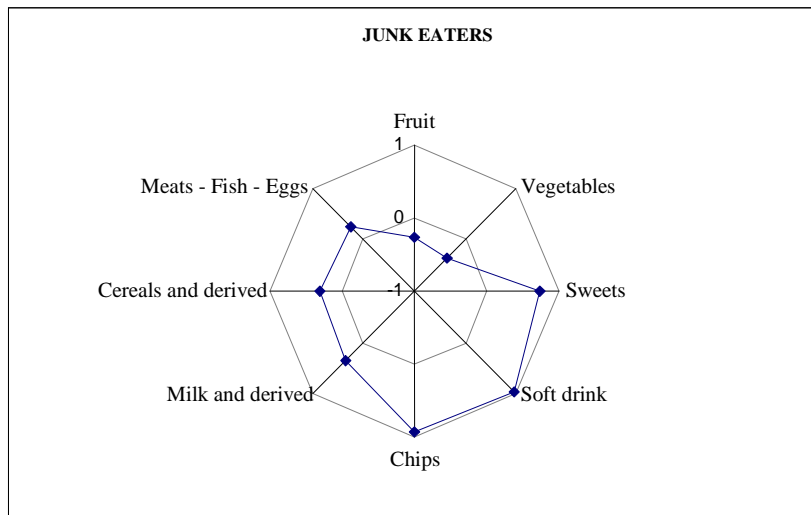
*All F values are significant for $p < .001$.

The three clusters: “Healthy Eaters” (n=2161); “Junk Eaters” (n=1744) and “Restrictive Eaters” (n=2293) differ significantly on all food groups.

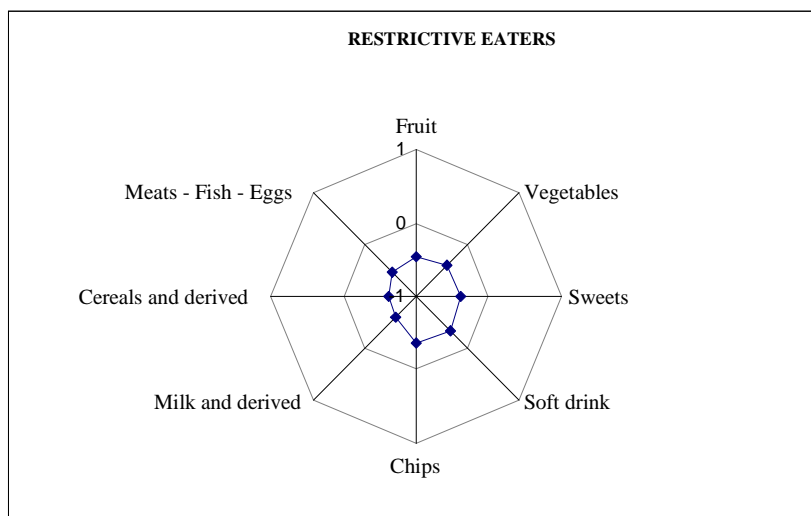
Figure 8.2. Radar plot and description of the three clusters.



Cluster one (Healthy eaters, n=2160) include the participants characterized by higher intake of fruit and vegetables and lower sweets, soft drink and chips intake compared with the total sample average. Scores on milk products, cereals and meats-fish are higher than sample's average.



Cluster two (Junk eaters, n=1743) comprises subject with the highest intake of junk food (sweets, soft drink and chips) and the lowest intake of fruit and vegetables. Also these subjects report a slightly higher consumption of milk products, cereals and meats-fish-eggs.



Cluster three (Restrictive eaters, n=2291) encompasses adolescents reporting a lower food intake on all food variables compared with the sample's average.

Descriptive analysis (Table 8.3) showed a high percentage of overweight (20%) and obesity (5.2%) in our sample. As far as dietary patterns are concerned, the higher percentage was found for Restrictive pattern (37%) followed by Healthy pattern (34.5%) and Junk pattern (28.5%). A worrying data is that more than half the sample (66.6%) reported not performing daily moderate or vigorous physical activity. Finally, as far as food-related lifestyle variables are concerned, the most common food-related lifestyle among adolescents from Veneto-Region is the habit to watch television during mealtime (53.9%).

Table 8.3. Descriptive analyses (%) of BMI status, dietary patterns, physical activity and food-related lifestyles by total sample and gender and significance of the difference.

Variables	Total Sample (N=6149)	Boys (N=3197)	Girls (N=2952)	χ^2
	%	%	%	
BMI Status				
Normal weight	74.7	70.6	79.3	
Overweight	20.0	23.0	16.8	
Obesity	5.2	6.5	3.9	63.79***
Dietary Pattern				
Healthy Eaters	34.5	30.3	39.1	
Junk Eaters	28.5	33.8	22.7	
Restrictive Eaters	37.0	35.9	38.2	94.52***
Moderate or Vigorous Physical Activity (MVPA)				
Not daily MVPA	66.6	60.1	73.6	123.96***
Food lifestyle behaviors				
Not daily breakfast	27.9	24.0	32.2	51.65***
Daily snack TV	30.5	31.4	29.5	2.52
Daily snack PC	22.2	27.1	16.9	90.75***
Daily TV during meal	53.9	53.7	54.1	0.08
Heavy TV viewing behavior	17.3	17.5	17.1	0.14

*** $p < .001$

About gender differences, males showed higher percentage of obesity and overweight, junk eating pattern and daily snacking while using computer than females. Instead, females showed a higher percentage of not engaging in daily physical activity and skipping breakfast. No gender differences were found for snacking while watching television and television viewing behaviors.

The results of the single models and full model regression analysis are shown in Table 8.4. The single model fitting information underlined a significant relationship between BMI status and the set of independent variables in each single model, supporting the hypothesis of the significant associations between the three individual domain weight-related and BMI status. However, the likelihood ratio tests of the singular models showed no significant association between snacking using PC and 4 hours or more watching television and BMI. The final full model accounted for 14.9% of the variance in BMI status. Significant associations between BMI and the set of the independent variables were found: socio-demographic characteristics, dietary patterns, physical activity and food-related lifestyle behaviors were significant in the full model.

Table 8.4. Multinomial logistic regression model on BMI status (normal weight, overweight and obesity): likelihood ratio tests and model fitting information.

	SINGLE MODELS		FULL MODEL	
	χ^2	<i>p</i>	χ^2	<i>p</i>
Model 1: Socio-demographics				
Gender	111.97	<.001	135.41	<.001
Age	20.20	<.001	29.06	<.001
FAS	15.21	<.001	8.09	<.05
Diet	403.62	<.001	337.52	<.01
Born in Italy	14.35	<.001	11.67	<.001
<i>Model fitting information</i>				
χ^2	508.2			
<i>df</i>	10			
<i>p</i>	< .001			
<i>Negelkerke R²</i>	0.114			
Model 2: Dietary Behaviors				
Dietary patterns (Clusters)	37.70	<.001	32.67	<.001
<i>Model fitting information</i>				
χ^2	523.48			
<i>df</i>	14			
<i>p</i>	<.001			
<i>Negelkerke R²</i>	0.127			
Model 3: Physical Activity				
Low physical activity	14.67	<.001	10.390	<.01
<i>Model fitting information</i>				
χ^2	510.26			
<i>df</i>	12			
<i>p</i>	< .001			
<i>Negelkerke R²</i>	0.116			
Model 4: Food-related lifestyles				
Not daily breakfast	28.47	<.001	22.36	<.001
Daily snack TV	15.48	<.001	10.14	<.01
Daily snack PC	1.03	0.598		
Daily TV during meal	35.80	<.001	46.13	<.001
Heavy TV viewing behavior	1.61	0.448		
<i>Model fitting information</i>				
χ^2	589.79		606.01	
<i>df</i>	20		22	
<i>p</i>	< .001		< .001	
<i>Negelkerke R²</i>	0.135		0.149	

Table 8.5. Multinomial logistic regression model: parameter estimates relative to the referent group “Normal weight”.

	SINGLE MODELS						FULL MODEL					
	Overweight			Obesity			Overweight			Obesity		
	B (SE)	OR (95%CI)	<i>p</i>	B (SE)	OR (95%CI)	<i>p</i>	B (SE)	OR (95%CI)	<i>p</i>	B (SE)	OR (95%CI)	<i>p</i>
Socio-demographics												
Intercept	-2.44 (0.22)		<.001	-3.89 (0.43)		<.001	-3.14 (0.27)		<.001	-5.18 (0.55)		<.001
Gender (Males)	0.59 (0.07)	1.80 (1.57-2.07)	<.001	1.00 (0.13)	2.71 (2.09-3.53)	<.001	0.69 (0.08)	1.99 (1.71-2.32)	<.001	1.26 (0.15)	3.53 (2.63-4.74)	<.001
Age	-0.18 (0.04)	0.83 (1.11-1.30)	<.001	-0.12 (0.08)	0.88 (0.97-1.31)	ns	-0.24 (0.05)	0.79 (1.16-1.39)	<.001	-0.17 (0.08)	0.84 (1.01-1.40)	.042
FAS	-0.10 (0.06)	0.91 (0.81-1.02)	ns	-0.39 (0.10)	0.68 (0.55-0.83)	<.001	-0.03 (0.06)	0.97 (0.86-1.10)	ns	-0.33 (0.11)	0.72 (0.58-0.90)	.004
Diet	1.37 (0.09)	3.95 (3.32-4.69)	<.001	2.22 (0.13)	9.18 (7.05-11.95)	<.001	1.31 (0.09)	3.70 (3.07-4.45)	<.001	2.27 (0.15)	9.65 (7.24-12.88)	<.001
Born in Italy	0.46 (0.16)	1.58 (1.15-2.16)	<.001	0.83 (0.34)	2.30 (1.19-4.45)	.020	0.48 (0.19)	1.62 (1.12-2.33)	.010	0.89 (0.40)	2.44 (1.10-5.38)	.028
Dietary Patterns												
Intercept	-2.64 (0.25)		<.001	-4.04 (0.50)		<.001						
Healthy Eaters		1.00			1.00			1.00			1.00	

		(Reference)			(Reference)			(Reference)			(Reference)	
Junk Eaters	-0.17	0.85	ns	-0.32	0.72	ns	-0.22	0.80	.026	-0.44	0.64	.026
	(0.10)	(0.70-1.02)		(0.19)	(0.50-1.04)		(0.10)	(0.66-0.97)		(0.20)	(0.44-0.95)	
Restrictive Eaters	0.30	1.35	<.001	0.33	1.39	.029	0.23	1.26	.008	0.25	1.28	ns
	(0.08)	(1.15-1.59)		(0.15)	(1.04-1.87)		(0.09)	(1.06-1.49)		(0.16)	(0.94-1.74)	
Physical Activity												
Intercept	-2.58		<.001	-4.35		<.001						
	(0.23)			(0.45)								
Low physical activity	0.15	1.16	.050	0.50	1.64	<.001	0.11	1.11	ns	0.47	1.60	.002
	(0.07)	(1.00-1.34)		(0.14)	(1.24-2.17)		(0.08)	(0.95-1.30)		(0.16)	(1.18-2.17)	
Food-related lifestyles												
Intercept	-2.79		<.001	-4.57		<.001						
	(0.24)			(0.46)								
Not daily breakfast	0.34	1.41	<.001	0.55	1.73	<.001	0.34	1.40	<.001	0.48	1.61	<.001
	(0.08)	(1.21-1.64)		(0.14)	(1.32-2.27)		(0.08)	(1.19-1.64)		(0.15)	(1.20-2.15)	
Daily snack TV	-0.31	0.73	<.001	-0.35	0.71	.035	-0.26	0.77	.002	-0.17	0.84	ns
	(0.09)	(0.62-0.87)		(0.16)	(0.51-0.98)		(0.09)	(0.65-0.91)		(0.16)	(0.61-1.15)	
Daily snack PC	-0.06	0.94	ns	0.11	1.12	ns						
	(0.10)	(0.78-1.13)		(0.17)	(0.80-1.57)							
Daily TV during meal	0.39	1.48	<.001	0.46	1.59	<.001	0.45	1.58	<.001	0.58	1.79	<.001
	(0.07)	(1.28-1.71)		(0.14)	(1.22- 2.08)		(0.08)	(1.36-1.83)		(0.14)	(1.35-2.37)	
Heavy TV viewing behavior	0.09	1.09	ns	0.18	1.19	ns						
	(0.10)	(0.90-1.31)		(0.17)	(0.86- 1.65)							

Finally, the parameter estimates for “Overweight” and “Obesity” relative to “Normal weight” category are shown in Table 8.5. Adjusting for socio-demographic characteristics and dieting we found a negative association in the full model between the cluster of “Junk eaters” and obesity and overweight. A positive association was found for the cluster of “Restrictive eaters” and the outcome variable. However, the association between restrictive dietary patterns and obesity disappeared in the full model when we also controlled for the effect of physical activity and food-related lifestyles.

Low physical activity level was positively associated with BMI in the singular model, even if when we controlled for dietary patterns and food-related lifestyles this variable remained positively associated only with obesity and not with overweight.

The single model on food-related lifestyle variables is the model with the higher *Negelkerke R²* (0.135). In the full model, among food-related lifestyles, skipping breakfast and daily television watching during meals were positively associated with obesity and overweight, despite the control of the other lifestyles variables, dietary patterns and physical activity. Moreover, snacking while watching television was negatively associated with obesity and overweight. However, this association disappeared for obesity in the full model. Finally, snacking using PC and heavy television viewing behaviors are not significantly associated with obesity and overweight.

9.4 DISCUSSION

The main purpose of the present study was to examine the association between BMI status, assessed with objective measures of height and weight, and dietary patterns, physical activity and food-related lifestyles variables in a broad sample of adolescents from the Veneto Region. Overall, these results underline the complexity of obesity-related behaviors and lifestyles in adolescence.

This work shows a high prevalence of obesity and overweight in adolescents from the Veneto Region, especially among males, underlining the need to better identify the factors associated with these phenomena among adolescents. The high prevalence of excess of weight problems may be partially explained (see Chapter 5) in terms of energy intake and expenditure. We have included three different domains in this study: dietary patterns, physical activity and food-related lifestyles.

Cluster analysis was used to identify groups of participants with different dietary patterns. Our results have shown that despite the lack of international studies investigating the cluster relationships between different eating behaviors in adolescents, this approach could be really useful (Boone-Heinonen et al., 2008; Sabbe et al., 2008) in the identification of different and specific food patterns linked with BMI status. As far as dietary patterns are concerned, most adolescents reported a restrictive pattern or a healthy pattern, especially among girls.

In line with previous studies (Hills et al., 2007; Pratt, Macera, & Blanton, 1999; Reilly, & McDowell, 2003; Reilly, et al., 2004), our results showed that few adolescents perform (around one-third) adequate levels of Moderate or Vigorous Physical Activity, as suggested by international recommendations, especially among girls (Cumming et al., 2008; Hills et al., 2007; Pearson et al., 2009; Sallis et al., 2000). The most common food-related lifestyles among adolescents is the habit of watching television during meals (53.9%) and skipping breakfast (30.5%).

Moreover, all the domains (dietary patterns, physical activity and food-related lifestyles) are associated with the outcome variable confirming that several factors at the individual level are associated with obesity and overweight and underlining the importance of studying them simultaneously (Davison, & Birch, 2001). No significant moderating effect was found for gender in the associations between dietary patterns, physical activity and food-related lifestyles variables and BMI status (data not shown), suggesting that these relationships are common for boys and girls.

9.4.1 ASSOCIATION BETWEEN BMI STATUS AND FOOD-RELATED LIFESTYLES

An important finding of this study is that watching television during meals and skipping breakfast represent the strongest variables associated with obesity and overweight.

Television viewing is one of the most common sedentary behaviors among adolescents associated mainly with poor dietary habits, but also with obesity and overweight (Boynton-Jarrett et al., 2003; Davison, & Birch, 2001, Gable et al., 2007; Hanley et al., 2000; Hernández et al., 1999; Janssen et al., 2004b; Janssen et al., 2005; MacFarlane, Cleland, Crawford, Campbell, & Timperio, 2009; Robinson, 2001; Vereecken et al., 2006).

Several reasons can be found in the literature to explain the role of television viewing behaviors with regard to dietary behaviors, obesity and overweight (Boynton-Jarrett et al., 2003; Davison, & Birch; Janssen et al., 2005; Vereecken et al., 2006). These reasons include an increased caloric intake during viewing, influences of food advertising which, in turn, are linked with individuals' food preferences, dietary consumption, reduced energy expenditure but also a misconception about knowledge of food nutritional values and characteristics of foods due to marketing strategies used in the advertising which are more focused on psychological and emotional needs, rather than feelings of hunger or real food characteristics (Vereecken et al., 2006).

However, in this study only the association between watching television during meals is associated with obesity and overweight, while heavy TV viewing is not associated with the outcome variable.

It is possible that the hours spent watching television are more strongly linked with dietary patterns, in terms of higher consumption of food normally advertised and a lower consumption of food that is less often advertised, than directly with BMI as confirmed by some meta-analytic studies which found a small effect size in the association between television viewing and body fat (Marshall, Biddle, Gorely, Cameron, & Murdey, 2004).

Even if several studies have analyzed the direct effect of television exposure on dietary behaviors and overweight, our findings suggest that the circumstances in which adolescents watch television should also be considered and may play an important role. Watching television during meals has been associated with more frequent quick suppers, lower fruit and vegetable intake and more pizzas, snack foods, and soda consumption (Coon et al., 2001, p. 8). Moreover, the use of television during meals involves not only the adolescents but also their family system. As suggested by Coon and colleagues (2001, p. e8) "*the presence of television at meals acts as a marker of fundamentally different dietary patterns for children whose families have incorporated television as a habitual part of their food cultures*". Thus, the habit of watching television during meals may be considered to be an important indicator of the separation between the private food routine and the food culture promoted on television (Coon et al., 2001).

Moreover, the importance of good breakfast habits has been observed in many studies in terms of good quality, large quantity and high frequency (Matthys et al, 2006). In line with other studies (Affenito et al., 2005; Huang et al., 2009; MacFarlane et al., 2009; Ortega et

al., 1996) we found a significant association between skipping breakfast and overweight and obesity. Eating breakfast may, in fact, can lead to more regular and healthy eating habits and exercise patterns, reduce dietary fat intake and minimize impulsive snacking (Nicklas et al, 2001a).

An unexpected finding was the negative association between snacking while watching television and overweight and obesity, and no association between snacking while using the PC and the outcome variable.

Even if, in the majority of the previous studies there was a relationship between snacking and overweight (Francis, Lee, & Birch, 2003; Nicklas et al., 2003), some longitudinal studies found no significant association (Field et al., 2004; Phillips et al., 2004). In addition, Vader and colleagues (2009) found that eating snacks was associated with a lower chance of being overweight regardless of the amount of television watched. In addition, our findings underline that snacking while watching television was associated with a lower risk of overweight. However, it is important to recognize that snack consumption is not an unhealthy behavior per se, indeed snacks can be both “healthy” or “unhealthy” (American Dietetic Association, 2003). Anyway, our item investigated snack consumption while watching television. Television viewing is characterized by advertising promoting mostly unhealthy food and the power of food advertisement is well documented in the literature (Halford, Gillespie, Brown, Pontin, & Dovey, 2004; Lobstein, & Dobb, 2005; Wiecha et al., 2006). Thus, it is unlikely that our reverse association between snack and overweight may be explained by the quality of snack intake.

Moreover, frequent snacking may be associated with other eating behaviors, such as eating less at meal time (Vader et al., 2009). Thus, further studies are needed to explain this controversial association taking into account, for example, information about the type of snack food, the portion size and the total numbers of snack food consumed. It is possible that this reverse association between snacking while watching television and overweight could be more clearly explained by snack type and quality and by the serving size of snacks consumed.

Finally, even if snacking while using the computer may also have an effect on unhealthy weight gain, this behavior could be less related to increased energy intake and overweight because computer use is accompanied by fewer food advertisements which are designed to invoke feelings of hunger than television (Swinburn, & Shelly, 2008; Verzeletti et al.,

2009a). It is possible that the association between snacking while using the computer and BMI is part of a complex lifestyle, in which, overall, sedentary behaviors, snacking and overweight are all associated.

9.4.2 ASSOCIATION BETWEEN BMI STATUS AND PHYSICAL ACTIVITY

Several studies have addressed the relationship between reduced physical activity levels and the higher risk of obesity and overweight in adolescence (Hills et al., 2007; Huang et al., 2009; Janssen et al., 2005). In our study, we found a significant association between a low level of moderate or vigorous physical activity and overweight and obesity. However, after controlling for all the other variables this association remained significant only for obesity, suggesting that moderate or vigorous physical activity is a less important variable in relation to overweight, as compared with dietary patterns and food-related lifestyle variables. Further research is necessary in order to investigate the potential mechanisms involved in this association to better explain differences between overweight and obese adolescents.

9.4.3 ASSOCIATION BETWEEN BMI STATUS AND DIETARY PATTERNS

Other unexpected findings of this study include the negative association between Junk Eaters pattern and overweight and obesity, and the positive association between Restrictive Eaters pattern and overweight. In other words, we found that adolescents with higher sweet, soft drink and chip intake and lower fruit and vegetables intake are less likely to be overweight or obese compared with people with healthy eating patterns. Moreover, adolescents reporting that they eat little of all food categories are more likely to be overweight or obese compared with people with a healthy eating pattern.

Moreover, other studies analysing the association between dietary behaviors in relation to obesity and overweight underlined controversial evidence revealing inconsistent or reverse associations (Alexy, Sichert-Hellert, Kersting, & Schultze-Pawlitschko, 2004; Boone-

Heinonen et al., 2008; Huang et al., 2009; Janssen et al., 2005; Rolland-Cachera, & Bellisle, 2002, Togo, Osler, Sorensen, & Heitman, 2001).

Different factors may contribute to these unexpected results causing inconsistency in terms of energy intake. Previous studies found in the adult population that foods that are high in added sugars are selectively under-reported (Krebs-Smith et al., 2000). Thus, it is possible that adolescents, especially if they are overweight or obese, tend to under-report the consumption of junk foods (soft drink, chips and sweets in this study).

In addition, overweight and obese people tend to under-report their overall food intake compared with normal weight subjects (Garaulet et al., 2000; Heitmann & Lissner, 1995; Janssen et al., 2005). Indeed, some authors suggest that people tend to under-report their intake proportionally to their excess of body weight (Rolland-Cachera, & Bellisle, 2002).

Another possible explanation is that diet or the attempt to lose weight are more often reported by overweight and obese adolescents compared with normal weight peers (Boone-Heinonen et al., 2008; Viner et al., 2006). However, we controlled the effect of being on a weight loss diet, therefore, it is unlikely that this is able to explain our result. Despite this, it is possible that overweight or obese adolescents are intentionally restricting their intake to control their excess of weight, even if they don't categorize these restrictions as "being on a weight loss diet" (Janssen et al., 2005).

Because dietary restriction is reported more often by overweight subjects, it is also possible that the *present* dietary pattern is not the factor responsible for the overweight status (e.g., the more important role of past dietary patterns) (Rolland-Cachera, & Bellisle, 2002).

Moreover, meals are mainly prepared by parents or other significant adults for adolescents. It is possible that parents may selectively restrict junk food in order to allow their overweight or obese adolescents to control or reduce their excess of weight. Similar results were, indeed, underlined in pre-school children (Gibson, 1998).

Another possible explanation is linked with the association between appetite and weight. Recent studies suggest (Carnell, & Wardle, 2008; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009) that overweight and obesity could be linked with the appetite regulation (e.g., higher responsiveness to food cues, more emotional eating, lower satiety responsiveness) more than unhealthy eating patterns. However, these findings need further confirmation in different cultural contexts and no final conclusion can yet be drawn.

Finally, we have only assessed dietary patterns in terms of frequency of consumption. We don't have any information about the portion size or the number of servings. It is possible that even if overweight or obese adolescents report consuming unhealthy food less frequently than normal weight peers, they really ate larger portion sizes (Janssen et al., 2005).

These reverse findings underline the need to develop and implement preventive interventions promoting not only healthy weight-control strategies, but also healthy eating habits in adolescent population involving both normal weight and overweight young people.

9.5 LIMITATIONS

Some limitations should be addressed in relation to this study. First, because of the cross-sectional design of the survey, inferences regarding cause and effect are not possible and the temporality of the associations between dietary patterns, physical activity and food-related lifestyles and BMI status is uncertain. In order to explain the factors involved in the insurgence and maintenance of excess of weight and to clarify certain relationships (e.g., dietary patterns and BMI) longitudinal studies may be more appropriate. Second, the data were based on self-report measurements. Self-report measures, which assess dietary intake in adolescence tend to result in reporting errors (Livingstone, Robson, & Wallace, 2004) and to be influenced by social desirability. However, students' responses were anonymous, therefore, adolescents had no reason to reply in a socially desirable way (Huang et al., 2009). Third, we only used adolescents' reports: obtaining data from multiple sources (i.e. parents) would probably be more informative and enable us to address, for example, differences between individual and familial food-related lifestyles. Fourthly, only a crude measure was used to collect dietary data. We assessed dietary intake by using single questions for each food with no reference to the portion size or amount consumed. Possible overestimation should be considered (Vereecken et al, 2008), even if FFQ validation studies have found that the HBSC FFQ is a reliable questionnaire that can be used for ranking subjects (Vereecken, & Maes, 2003). Fifth, in this study we assessed several behaviors and lifestyles including weekdays habits. Lifestyles behaviors, physical activity and dietary patterns may yield different results at the weekend (Kotz, & Story, 1994; Rohm Young, Jerome, Chen, Laferriere, & Vollmer, 2009; Vader et al., 2009).

9.6 CONCLUSION

Overall, our results underscore that overweight and obesity are simultaneously associated with several food-related lifestyles, physical activity and dietary patterns. In terms of energy balance-related behaviors, obesity and overweight seem to be part of a complex configuration of unhealthy behaviors and habits, which should be considered in planning educational and preventive interventions.

These findings suggest that prevention and intervention programs, targeting adolescents' obesity and overweight, frequently centering on diet and/or physical activity, should also be focused on food-related lifestyle behaviors which play an important role in regard to excess of weight problems. However, the reverse results on dietary patterns and obesity and overweight also suggest the possible benefits for adolescents of interventions promoting healthy eating habits and weight-control behaviors for all, overweight and not overweight adolescents.

Although several factors are likely to contribute to the higher prevalence of obesity and overweight among adolescents, this study is focused on changeable individual factors underlining potential intervention target among adolescent populations.

In conclusion, the approach to simultaneously studying the role of dietary patterns, physical activity and food-related lifestyles behaviors associated with adolescents' energy balance may make the preventive programs aiming to prevent weight gain among adolescents more complex, but it will also make them more effective because it considers the complexity and the synergistic effects of obesity-related lifestyles and behaviors. Moreover, as suggested by Kremers and colleagues (2004, p. 604), this approach allows us to consider the individual's motivational aspects, which are particularly relevant for health behavioral changes: *“An advantage of the energy balance approach lies in the fact that some individuals might be interested in reaching energy balance by changing their snacking behaviour, while others might be more inclined to change their level of physical activity during leisure time. Offering a target group the possibility of choosing how to maintain their energy balance will constitute an attractive feature for intervention designers trying to achieve the prevention of obesity”*.

Further studies should investigate the role and the influences of micro- and macro-contexts of life in which these behaviors take place in adolescence.

CHAPTER 10

THE ROLE OF BEHAVIORAL, EDUCATIONAL AND RELATIONAL FAMILY FACTORS, BODY MASS AND BODY IMAGE ON ADOLESCENTS' BODY DISSATISFACTION

10.1 INTRODUCTION

As described in chapter 6, parents influence the onset and maintenance of children's and adolescents' overweight and weight-related behaviors and lifestyles in two main ways (Ritchie, Welk, Styne, Gerstein, & Crawford, 2005). Firstly, in a direct way, building and determining the physical and social environment in which adolescents live. Secondly, in an indirect way, through socialization, relational processes and modelling. Moreover, during adolescence parents are an important target of identification who influence adolescents' attitude towards body shape, dietary behaviors, physical activity and food-related lifestyles and, subsequently, adolescents' weight status (Burgess-Champoux et al., 2009; Davison, & Birch, 2001; Rodgers, & Chabrol, 2009; Sen, 2006; Wisniewski et al., 2009).

Family meals may play a relevant role in the prevention and change of children's and adolescents' overweight (Sen, 2006). Several studies have identified an association between frequency of family meals and dietary behaviors, quality of diet and psychosocial well-being among adolescents (Burgess-Champoux et al., 2009; Fulkerson, Strauss, Neumark-Sztainer, Story, & Boutelle, 2007; Gillman et al., 2000; McClain, et al., 2009; Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003; Videon, & Manning, 2003; Verzeletti et al., 2009b).

While studies have found an association between frequency of family meals and healthier dietary behaviors among adolescents that, in turn, should have an impact on adolescents' BMI, fewer studies have investigated the direct association between family meals and adolescents' body mass. Studies have found an association between a high frequency of

family meals and a lower risk of becoming and remaining overweight (Sen, 2006), while other longitudinal studies have found no significant association (e.g., Taveras et al., 2005). Moreover, as well as the frequency of family meals, the circumstances in which meals are consumed also play an important role (Branca et al., 2007). The use of television during meals has been found to be associated with poor dietary behaviors (Boutelle, Birnbaum, Lytle, Murray, & Story, 2003; Coon et al., 2001; Feldman, Eisenberg, Neumark-Sztainer, & Story, 2007; Verzeletti et al., 2009a,b), that, in turn, are linked with adolescents' BMI (see Chapter 5). As affirmed by Coon and colleagues (2001, p. 2) *“Because children learn television-viewing habits, as well as eating habits, primarily from parents, the choices parents make about the use of television during meals may be associated with choices that they make regarding the foods they buy and make available to their children, independently of children's direct requests for advertised foods”*.

In addition, the literature on specific food-related parenting practices in adolescence indicates controversial results concerning the association between family restriction, parenting practices and dietary behavior and body mass in adolescence. On the one hand, some studies have found that restrictive parenting practices may increase children's food intake and preference for restricted foods, that, are usually unhealthy (e.g., Birch, & Fisher, 2000; Brown, & Ogden, 2004). On the other hand, studies have also found that restrictive parenting practices are associated with adolescents' healthier dietary behaviors (e.g., De Bourdeaudhuij, & Van Oost, 2000, Hearens et al., 2008; van Horst et al., 2007; Verzeletti et al., 2009b).

Although it is a topic which has been investigated less than adolescents' dietary behaviors, parenting practices may also influence also adolescents' weight status. Studies suggest that parental restrictions are linked with higher weight status (Fisher, & Birch, 1999a; Moens, Braet, & Soetens, 2007). In contrast, Robinson and colleagues (2001) found that parents who report greater control on food intake had daughters who were less likely to be overweight, while no association was found for males. Finally, other studies have found no association between parental feeding practices and children's weight (Wardle, Sanderson, Guthrie, Rapoport, & Plomin, 2002).

In addition to behavioral (family food-related lifestyles) and educational (parenting practices) variables, relational family factors should also be considered. Family functioning and the quality of relationships with parents have seldom been investigated in association

with weight status, dietary behaviors and food-related lifestyles, and, overall, it should be noted that these associations, if and when found, are modest (De Bourdeaudhuij, & Van Oost, 2000; McClain, et al., 2009). However, positive relationships with parents may be considered as a protective factor against psychosocial consequences linked with overweight and obesity and adolescents' body image and dissatisfaction (Mellin et al., 2002). One of the most common indicators adopted in this research field, in order to assess the quality of parent-adolescent relationships and parental involvement, is the communication between adolescents and parents (e.g., Al Sabbah et al., 2009; Currie, Hurrelmann, Settertobulte, Smith, & Todd, 2000). Other studies, on the other hand, have considered perceived family social support (e.g., Presnell et al., 2004). In this study, in line with Marta (1997), family functioning and the quality of relationships with parents have been assessed in terms of both communication with parents and perceived family social support. In fact, both communication with parents, meaning parental and adolescent openness in talking about different topics, and perceived social support from family, meaning the adolescent perception to rely on parents, are central aspects of family relationships (Calandri, Borca, Begotti, & Cattelino, 2004).

Two of the most important consequences linked with adolescents' weight are poor body image and body dissatisfaction which, in turn, are associated with unhealthy dieting behaviors and several psychosocial and relational problems, such as depressive symptomatology (Chaiton et al., 2009; Franko, & Striegel-Moore, 2002; Ohring, Graber, & Brooks-Gunn, 2002; Paxton et al., 2006; Stice, & Bearman, 2001). Like obesity, body dissatisfaction is also widespread in western society, especially in adolescence and young adulthood (Neumark-Sztainer et al., 2006a).

The definition of body dissatisfaction varies across studies. In some studies poor body image and body dissatisfaction are considered as similar constructs, in which body dissatisfaction is a measure of body image (Rosenblum, & Lewis, 1999; Wardle, & Cooke, 2005). Other studies suggest that body dissatisfaction should be distinguished from the accuracy of body size perception (Presnell et al., 2004). Thus, body dissatisfaction may be defined in terms of affective, cognitive and behavioral components that together determine the individuals' subjective evaluation of their body image (Thompson et al., 1999). While

body image¹⁹ is a self-evaluative function influenced by the self-evaluation of our own body, personal expectations about physique and the perceived evaluation of others (Lerner, 1987; Rosenblum, & Lewis, 1999).

Moreover, taking as a starting point the conceptualization of body image proposed by Gleaves and colleagues (1995), Barker and Galambos (2003, p.141) define body dissatisfaction as “*the affective component of the multidimensional construct of body image, that is, how individuals feel about their bodies*”.

In the present study we considered body image in terms of adolescents’ perception of their body weight, while, body dissatisfaction was defined in line with Barker and Galambos (2003) in terms of the affective component of body image.

Positive family relationships (high perceived family social support and ease of communication with parents) may play the role of a buffer on negative social and cultural influences, sustaining adolescents in the development of positive body image and lower levels of body dissatisfaction (Al Sabbah et al., 2009; Ata et al., 2007; Barcker, & Galambos, 2003; Bearman et al., 2006; Jones, 2004; May et al., 2006; Presnell, & Spangler, 2002; Presnell, Bearman, & Stice, 2004; Ricciardelli et al., 2000; Stice and Whitenton, 2002; Stice, Presnell, & Spangler, 2002; Swarr, & Richards, 1996).

Moreover, studies have revealed differences between the role of the mother and the father in influencing these outcomes among adolescents. Studies have found that only father-child conflicts are associated with weight concerns in adolescence in both genders (May et al., 2006). A cross-sectional study (Al Sabbah et al., 2009) involving 24 countries found that difficulty in talking to fathers was more common than difficulty in talking to mothers among adolescents. In addition, difficulty in talking to fathers was associated with weight dissatisfaction among both boys and girls adolescents in most countries, while difficulty in talking to mothers was associated with body weight dissatisfaction for girls in most countries but rarely for males (Al Sabbah et al., 2009).

Overall, a greater body dissatisfaction and poor body image has been found in heavier children and adolescents (Al Sabbah et al., 2009; Barker, & Galambos, 2003; Clark, &

¹⁹ More information about the development of the body image construct, individual and environmental correlates and risk factors among adolescents can be found, for example, in: Gleaves, Williamson, Eberenz, Sebastian, & Barker, 1995; Lerner, 1987; Molinari, & Riva, 2004; Paxton, Eisenberg, & Neumark-Sztainer, 2006; Presnell, Bearman, & Stice, 2004; Ricciardelli, & McCabe, 2001; Rosenblum, & Lewis, 1999, Wardle, & Cooke, 2005.

Tiggeman, 2008; McCabe, & Ricciardelli, 2006; Paxton et al., 2006; Presnell et al., 2004; Stice, & Whitenton, 2002; Rosenblum, & Lewis, 1999; Wardle, & Cooke, 2002).

However, other studies have found that more than half of overweight adolescents are not aware that they are overweight (Brener, Eaton, Lowry, & McManus, 2004; Daniels, 2005). For this reason, in this study, we hypothesize that body dissatisfaction is associated with both, adolescents' body mass and poor body image (conceptualized in terms of adolescents' perception of body image).

Unfortunately, studies involving both parents and adolescent males and females in this regard are lacking. Most studies on body image and body dissatisfaction have focused their attention only on adolescent girls and on the role of mothers, fewer studies have involved both gender participants and less is known about the role of fathers (Ata et al., 2007). In addition, studies involving both genders as participants have had mixed results: studies have found greater body dissatisfaction among girls as compared with boys (e.g., Al Sabbah et al., 2009; Muris, Meeters, Vande, & Mayer, 2005; Presnell, et al., 2004), while other studies found no gender differences (Eisenberg et al., 2003).

Finally, in terms of the developmental perspective, longitudinal studies (e.g., Rosenblum, & Lewis, 1999) have found that changes in body image and beliefs about their body undergo important changes at the ages of 13 and 15 years, the target age of this work. Indeed, adolescence is commonly considered as the time in which body image changes and body dissatisfaction and concern increases (e.g., Clarck, & Tiggemann, 2008).

Although it is well recognized that family environment influences the onset and maintenance of overweight, shapes dietary behaviors and food-related lifestyles, and may have an impact on psychosocial outcomes body-related, such as body image and body dissatisfaction, the role of family variables has mainly been studied in childhood and less in adolescence.

Furthermore, the role of family food-related lifestyles and parenting practices has mainly been assessed in relation to dietary behaviors, and less in association with adolescents' weights status. In fact, the role of some family variables on adolescent body mass (e.g., restrictive parenting practices) remains presently unclear.

In addition, despite several authors underlining the importance of focusing on parent-offspring relationships and family functioning, in order to better understand several adolescent health behaviors (e.g., Scabini, Lanz, & Marta, 1999; Marta, 1997; Noller,

1994; Scabini, 1995), in this research topic family functioning and relationships with parents have been investigated less than behavioral family factors such as food-related behaviors and lifestyles. Understanding the role of parent–offspring relationships in psychosocial consequences linked with adolescents’ evaluation of their body (e.g., body image and body dissatisfaction) involving both males and females, and investigating the role of both parents, may help in the development of relevant and more effective intervention strategies and policies for both adolescents and families.

Finally, although the importance of several family factors on weight issues in adolescence is recognized in the literature, as described in chapter 6, most studies have focused their attention on factors within a single domain (e.g., behavioral correlates). However, the family can influence body mass, weight-related behaviors, body image and body dissatisfaction in adolescence in several ways including through behavioral, relational and educational factors. Few studies have examined the interplay of family factors on adolescents’ body well-being and body mass in adolescence (Fulkerson, Strauss, Neumark-Sztainer, Story, & Boutelle, 2007). Thus, examining multiple family variables, across different domains, in population studies may be a promising approach in order to better explain, with a broader approach, the role of family factors on adolescents’ weight status, body image and body dissatisfaction. For these reasons, in the present study, we are interested in understanding the role of several family variables, across different domains, on adolescents’ BMI, body image and body dissatisfaction.

The main aim of this study was to examine the association between objective adolescents’ BMI, body image and body dissatisfaction and family food-related lifestyles (meals with parents and the use of television during meals), restrictive parenting practices and family functioning (communication with parents and perceived family social support).

In order to meet this aim we have identified an integrative model that links behavioral, educational and relational family variables, adolescents’ BMI and body image to body dissatisfaction (Figure 10.1).

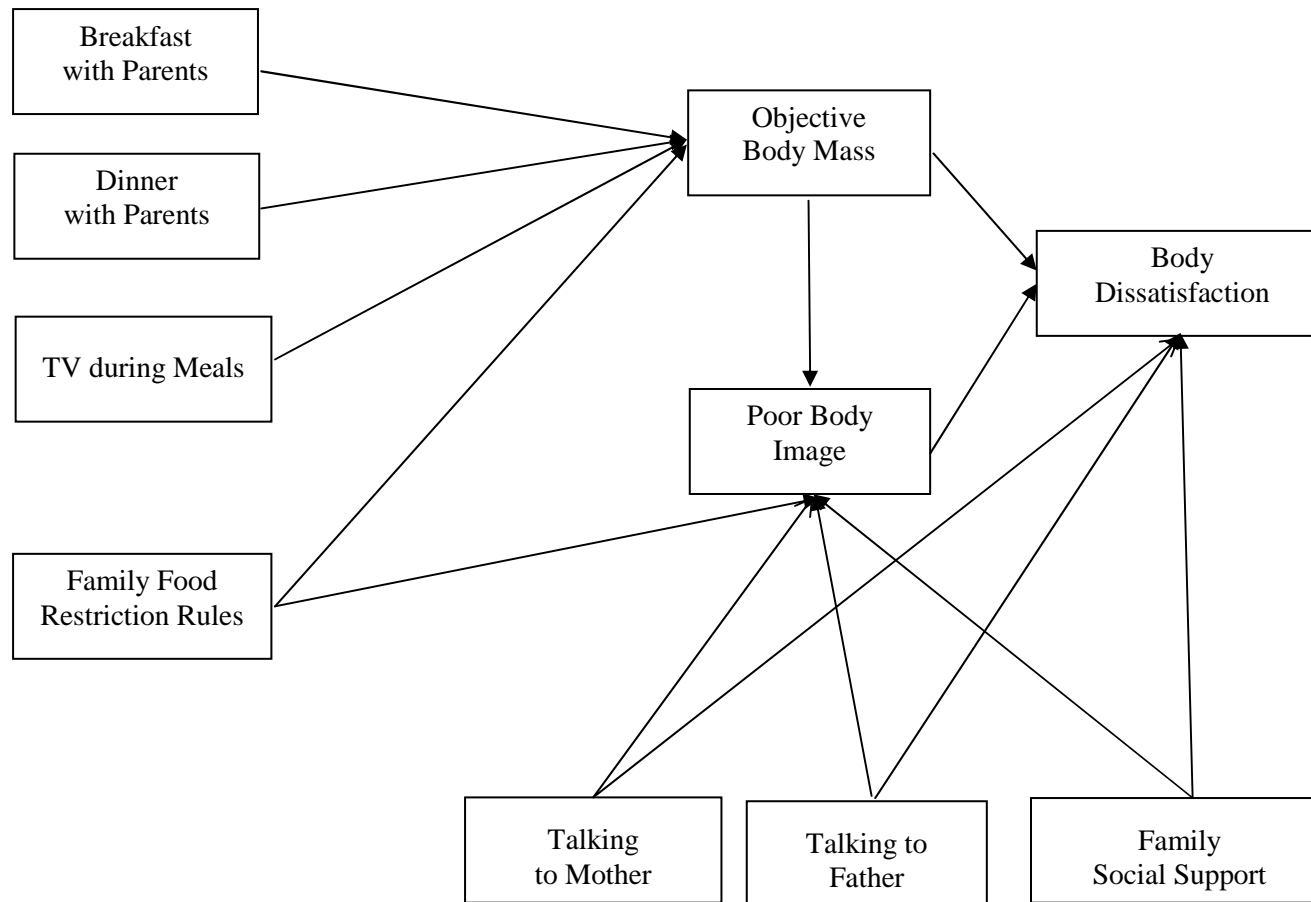
We have hypothesized a negative association between a greater frequency of family meals (dinner and breakfast with parents) and BMI, and a positive association between a greater frequency of meals consumed while watching television and BMI. In other words, we have hypothesized that the increase in the frequency of family meals is associated with lower

adolescent body mass, whereas, the increase in the frequency of family meals consumed while watching television is associated with higher adolescent body mass.

The model also posits an association between family restrictive food rules and adolescents' BMI and body image. Despite the mixed results on family restrictive food rules concerning adolescents' weight, non-experimental studies have found, mostly, a positive association between restrictive parenting practices and adolescents' healthier dietary behaviors (De Bourdeaudhuij, & Van Oost, 2000, Hearens et al., 2008; van Horst et al., 2007; Verzeletti et al., 2009a,b) that, in turn, should be associated with a healthier body weight. Moreover, studies which also involve Italian adolescents, have found significant association between more restrictive family rules on unhealthy food intake and healthier dietary behaviors among adolescents: higher consumption of fruit and vegetable and lower soft drink intake (Verzeletti et al., 2009a,b). Thus, in line with the results of Robinson and colleagues (2001), higher family restrictive food rules should be negatively associated with adolescents' BMI. Moreover, we hypothesized that positive family relationships (high perceived family social support and ease of communication with parents) are protective factors which sustain adolescents in the development of a positive body image and lower levels of body dissatisfaction. Thus, we have hypothesized a negative relationship between adolescents' communication with parents, perceived family social support and poor body image and body dissatisfaction.

In addition, we hypothesized that body dissatisfaction was positively associated with objective body mass and body image. Thus, both objective body mass and perceived body mass (body image) should contribute to determine adolescents' dissatisfaction with their body. Body mass, however, is hypothesized to be positively associated with adolescents' body image. So, larger body mass should be positively linked with adolescents' perception of being heavier, and both objective body mass and the relative perception, would contribute to increasing adolescents' body dissatisfaction.

Figure 10.1. Hypothesized model assessing behavioral, educational and relational family variables, BMI and body image on adolescents' and body dissatisfaction.



Finally, studies suggest that gender differences represent an important factor in this research topic (e.g., Hearens et al., 2008; Sweeting, 2008). For example, gender was found to moderate the effect of BMI on body dissatisfaction (Presnell et al., 2004), other studies have found a greater impact of BMI on body dissatisfaction in adolescent girls compared with boys (Stice, & Whintenton, 2002; Jones, 2004), while other studies have found gender differences in the communication with parents (Al Sabbah et al., 2009; Marta, 1997). Considering the importance of gender differences, we tested the moderation effect of gender on the relationships specified in the model.

10.2 METHOD

10.2.1 PARTICIPANTS

The present data are part of the 2005-2006 (HBSC) survey. Data for the Italian Veneto Region were obtained from a sample of middle (first grade, ±11-12 years old and third grade, ±13-14 years old) and high schools (second grade ±15-16 years old) randomly selected from the school list provided by the Regional School Office. Of the 244 schools selected for participation, 240 schools (98% response) agreed to participate. In each participating school, 2 classes (about 40 pupils) were randomly selected. Of all pupils approached, 3% did not get consent from their parents; 6.6% of the pupils were absent on the day of testing. In total, 6,744 pupils completed the questionnaire.

For the current study only adolescents attending third grade of middle school (±13-14 years old) and second grade of high schools (±15-16 years old) were included because in the questionnaire of younger adolescents the scale about body dissatisfaction was not included. So that, from the original sample, 4,647 participants were included in the study. Only adolescents with no missing data on all dependent and independent variables were included in this study, resulting in a final sample of 3,880 participants (50.3% males).

Given the number of subjects with at least one data item missing it is possible that the young people included in the analysis may differ systematically from the original sample. For this reason, a chi-squared test was used to compare the original study's participants with students who were included in this study. The sub-sample which was excluded from the current study differed significantly from the original sample in terms of gender ($\chi^2_{(1)}=7.56$; $p<.05$) and age category ($\chi^2_{(1)}=5.26$; $p<.05$) distribution. More missing data were

found among girls (55.1% of the excluded sample) and among older adolescents aged 15-16 years old (51.8% of the excluded sample).

Among the final 3,880 participants of this study, 43.7% of adolescents were aged 13-14 years (M=13.98, DS=0.47) and 56.3% were aged 15-16 years (M=15.99, DS=0.61).

10.2.2 MEASURES

Body Mass Index (BMI). BMI was obtained using objective measures of height and weight (see Paragraph 8.2.2 for the detailed procedure). Overweight and obesity were identified using age- and gender specific international cut-off points (Cole et al., 2000), based on the average centile estimates to pass through BMI values of 25 and 30 kg*m² respectively, at the age of 18 years.

Poor Body Image. Body image has been operationalized in terms of self-perception of body weight status (Németh, & Ojala, 2007). A single item assessed body image by asking: “*Do you think your body is ... ?*” with five response options: (1) Much too thin; (2) A bit too thin; (3) About the right size; (4) A bit too fat; (5) Much too fat. This version of the body image item was based on that used in the 2001-2002 HBSC survey (Mulvihill, Németh, Vereecken, 2004). Validation studies were carried out in Finland, Hungary and Belgium-Flanders (Németh, & Ojala, 2007).

Body Dissatisfaction. Body Dissatisfaction has been operationalized in terms of adolescents’ emotional investment about their bodies. In to assess body dissatisfaction the Body Image Subscale of the Body Investment Scale (Orbach, Mikulincer 1998) was used. The subscale contained six items aimed at assessing the affective and emotional component of body image. This scale was inserted as an optional question in 2005-2006 HBSC survey, and has been piloted in Finland and Hungary (Németh, & Ojala, 2007). As suggested by the HBSC international protocol, the scale is suitable for use only with 13 and 15 year olds participants and not with younger adolescents (11 years old) (Németh, & Ojala, 2007). Before the items, the following sentence was written in the questionnaire: “*Here are some statements about one’s feelings about his/her body. There are no right or wrong answers. We would like to know what your feelings about your body are. Please*

evaluate how statements relate to you by checking the degree to which you agree or disagree with each one. Please tick one box for each line.” After this sentence six items were presented: “I am frustrated with my physical appearance”; “I am satisfied with my appearance”; “I hate my body”; “I feel comfortable with my body”; “I feel anger toward my body”; “I like my appearance in spite of its imperfections”. The response options were: (1) *Strongly disagree*; (2) *Disagree*; (3) *Neither agree nor disagree*; (4) *Agree*; (5) *Strongly agree*. The item responses were averaged in order to measure body dissatisfaction. The internal consistency of the scale in our sample was good ($\alpha = 0.90$).

Meals with parents. The frequency of meals with parents was assessed with two items by asking: “How often do you have breakfast together with your mother or father?” and “How often do you have an evening meal together with your mother or father?”. The six response options were: (1) Never; (2) Less than once a week; (3) 1-2 days a week; (4) 3-4 days a week; (5) 5-6 days a week; (6) Every day. These items were inserted for the first time in the 2005/2006 HBSC survey. The pilot study was carried out in 2004 in Italy and in Belgium Flanders. Test retest Spearman’s correlations were good for both items in both countries (varying between 0.64-0.78 for the three populations) (Vereecken, 2007).

Television watching during meals. The habit of watching television during meals was assessed by asking: “How often do you watch TV while having a meal?” with six response options: (1) Never; (2) Less than once a week; (3) 1-2 days a week; (4) 3-4 days a week; (5) 5-6 days a week; (6) Every day.

Family rules. Family restriction rules were assessed with four items by asking: “Do you get the following items from your parents if you ask for them?” *Coke or other soft drinks that contain sugar/ Sweets or chocolates/ Biscuits or pastries/ Crisps*. There were four response options: (1) “No, I never get that”; (2) “I get that sometimes”; (3) “I get that every time I ask for it”; (4) “I can take it when I want it”. The item responses were averaged to represent the measure of family restriction rules. The scale was inserted for the first time in the Belgium Flemish HBSC in 2000 and as optional scale in the international protocol in 2005-2006 HBSC survey. Validation studies carried out in Belgium Flanders and Italy in 2004 found that the internal consistency of the restriction rules scale was good as well as

the test retest ICC (0.69 among Belgian-Flanders adolescents and 0.90 among Italian adolescents) (Vereecken, 2007). The internal consistency of the scale in our sample was good ($\alpha = 0.89$).

Communication between parents and adolescents. Adolescents' communication with parents was assessed by asking "*How easy is it for you to talk to the following persons about things that really bother you? Father/Mother*". The possible response options were: (1) Very easy; (2) Easy; (3) Difficult; (4) Very difficult; (5) Don't have or see this person. The items were inserted in HBSC from the 1986 survey onwards. After taking into account the differences between communication with mothers and fathers in adolescence reported in the literature, we have chosen to consider these items separately (e.g., Al Sabbah et al., 2009; Pedersen, Granado Alcón, Rodriguez, & Smith, 2004).

Perceived Family Social Support. Family social support was assessed using the Italian version (Prezza, & Principato, 2002) of the Multidimensional Scale of Perceived Social Support – MSPSS - family subscale (Zimet, Dahlem, Zimet & Farley, 1988). The family subscale of the MSPSS consists of the four following items. "*We are interested in how you feel about the following statements. Read each statement carefully. Indicate how you feel about each statement. My family really tries to help me; I get the emotional help and support I need from my family; I can talk about my problems with my family; My family is willing to help me make decisions*". The possible response options were: (1) Very Strongly Disagree; (2) Strongly Disagree; (3) Mildly Disagree; (4) Neutral; (5) Mildly Agree; (6) Strongly Agree; (7) Very Strongly Agree. The item responses were averaged in order to measure perceived social support in the realm of the family. In line with the Italian validation studies (Prezza, & Principato, 2002), the internal consistency of the scale in our sample was good ($\alpha=0.84$).

10.2.3 STATISTICAL ANALYSIS

Before starting the statistical analysis, all the items were recoded in the same direction in which with the increase of values corresponds an increase of the level of variable (e.g., higher frequency of behaviors, rules, higher perceived social support and so on).

Firstly, bivariate correlations between study variables and descriptive statistics, for the total sample and by adolescents' gender, were carried out.

Secondly, structural equation modeling with the program LISREL 8.7 (Jöreskog & Sörbom, 1996) was used to test the fit of the data to the hypothesized model (Figure 10.1).

Several indices were considered in order to evaluate the model's overall goodness of fit. Chi square (χ^2) was used as a test of the null-hypothesis to evaluate whether the data fit the model or not. However, especially in the case of large samples, like in this study, of the reliability of this index has been criticized (Bentler, & Bonett, 1980; Jöreskog & Sörbom, 1996). Therefore, we also used other indices to assess the fit of the model: the Comparative Fit Index (CFI) and the Non-Normed Fit Index (NNFI) with values ranging from 0 (a poor fit) to 1 (a perfect fit); and the Normed Fit Index (NFI), which express good fit for values above .95 and acceptable fit with values ranging from .90 to .95 (Bollen & Long, 1993). Finally, we also used the Root Mean Squared Error of Approximation (RMSEA), which reflects a good fit for values lower than .06 (Hu & Bentler, 1999).

Finally, we tested the model on gender sub-groups using the multi-group approach (Jöreskog & Sörbom, 1996; Kline, 2005). The multi-group approach allows us to answer one main question "*Does group membership moderate the relations specified in the model?*" (Kline, 2005, p. 289). In particular, following Jöreskog and Sörbom (1996) and Kline (2005), we first tested the hypothesis of the invariance of the covariance matrices between males and females. Secondly, if the covariance matrices were significantly different, we tested the hypothesis of form invariance (same dimensions, and same patterns of fixed, free, and constrained values in all matrices) comparing the fit and parameters of the model between boys and girls.

10.3 RESULTS

Descriptive statistics for the total sample and gender and bivariate correlations among variables are shown in Table 10.1.

All bivariate correlations among study variables were in the expected direction with the exception of family restriction rules that were positively associated with BMI and poor body image. In particular, high-moderate correlations were found between BMI and body image ($r = .62$) and between body image and body dissatisfaction ($r = .43$). Moreover, a positive correlation was found between talking to father and talking to mother ($r = .43$) and between perceived family social support and talking to parents ($r = .34$ for father and $r = .46$ for mother), indicating that the relational family variables are moderately inter-related. Correlations among the other variables ranged from very low ($.01$) to moderate ($.34$).

Significant gender differences were found for several variables. Males had higher body mass and reported more frequent breakfasts with parents. Males also showed higher levels of ease of talking to father and perceived family social support than females. Females reported higher levels of poor body image, body dissatisfaction and more strict parental restriction food rules. Finally, no gender differences were found for the frequency of evening meals with parents, watching television during meals and easiness of talking to mother.

Moreover, obese and overweight adolescents report higher levels of poor body image, body dissatisfaction, more strict parental restriction rules and less frequent evening meals with parents (data not shown). No differences were found for the relationship with parent variables (communication and social support) and the frequency of breakfast with parents.

Table 10.1. Correlations, means and standard deviations among study variables and gender differences.

	1	2	3	4	5	6	7	8	9	10	M (SD)
1. Body Mass	-										21.59 (3.60)
2. Poor Body Image	.62**	-									3.21 (.68)
3. Body Dissatisfaction	.29**	.43**	-								2.28 (.85)
4. Breakfast with parents	-.07**	-.08**	-.11**	-							2.95 (1.95)
5. Dinner with parents	-.03*	-.04*	-.08**	.18**	-						5.51 (1.03)
6. TV during meals	.10**	.04**	.05**	-.07**	.04*	-					4.68 (1.84)
7 Family restriction rules	.12**	.14**	.11**	.13**	-.08**	-.12**	-				1.83 (.79)
8 Talking to father	-.02	-.09**	-.19**	.15**	.13**	-.06**	.08**	-			3.25 (1.00)
9 Talking to mother	.01	-.04*	-.14**	.17**	.11**	.01	.07**	.43**	-		3.81 (.93)
10 Family Social Support	-.01	-.06**	-.21**	.19**	.18**	-.01	.07**	.34**	.46**	-	5.73 (1.34)
Female	21.41 (3.42)	3.35 (0.67)	2.54 (0.91)	2.83 (1.92)	5.53 (1.03)	4.70 (1.85)	1.88 (0.80)	3.06 (0.95)	3.79 (0.92)	5.65 (1.40)	
Males	21.76 (3.76)	3.07 (0.68)	2.02 (0.71)	3.06 (1.97)	5.50 (1.03)	4.67 (1.83)	1.78 (0.78)	3.45 (1.01)	3.82 (0.95)	5.81 (1.27)	
t-test	9.12**	169.84***	385.10***	13.56***	0.64	0.19	18.24***	156.49***	1.37	13.04***	

***p<.001; ** p<.01; *p<.05.

Multivariate analyses began by testing the hypothesized model on the total sample (Figure 10.1). Figure 10.2 represents the tested model with estimated standardized parameters. Fit indices were: $\chi^2_{(31)} = 50.39$ ($p < .001$), CFI = 1.00, NFI = .99, NNFI = 1.00, RMSEA = .011.

The resulting indices suggest that the model provides a good fit to the data. The squared multiple correlations for the structural equation indicate that the model accounts for a portion of the variance in study variables as follows: 3% of the variance in objective BMI, 39% of body image and 23% of body dissatisfaction. Thus, the proportion of variance explained was low for BMI, while it was moderate for body image and body dissatisfaction.

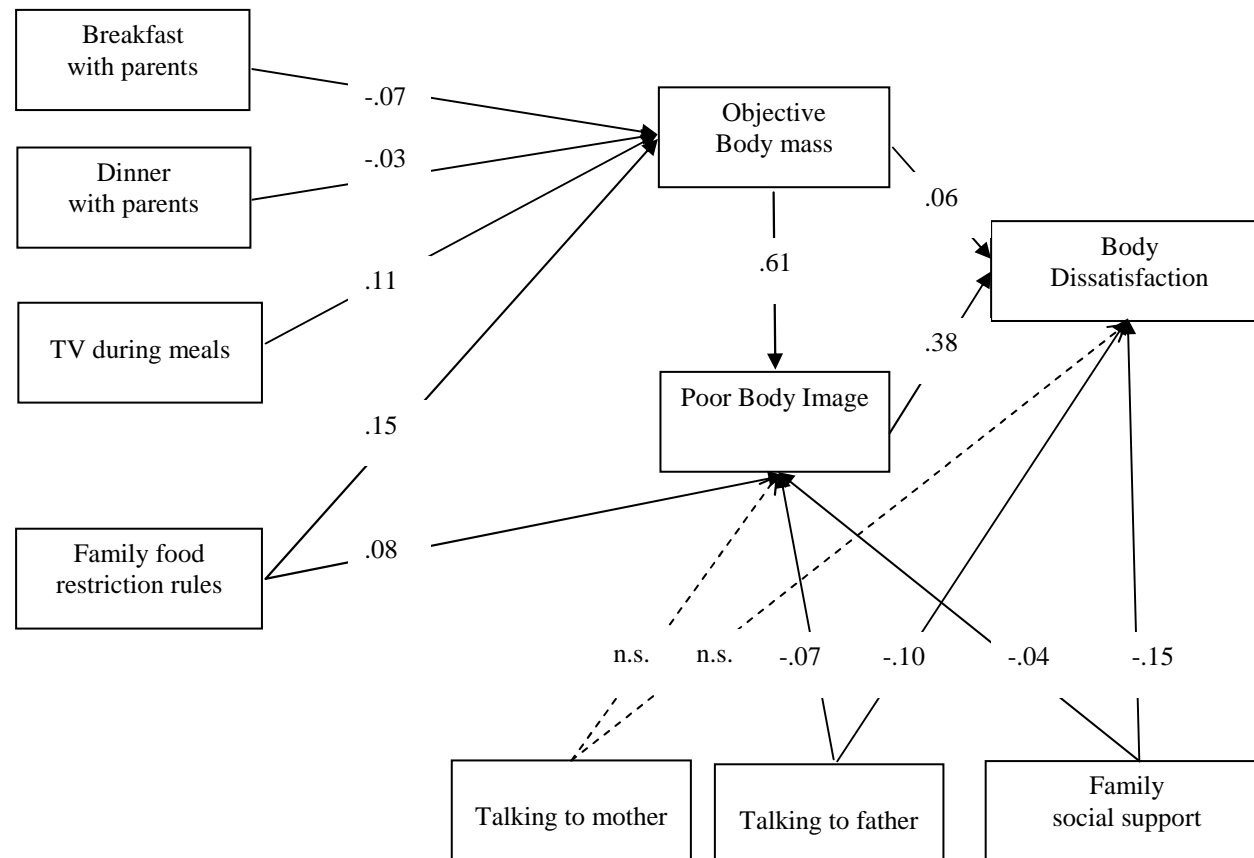
In the tested model, and in line with our hypothesis, a negative relationship was found between the frequency of evening meals and breakfast with parents and body mass, while a positive association was found between the frequency of watching television during meals and adolescents' body mass. Moreover family restriction rules were positively associated with BMI and poor body image.

Finally, the ease of communication with father and the family perceived social support were negatively related with poor body image and body dissatisfaction.

The only effects which were not significant in the model were the direct effects of ease of communication with mother on adolescents' poor body image and body dissatisfaction.

In addition to the direct relationships, we also found some modest indirect relationships (not shown in Figure 10.2). Breakfast with parents and the habit of watching television during meals was indirectly associated with body image through BMI (respectively -.02, .03) and on body dissatisfaction through BMI (respectively -.01, .02). An indirect effect was also found between parental restriction rules and body image, through BMI (.08) and with body dissatisfaction through BMI and body image (.08).

Figure 10.2. Path analysis standardized coefficients for the hypothesized conceptual model on adolescents' body dissatisfaction.



Moreover, talking to fathers indirectly affected body dissatisfaction through body image (-.02). Finally, body mass had an indirect effect on body dissatisfaction through body image (.05).

After having tested the model on the total sample, it was tested separately in the two gender sub-samples. Fit statistics indicate that the model has adequate fit in the two sub-samples and confirmed the hypothesized relationships among variables across males and females and the consistency and robustness of the model.

The multiple group model tested the extent to which this model is consistent across gender, in terms of covariance matrices and forms (dimensions, and patterns of fixed, free, and constrained values). The fit indices presented indicate no significant differences in the covariance matrices ($H_0: \sum_m = \sum_f, \chi^2_{(55)} = 3.87, n.s; CFI = 1.00, NFI = .99, NNFI = 1.00, RMSEA = .00$) between males and females.

10.4 DISCUSSION

The results of the current study, involve a large sample of adolescents, confirmed the importance of several family factors, across different domains, in influencing adolescents' body dissatisfaction, in turn associated with adolescents' BMI and body image. The study validates, on the whole, the hypothesized model in which family lifestyles, restrictive parenting practices, communication with parents and perceived family social support were differently related with adolescents' BMI, body image and body dissatisfaction.

In particular, our findings underline a negative association between healthier family lifestyles and adolescents' BMI, and a positive association between restrictive parenting practices and adolescents' BMI and poor body image. Moreover, a perceived ease in communication with fathers and perceived family social support is protective against adolescent's poor body image and body dissatisfaction. BMI is positively associated with poor body image, and both (BMI and body image) are associated with adolescents' body dissatisfaction.

Healthier family lifestyles are negatively associated with adolescents' BMI. In particular, we found that more frequent meals with parents and fewer meals consumed while watching television are associated with lower adolescent body mass.

Watching television during meals is considered an important marker for the families who have included the television as a habitual part of their food culture (Coon et al., 2001). A

high frequency of family meals consumed while watching television is associated with less healthy food consumption patterns and dietary behaviors among adolescents (Boutelle, Birnbaum, Lytle, Murray, & Story, 2003; Coon et al., 2001; Feldman, Eisenberg, Neumark-Sztainer, & Story, 2007; Verzeletti et al., 2009a), which, in turn, may result in higher BMI. Different mechanisms may explain the association between the use of television during meals and dietary intake (Coon et al., 2001; Feldman et al., 2007), among which the influence of food advertising on individual and familial food choice and eating patterns is one of the most important. Overall, most studies have assessed the association between the use of television during meals and dietary behaviors: This study suggests that watching television during meals is also positively associated with higher body mass among adolescents and that this unhealthy lifestyle should be considered in preventive intervention aimed at promoting healthy weight-related behaviors. In fact, as recently suggested by Feldman and colleagues (2007), watching television during meals influences adolescents' dietary behaviors, even when controlling for the overall daily hours spent watching television. Further studies are necessary in order to better explain the specific mechanisms potentially involved in the association between television during meals and weight status among adolescents and the similarities between overall free time spent watching television and the use of television during meals in association with adolescents' dietary behaviors. Moreover, although watching television during meals is associated with worse dietary behaviors than not watching television during meals, a recent study (Feldman et al., 2007) found that adolescents who watch television during meals are more likely to show healthier dietary behaviors compared with adolescents who do not eat regularly with their family.

In line with other studies, we found that the frequency of meals with parents (breakfast and evening meals) is also negatively associated with body mass: more frequent meals with parents are associated with lower levels of adolescents' body mass (Sen, 2006).

Eating together has been found to be associated with better quality of dietary behaviors but also with adolescents' well-being (see Chapter 6). In fact, during family meals parents may monitor, observe and limit adolescents' food intake and may play the role of models for healthy eating behaviors (e.g., cooking well-balanced meals, adequate portion size) (Burgess-Champoux et al., 2009; Feldman et al., 2007; Gillman et al., 2000; Neumark-Sztainer et al., 1999b; Neumark-Sztainer et al., 2003; Nielsen et al., 2002; Patrick, &

Nicklas, 2005; Videon, & Manning, 2003). Moreover, family meals are an important family opportunity to establish a daily moment in which to communicate, to improve family relationships, increasing family connectedness and to enhanced overall adolescent health behaviors and well-being (Burgess-Champoux et al., 2009; Contento et al., 2006; Eisenberg et al., 2004; Fulkerson et al., 2007; Neumark-Sztainer et al., 2004; Sen, 2006).

However, our model explained only 3% of the variance in objective BMI, suggesting that even if family lifestyle behaviors are associated with body mass, there are other important factors influencing these outcome involving individual, familial and environmental factors. Moreover, beyond the frequency of meals, the types and the portions of food consumed during family meals also play an important role (Sen, 2006), thus, future research involving these factors may help to better understand the role of family food-related lifestyles on adolescents' weight mass.

Parental restriction on unhealthy food intake was found to be positively associated with adolescents' BMI and poor body image in our study: more strict family restriction rules are associated with higher body mass and poorer body image among adolescents.

These findings, supporting the thesis of Fisher and Birch (1999b), who found a positive association between parental restriction rules and higher weight status among children aged 3-5 years old. As suggested by these authors, it is possible that the restriction to palatable foods is linked with an increase in children's desire for the restricted foods and attempts to obtain them (Fisher, & Birch, 1999a). Because the restricted foods by parents are usually "unhealthy foods", it is possible that this parenting practice may increase the risk of overweight promoting over consumption of restricted foods (Davison, & Birch, 2001). It is also possible that the restriction to palatable foods may promote the intake of these foods in unrestrictive circumstances (Fisher, & Birch, 1999a).

However, our study is focused on adolescence and not on childhood, thus, in light of the change in the relationships and influences of parents in adolescence, further studies investigating the association between restrictive family practices and weight status are needed to confirm this association in this developmental period and to clarify additional mechanisms involved.

Overall, it is possible that parental restriction may lead to higher weight status among adolescents, but it is also possible that parents are adopting more restrictive practices due to a pre-existing adolescent tendency to overeat or as a parental attempt to reduce their

adolescents' excess of weight (Benton, 2004; Brown & Ogden, 2004). Only further longitudinal study, analyzing family restriction from childhood and monitoring weight mass throughout time, will help to better assess this association. In fact, a recent study with early adolescents found that both being too permissive and being too strict may lead to less healthy dietary behaviors among adolescents (Vereecken et al., 2009). Thus, parents should be trained to adopt firm, but not coercive, food parenting practices in order to have a positive impact on children's dietary behaviors (Vereecken et al., 2009).

Moreover, as suggested by Paxton and colleagues (2006), parenting practices may influence adolescents' overweight and indirectly, therefore, also their body image. In this study we found a positive association between restrictive parenting practices and poor body image among adolescents. A greater use of food to control adolescent's dietary behaviors was previously found to be associated with higher levels of body dissatisfaction (Brown & Ogden, 2004).

Brown and Ogden (2004, p. 269) explained this result affirming that *"Food is embedded with a complex set of meanings removed from hunger and satiety. It is possible that using food to change behaviour detaches food further from its role in satiating hunger and promotes a more problematic relationship with eating"*.

Moreover, family rules are usually associated with some explanation by parents concerning the reasons behind these rules. Thus, it is also possible that parents justify their food restriction with comments or teasing regarding adolescents' weight, influencing adolescents' body image. As far we know, no other studies have assessed the influence of restrictive parenting practices on adolescents' body image, therefore, further qualitative and quantitative studies are needed to confirm and explain this association.

Moreover, relational and interpersonal family factors are involved in the development of body dissatisfaction and poor body image among adolescents (Boutelle, Eisenberg, Gregory, & Neumark-Sztainer, 2009; Stice, & Whitenton, 2002).

In this study we found that perceived family social support is a protective factor against adolescents' body dissatisfaction and poor body image. Previous studies have underlined that family social support plays a role of a buffer for negative sociocultural influences and supports adolescents in developing and maintaining positive body image and body satisfaction over time (Bearman et al., 2006; Ricciardelli et al., 2000; Stice et al., 2002; Stice, & Whitenton, 2002). Adolescents who report high connectedness to their families

are more satisfied with their appearance, are more likely to think that their body was the right size and less likely to have unhealthy dieting behaviors compared with adolescents who report low connectedness to their families (McCreary Center Society, 1999). Moreover, longitudinal studies (Archibald et al., 1999) found that adolescents who report more conflict and less supportive relationships with their parents were less satisfied with their body one year later.

The perception of being accepted, appreciated and supported by parents may help adolescents to have more positive feelings about themselves and their bodies and help adolescents to be more resilient to socio-cultural pressures to be thin (Stice, & Whitenton, 2002).

As far as the quality of the relationships with parents was concerned, we found, in line with the literature, that for both male and female adolescents, it is easier talking to mothers than talking to fathers (e.g., Al Sabbah et al., 2009; Dallago, & Santinello, 2006; Marta, 1997).

Despite this, only the communication with fathers is negatively associated with poor body image and body dissatisfaction. Ease in talking to fathers can support adolescents in having a positive body image and body satisfaction, while no significant associations were found for communication with mothers. These results are consistent with previous studies in which low communication with parents was related with unhealthy weight control, body dissatisfaction and lower psychosocial well-being (Al Sabbah et al., 2009; Neumark-Sztainer et al., 2003b; Ackard, Neumark-Sztainer, Story, & Perry, 2006).

However, most studies on parent-children relationships in this research topic have focused on mother-children relationships and have marginalized the role of father, which is mainly addressed in terms of fathers absence (Al Sabbah et al., 2009). Thus, studies assessing the role of mother- and father-adolescent relationships on body outcomes are still lacking.

Positive relationships and the acceptance of both mothers and fathers have been found to be protective factors against body dissatisfaction among adolescents girls, but not among boys (Barker, & Galambos, 2003). Moreover, previous studies have found that only the relationships and conflicts between father-adolescents are predictive of weight concerns among adolescent boys and girls (May et al., 2006). In addition, a recent study found that difficulty in communication with both mother and father were related to body weight dissatisfaction among girls, while among boys, only difficulties in talking to fathers were related to body dissatisfaction (Al Sabbah et al., 2009).

As recently suggested in a review study by Rodger and Chabrol (2009), mothers and fathers have been alternatively identified in the literature as the primary source of influence on adolescents' body image and body dissatisfaction, however, in general, across various studies, the importance of both parents as a source of identification for adolescents has emerged.

Concerning the different role of communication with mothers and fathers, a possible explanation of our results might be that *“even though fathers may be less involved in parenting than mothers overall, they may step in when more serious child-rearing problems arise and when conflict and negativity are more likely”* (May et al., p. 738).

Moreover, the nature of parent-children communication is different for mothers and fathers: fathers and mothers talk about different topics (Al Sabbah et al., 2009). In addition, Marta (1997) underlined that mother and father have different perceptions about their relationships with their adolescent. In particular, fathers seem to be a more reliable source of information regarding their children adjustment. Even if less involved in child-rearing, fathers emerge as an important parent in situations at risk for the adolescents (Marta, 1997). Finally, father-adolescent relationships is less focused on affective aspects and more on discipline. Father in adolescence promote the acquisition of social status and the individuation process; he encourage and support the adolescent in a constant analysis and examination of reality (Andolfi, 2001; Graziano et al., 2009; Marta, & Scabini, 2003; Scabini, & Cigoli, 2000). This developmental role of fathers in adolescence may partially explain our results that focus attention on the father-adolescent relationship in association with body image and body dissatisfaction.

Another possible explanation is linked with the gender-linked transmission model (see Rodger & Chabrol for a review, 2009). The model states that mothers are more influential for girls, while fathers for sons: however, this hypothesis cannot be confirmed in our study, in which the patterns of relations were the same for boys and girls.

However, our data did not allow us to explain the different role played by mothers and fathers in the relationships that adolescents experience with their body. In order to assess the role played by each parent in the development of body image and body satisfaction among adolescents, more studies involving both parents and adolescent males and females are needed to improve our understanding of the specific roles of mothers and fathers (Rodger & Chabrol, 2009).

Finally, as expected, this study found higher levels of body dissatisfaction and poor body image among females. Furthermore, we found that weight status and poor body image are positively associated with body dissatisfaction among adolescents. Finally, weight status showed an indirect effect on body dissatisfaction through body image. Previous studies found an association between body mass and poor body image or body dissatisfaction, especially among females (Al Sabbah et al., 2009; Barker & Galambos, 2003; Clark, & Tiggeman, 2008; Chaiton et al., 2009; Jones, 2004; McCabe, & Ricciardelli, 2003; Paxton et al., 2006; Presnell et al., 2004; Stice, & Whitenton, 2002; Rosenblum, & Lewis, 1999; Wardle, & Cooke, 2002).

Most of these studies assessed only the relation between adolescents' weight status or body image on adolescents' body dissatisfaction. Our results, add that both objective weight and body image contribute to explaining adolescents' body dissatisfaction. Thus, if on the one hand higher body mass is positively associated with body dissatisfaction, adolescents' awareness and perception of their body also play a role.

Heinberg and colleagues (2001) underlined that in order to engage in healthy eating and exercise people need a level of body image distress that is neither too nor to high. In fact, not being aware of one's own weight may be linked with not engaging in healthy behaviors even if they are necessary, and an excessively high body image distress which may lead people not to engage in healthy weight-related behaviors due to a perceived inability to make changes to their bodies (Neumark-Sztainer et al., 2006a).

In other words, even if body image is associated with body mass, adolescents' perception about their body plays a crucial role in influencing body dissatisfaction. From a preventive point of view, our results suggest the importance of taking into account, together, weight status, and affective, perceptive and emotional component of adolescents' body. Preventive intervention which promotes healthy weight behaviors should not only focus on body mass, but also to help adolescents develop a positive, but also realistic, sense of their body. Indeed, longitudinal study has shown that body dissatisfaction is not a motivating factor for engaging in healthy weight management behaviors (Neumark-Sztainer et al., 2006a; van den berg, & Neumark-Sztainer, 2007). On the contrary, body dissatisfaction predicts the use of risky behaviors (e.g., unhealthy dietary behaviors) that may place adolescents at risk of weight gain and poorer health: body satisfaction does not lead to an increase of BMI

among overweight young people but predicts less weight gain over time (Neumark-Sztainer et al., 2006a; van den berg, & Neumark-Sztainer, 2007).

Looking at the indirect effects, BMI mediated the association between family food-related lifestyles and body image and body dissatisfaction. Both, BMI and body image, mediated the association between parenting practices and body dissatisfaction. Finally, body image mediated the association between communication with father and body dissatisfaction and the association between BMI and body dissatisfaction.

Overall, BMI and body image mediated many of the associations between behavioral, educational and relational family variables and adolescents' body dissatisfaction. Individual body characteristics (body mass and body image) can, thus, be conceptualized as the primary mediator in the relationship between family variables and adolescents' body dissatisfaction, underlining an interaction between individual and environmental characteristics in influencing body outcomes (e.g., Davison, & Birch, 2001; Neumark-Sztainer, 2005). From a more ecological perspective, it is not possible to consider adolescents' and family's characteristics separately (e.g., Davison, & Birch, 2001; Neumark-Sztainer, 2005): preventive intervention targeted on adolescents' weight dissatisfaction should take into account this multilevel perspective.

Overall, the theoretical model explains 23% of the variance of adolescents' body dissatisfaction suggesting that both family context and individual weight issues, are important factors to consider in understanding adolescents' body dissatisfaction. Future research should investigate, from a longitudinal perspective, how family factors may influence adolescents' body dissatisfaction in order to theorize additional mechanisms that might lead to positive body outcomes and support the identification of effective strategies to promote adolescents' body awareness and more positive feelings towards their body.

Finally, in the present study, although girls reported higher levels of poor body image and body dissatisfaction, less frequent breakfasts with parents, more strict family food restriction rules and lower perceived family social support and communication with fathers, we found the same pattern of relationships between variables in both males and females.

Overall, previous studies found that girls are more dissatisfied with their bodies than boys (e.g. Barker, & Galambos, 2003) and a moderation effect of gender on body dissatisfaction has been found (e.g., Al Sabbah et al., 2009; Chaiton et al., 2009). Moreover, parents

experience the excess of weight of their daughters as more problematic than sons' excess of weight, with a subsequent impact on family functioning for boys and girls (see Bosch et al., 2004 for a review). Several explanations have been advanced in the literature to explain these gender differences, among which a greater societal pressure to be thin and higher prejudices about overweight among girls seems to play an important role (e.g., Mendelson, & White, 1985; Bonino et al., 2003). However, in the present study no moderation effect of gender was found. In other words, even if males and females experience different levels of body dissatisfaction, the same pattern of relationships among familial and individual variables were found across gender. Thus, in terms of our sample, our results suggest that interventions aimed at improving family relationships, food-related lifestyle behaviors and parenting practices could be targeting at both males and females to promote adolescents' body satisfaction.

10.5 LIMITATIONS

This study has some limitations that should be considered in the interpretation of the results.

Firstly, due to the cross-sectional design of the survey, inferences in terms of cause-effect cannot be conclusive. For example, food-related parenting practices could determine but also be the result of adolescents' food-related behaviors (van der Horst et al., 2007). Moreover, as underlined by Sen (2006), possible bidirectional effects should also be considered. For example, regarding the association between family meals and BMI, it is possible that adolescents' normal weight might perceive more enjoyment from family meals and, therefore, participate more regularly in them than overweight adolescents (Sen, 2006).

Secondly, in this work we assessed family factors and outcomes variables using only adolescents' perception. It is possible that adolescents have a different perception of family variables (e.g., restriction rules) than their parents. For example, as described by Marta (1997), parents report different perceptions regarding family relationships compared with adolescents and, among parents, fathers are more realistic in describing their relationships with adolescents than mothers. Thus, a multi-informant approach might be more appropriate in order to better explain the role of family lifestyles, family parenting

practices and family relationships on adolescents' BMI, body image and body dissatisfaction. A recent multi-informant study found a significant disagreement between adolescents and their parents regarding the perception of family food rules, availability and accessibility of foods at home (van Assema, Glanz, Martens, & Brug, 2007). However, the same study underlined that parents tend to answer in a more socially desirable way than adolescents, suggesting student measures might be more valid (van Assema et al., 2007).

Thirdly, our sample does not allow the analysis of the role of adolescents' ethnic group. This lack limits the generalizability of these findings because the standard of beauty and body image correlates and may differ across ethnic groups (e.g., Paxton et al., 2004).

Fourthly, family correlates of adolescents' body mass, body image and body dissatisfaction are not limited to the variables included in this study. Other parental (e.g., parental overweight), environmental (e.g., availability) or family characteristics (e.g., family structure) may be other important family correlates that have not been addressed in this study. However, this study may provide useful insights into relational family variables that are insufficiently investigated in this research area.

Finally, we only tested the role of general family communication and social support on adolescent body dissatisfaction, leaving aside the role of specific family communication regarding weight and body. Future studies might test the interaction effects between general parental support and communication and specific body- and weight-related parental comments (e.g., parental weight teasing) to identify more specific family communication dynamics and mechanisms influencing adolescents' body dissatisfaction (Rodger, & Chabrol, 2009).

10.6 CONCLUSION

Despite some limitations, these findings emphasize the importance of the family environment in influencing adolescents' body dissatisfaction. The influence of parents and family environment on these outcomes is often discussed in the literature given the increased desire of autonomy among adolescents. However, our findings, in line with other studies (Hearens et al., 2008), underline the important role played by parents, beyond childhood, on adolescent health behaviors and well-being.

In particular, as well as food-related lifestyle variables, this study underlines the importance of educational and relational variables in influencing not only BMI but also the perception and the relation that adolescents experience with their body.

Taken together, our findings suggest that family food-related lifestyles are associated with adolescents' weight status. Moreover, parenting practices are related with adolescents' weight status and poor body image. The quality of the relationships with parents (family communication and social support) is associated with a better body image and lower body dissatisfaction levels among adolescents. Finally, both, BMI and body image are associated with adolescents' body dissatisfaction.

From the results of the present study, we can draw some conclusions and suggestions for future research and intervention.

These findings suggest that having regular family meals may help adolescents to maintain a healthy weight status. Families should be encouraged to eat together and turn off the television during meals. Indeed, family meals may, on the one hand, improve adolescents' dietary behaviors and, on the other hand, becoming a family opportunity to establish a daily moment to communicate and increase family connectedness (Eisenberg et al., 2004; Fulkerson et al., 2007; Neumark-Sztainer et al., 2004; Sen, 2006).

Moreover, parenting practices may influence adolescents' weight status: restrictive parenting practices are associated with higher weight status and poorer body image among adolescents. As suggested by Vereecken and colleagues (2009), parents should be trained to adopt firm but, not coercive, food parenting practices (Vereecken et al., 2009). Indeed, *“improving relationships among family members and providing education about the adverse effects of restrictive feeding practices may be expected to ameliorate overweight and obesity”* (Wisniewski et al., 2009, p. 78).

In addition, improving family support and the communication between parents and adolescents has been found to have a positive impact on adolescents' health behaviors and psychosocial well-being (e.g., Al Sabbah et al., 2009; Cattelino et al., 2001; Cattelino, Calandri, Borca, Bonino, & Graziano, 2005; Marta, 1997; Mellin, Neumark-Sztainer, Story, Ireland, & Resnick, 2002; Prezza, & Pricipato, 2002; Santinello, & Vieno, 2007b; Scabini, Lanz, & Marta, 1999; Vieno, Santinello, Pastore, & Perkins, 2007). In particular, our results suggest that improving the relationships between parents and adolescents, in terms of communication and social support, may have a positive impact on adolescents'

body dissatisfaction. These findings also suggest that improving the quality of the relationships between parents and adolescents might be a factor which is able to help adolescents in the development of positive body image. However, this study has also underlined that mothers and fathers may play a different role in influencing body image and body dissatisfaction among adolescents, further research should examine these differences in developing prevention programs characterized by tailored strategies for mother and father.

Moreover, intervention targeting on healthy weight management should also be focused on the promotion of positive body image and body satisfaction, which in turn may lead to less weight gain over time (Neumark-Sztainer et al., 2006a; van den berg, & Neumark-Sztainer, 2007). Thus, programs aimed at promoting healthy weight but also body awareness, positive body image and satisfaction should be encouraged because they are more likely to be effective for weight management, but also for overall health and well-being promotion among adolescents in the light of the unhealthy behaviors linked with body dissatisfaction (Neumark-Sztainer et al., 2006a; Olmsted, & McFarlane, 2004).

Furthermore, our findings suggest that intervention aimed at promoting healthy weight-related behaviors and to prevent body dissatisfaction and poor body image among adolescents should involve adolescents and both parents. These findings suggest that behavioral, educational and relational family factors may help and influence adolescents' body outcomes. In particular, to be effective, interventions should extend beyond involving and considering proximal and distal socio-environmental factors in which adolescents, and particularly their families, live (Neumark-Sztainer, 2005). Moreover, different family domains should be considered as being simultaneously to the improvement of the effectiveness of interventions including relational and psychological variables: increasing family social support and reducing adolescent feelings of isolation may represent useful strategies to optimize the effectiveness of preventive and curative interventions (Bosch et al., 2004).

Finally, in this study we have focused on several family factors, across multiple domains, in relation to adolescents' body dissatisfaction which is, in turn, associated with adolescents' weight mass and body image. Future research should investigate the role of other proximal and distal potential levels of influence (e.g., peers, school, neighborhood).

Indeed, studying the role of different adolescents' contexts of life might increase the understanding of mechanisms leading to negative body outcomes among adolescents.

GENERAL CONCLUSION

Overall, this work aims to assess the individual and familial behavioral and relational correlates linked with obesity, overweight and body dissatisfaction, as well as the prevalence of these conditions, in a broad and representative sample of adolescents from the Veneto region in order to increase the understanding of these health outcomes and to contribute to the identification of potentially effective prevention strategies. Moreover, this study is strengthened by the use of objective measures of weight and height that allow adolescents' weight status to be categorized with more accuracy and in a way that is not influenced by adolescents' self-reported bias regarding weight or height.

The theoretical section has addressed, in light of the international literature, the measurement of obesity and overweight in childhood and adolescence, the increasing prevalence and trends of these phenomena, the physical and psychosocial consequences linked with excess of weight problems and the individual, familial and environmental correlates associated with these health outcomes. Moreover, the first section discussed the complexity of these health outcomes in terms of multifactorial and multifaceted influences (Lytle, 2009) and identified some limitations in the literature which are the base of the three research studies of this thesis.

The findings of the first study identified a discrepancy between self-reported weight and height and measured weight and height among adolescents. The accuracy of self-reported weight and height has been statistically improved through a calibration equation which was identified on the basis of measured height and weight. Moreover, a significant decrease of normal weight adolescents and an increase in the prevalence of obesity were found in the adolescents from the Veneto region from 2000 to 2006. These findings underlined, as in several other countries (e.g., Lobstein et al., 2004), that excess of weight problems are widespread among adolescents (around a quarter of the sample is overweight or obese), and that the prevalence of obesity is increasing. In line with the international literature, these results demonstrate the need to promote healthy food-related behaviors and lifestyles linked with obesity and overweight and to prevent weight gain in adolescents' population. As affirmed by Lobstein and colleagues (2004) and discussed in the first section of the present work, in order to manage the increasing prevalence of obesity and overweight

“prevention is the only realistic solution” (Lobstein et al., 2004, p. 7).

In a recent meta-analytic review study on obesity prevention programs for children and adolescents, Stice and colleagues (2006) underlined some effective preventive practices. Analyzing several prevention programs on obesity and overweight they found that most of these programs did not produce significant weight gain prevention effects and most interventions underlined changes with low effect size. So, what works? This meta-analytic study (Stice, Shaw, & Marti, 2006) suggested that the most effective programs are of a relatively intensive duration (average duration 40 hours). More effective intervention was found either among programs focused only on weight gain prevention, or among more general health promotion interventions (e.g. focused on physical activity). However, this last category shows a positive impact on weight gain prevention with the advantage of also having positive effects on multiple health outcomes. Moreover, adolescence (compared with children and preadolescence) is the age target in which the intervention effects were stronger. Finally, intervention programs were more effective for females than males.

However, presently, overweight obesity prevention programs show little effectiveness compared with the scale of the problems, underlining the need to identify effective prevention strategies (Lobstein et al., 2004; Stice et al., 2006).

For this reason, studying individual, micro- and macro-environmental correlates of excess of weight problems among adolescents may facilitate the identification of prevention strategies to improve the effectiveness of the interventions aimed at reducing obesity and overweight among adolescents. Adolescence is indeed a critical stage for the onset and maintenance of obesity and overweight, but also for the development of obesity-inducing behaviors and lifestyles. Thus, the identification of factors that exert an influence, at different levels and across different domains, on these health outcomes is a crucial point in this research topic. In fact, the most powerful, and amenable to change, factors should be the starting point for effective intervention (Perry, 1999). Moreover, identifying and effecting change patterns of risk and protective factors, through interventions that considering the complexity and the multifactorial nature of health behaviors, should results in behavior change (Perry, 1999). In this sense, research is a fundamental step that may lead to more effective preventive intervention through an identification of the protective factors that should be promoted among adolescents and their environment, and patterns of risk factors which should be prevented in terms of targeted behaviors (Bonino, Calandri, &

Cattelino, 2006).

From this perspective, the main purpose of the second study was to examine the association between BMI status, assessed with objective measures of height and weight, and dietary patterns, physical activity and food-related lifestyles variables. In fact, although from a theoretical point of view multiple domains and correlates, at the individual level, influence obesity and overweight in adolescence, most studies have only assessed the effect of a specific domain (e.g., physical activity) on overweight and obesity, leaving aside the co-occurrent role of other domains (e.g. dietary patterns). Indeed, our results, underline that dietary behaviors, physical activity and food-related lifestyles simultaneously influence adolescents' weight status. Beyond the specific association between each variable and weight status, already discussed in chapter nine, in line with Power and colleagues (2010), our results suggest that effective programs should involve factors across different domains.

In particular, more effective programs should be focused simultaneously on several factors. Firstly, they should be focused on promoting healthy dietary behaviors and healthy weight-control strategies in the adolescent population. Our controversial results, on dietary patterns and BMI and the distribution of sample across cluster, support the results of qualitative studies (Power, Bindler, Goetz, & Darathe, 2010) that found that adolescents are not completely aware about what's "healthy eating" means and that they often adopt unhealthy weight-control strategies (e.g. restrictive dietary patterns). In this perspective education programs on healthy dietary behaviors should be encouraged for all, overweight and not-overweight adolescents. However, in line with the literature, to be effective a preventive approach should not be informative, or at least not only informative (Bonino et al., 2006; Santinello et al., 2009; Story et al., 2002; Ferrer-Wreder, Stattin, Cass Lorente, Tubman, & Adamson, 2004). Thus, this aim should be accomplished by focusing attention on the positive side of healthy dietary behaviors, like the good taste of healthy foods, and promoting catchy ways to include healthy foods in daily dietary habits (Story et al., 2002). In promoting healthy dietary behaviors the emphasis should be put on healthy living and on weight loss strategies. Finally, in order to reach this aim, proximal and distal factors should be involved to limit adolescents' exposure to unhealthy foods (Power et al., 2010). Secondly, as far as promoting adequate exercise level among adolescents in concerned, our findings underline that few adolescents (around one third) perform adequate levels of

physical activity and that low physical activity is associated with obesity. In line with the international literature, physical activity should be promoted among adolescents proposing different activities that are both fun and motivating (Power et al., 2010). Exercise should be promoted in a supportive and non competitive environment that supports experimentation and fun (Power et al., 2010). Parents should be involved in this process and environmental settings should be considered. Finally, another potential indirect strategy would be to address and modify the barriers that adolescents perceive as limiting their physical activity level.

Thirdly, turning to promoting healthy lifestyles, in our study food-related lifestyles, like watching television during meals and skipping breakfast, were strongly related with obesity and overweight. Thus, intervention programs, targeting adolescents' obesity and overweight, frequently centering on diet and/or physical activity, should be also focused on food-related lifestyle behaviors which play an important role in regard to excess of weight problems. Adolescents should be trained regarding the importance of healthy lifestyles (e.g., breakfast consumption). Intervention strategies aimed at limiting sedentary behaviors, encouraging families to turn off television during meals and promoting regular breakfast habits may support the effectiveness of interventions aimed at promoting healthy weight among adolescents.

Moreover, in the light of the complexity of factors across different domains associated with obesity and overweight which can be different within each individual, tailoring health education strategies using a cluster-based approach may be a promising new approach to address multiple behavior change in more than one way (de Vries et al., 2008).

However, several proximal and distal factors play an important role in influencing adolescents' weight status and overweight-related behaviors and lifestyles (e.g., Davison, & Birch, 2001; Neumark-Sztainer, 2005). In particular, the third study of this work is focused on the role of the family. Indeed, the family is one of the most important contexts that may make a significant difference regarding weight-related issues and positive body image and body acceptance among children and adolescents (Neumark-Stainer, 2005). Moreover, interventions aimed at promoting healthy weight and preventing weight gain are more effective if family factors are considered and at least one parent is involved (e.g., Golan, Weizman, Apter, & Fainaru, 1998b; Gruber & Haldeman, 2009; Story, 1999).

In this perspective the main aim of the third study was to study the association between adolescents' body mass, body image, family food-related lifestyles (e.g., frequency of meals with parents), restrictive food parenting practices and family functioning (communication with parents and perceived family social support) on adolescents' body dissatisfaction.

In line with the literature (van der Horst et al., 2007), in the third study we found that the role of parents is particularly important in adolescence in influencing overweight-inducing lifestyles but also the relationship that adolescents experience with their bodies (poor body image and body dissatisfaction). The third study show that several family factors, across different domains, are associated with adolescents' body dissatisfaction, in turn, related with adolescents' weight status and poor body image. In particular, behavioral factors (family meals and the use of television during meals), educational factors (restrictive food rules) and relational factors (family social support and communication with parents) should be considered as potential influences on adolescents' body dissatisfaction, BMI and body image. Family food-related lifestyles and parenting practices were found to be positively associated with adolescents' BMI, while higher perceived family social support and communication with fathers were negatively associated with poor body image and body dissatisfaction. Furthermore, we found that body mass and poor body image were positively associated with body dissatisfaction among adolescents.

In line with the literature, due to the multiple family influences on adolescents' weight issues, our findings support the idea that preventive interventions that achieve and maintain a healthy weight are more likely to be effective if families are involved (Gruber & Haldeman, 2009). In fact, as suggested in previous studies for the successful outcome of overweight prevention programs, parents should be considered as one of the most important agents of change (e.g., Golan, & Weitzman, 2001) because they have an important role in the onset and maintenance of overweight status and overweight-related lifestyles. Moreover, even if the involvement of parents is essential, because family may create a home environment promoting healthy weight-related habits (Golan, & Weitzman, 2001), our findings suggest that family influences overreach adolescents' weight, and also involve adolescents' body image and body dissatisfaction.

Moreover, despite the fact that families are a “*central unit for making behavior changes that support healthy eating and physical activity habits*” (Gruber & Haldeman, 2009; p. 6), families also need to be educated and supported in this process and role.

From the third study it is possible to draw some suggestions in terms of preventive intervention concerning what do with families. Firstly, families should be educated regarding the importance of food-related family lifestyles. Parents may influence adolescents’ food-related lifestyles providing an environment that supports and promotes healthy food-related behaviors but they should also be a role model for them (Neumark-Sztainer, 2005). In this sense, parents should be aware of this role. Using the words of Brown and Ogden (2004, p. 270) parents should be encouraged to adopt a “*do as I do not what I say*” approach with their adolescents to promote healthy food-related behaviors and lifestyles, thus indirectly influencing adolescents’ weight status. In particular, our data suggest that encouraging families to eat together and turn off the television during meals may be a useful strategy for improving family food-related lifestyles. However, parents should be helped in recognising that many factors contribute to the onset of weight-related issues and that although they play a crucial role, the family is not the only context of influence in which these behaviors take place (Neumark-Sztainer, 2005). Thus, family should be educated about the multiple influence of “obesogenic environment” but should also be aware that they may partially filter these influences providing a healthy family environment (Neumark-Sztainer, 2005).

Moreover, parents should be trained about the effect of their food-related parenting practices. Our study found a positive association between more strict restriction rules and adolescents’ weight status and poorer body image. As suggested by Vereckeen and colleagues (2009), parents should be trained to adopt firm but not coercive, food parenting practices.

Furthermore, improving the relationships between parents and adolescents, in terms of social support and communication (especially with fathers), may contribute to decreasing adolescents’ body dissatisfaction. Parents should be supported into providing a supportive environment for their adolescents in which they can feel accepted and not criticized (e.g., Cattelino, & Bonino, 1999; Marta, 1997; Neumark-Sztainer, 2005). Improving family support and communication with parents may encourage adolescents to talk with their parents about several relevant topics including their weight and body concerns. In order to

meet this aim, parents should limit weight-related teasing and negative comments about adolescents' bodies (Neumark-Sztainer, 2005). In fact, adolescents need to feel that their identity and their relationships with parents go beyond physical appearance (Neumark-Sztainer, 2005). In addition, our results underline the importance of communication between father and adolescents on body image and body dissatisfaction of young people. Thus, the family, as a system, should be involved in preventive interventions aimed at promoting healthy weight and body satisfaction among adolescents. Indeed, previous studies have underlined that both parents influence adolescents' weight-related issues and that both mothers and fathers play a unique contribution (May et al., 2006). Moreover, family support and communication with parents has been found to be linked, in terms of protective factors, with several other health-related and risk behaviors among adolescents, but also with adolescents' well-being and psychosocial functioning (e.g., Boutelle et al., 2009; Cristini et al., 2007; Cattelino et al., 2005; Graziano et al., 2009; Marta, 1997; Prezza, & Pricipato, 2002; Santinello, & Vieno, 2007b; Scabini et al., 1999; Vieno et al., 2007). Thus, the promotion of family functioning, in terms of positive family communication and support, might be an effective and useful strategy across different health behaviors. Thus, interventions targeting adolescents' overweight and body dissatisfaction should be focused, not only on body weight, but also on the image and the dissatisfaction that adolescents experience regarding their body, encouraging young people to share and to express their feelings about their bodies. Finally, intervention programs involving families and adolescents should be more focused on health behaviors and less focused on weight gain prevention. In other words, the attention should be put on healthy living and not on physical appearance.

The specific limitations and the implications for future directions of the three studies have already been already discussed in each research chapter. However, as with all studies, this thesis provides the opportunity for further reflection and debate and should constitute a stimulus for further research.

Although parents play an important role in the prevention of excess of weight problems and the promotion of healthy food-related behaviors and lifestyles, as affirmed by Neumark-Sztainer (2005; p. 138), preventive actions and strategies would also need *“to occur at different levels of influence to help families be more supportive and to help youth*

feel better about their bodies and engage in more healthful eating and physical activity behaviours”.

In this perspective, some authors suggest that obesity and overweight should be addressed in a multilevel approach that considers the broader context in which overweight and food-related behaviors emerge (Davison, & Birch, 2001; Huang, & Glass, 2008; Lytle, 2009). Thus, these health outcomes should be studied by considering the complex systems in which individual behaviours take place, including interpersonal, organizational, community and governmental levels that provide the contexts able to promote or discourage health-related behaviors (e.g., Lytle, 2009; Story et al., 2002). Thus, further studies need to place more attention on the other significant contexts of life, including both proximal contexts (e.g. peers) but also more distal contexts (e.g. neighbourhood). For this reason in the upcoming HBSC survey (data are currently being collected) more environmental variables have been addressed in the questionnaire to better identify the role of contextual variables (e.g., school policy, school vending machines, local area facilities for physical activity and so on).

Moreover, this work shows that there are multiple individual and familial influences across multiple domains associated with adolescent overweight and obesity and that the relationships between these factors are complex. Future studies should examine how these factors influence obesity and overweight. Thus, on the one hand, models studying factors associated with obesity, overweight and body dissatisfaction are still needed, in the light of the low explanatory power of the current models available in the literature and, in regard of this, the inclusion of more psychosocial variables might be promising approach. On the other hand, adopting a longitudinal perspective constitutes an appropriate way of enhancing the understanding of these health outcomes and better addressing the processes and the mechanisms involved in the interaction between individual and environmental factors on adolescents weight issues.

Furthermore, studies have found that unhealthy behaviors tend to cluster within the individual (e.g., overweight, smoke and so on) (e.g., Alamian, & Paradis, 2009, de Vries et al., 2008; Kremers, De Bruijn, Schaalma, & Brug, 2004; van Nieuwenhuijzen et al., 2009). Thus, further research focusing on common protective factors across different health behaviors would be suitable in order to identify a more integrated approach to promoting

healthier lifestyles and to implementing prevention programs targeting clusters of behavioral risk factors in youth.

In the light of increasing prevalence of obesity, the auspice is that also in our country in the near future, research and intervention on this topic become spreader involving a multilevel and longitudinal perspective. Moreover, the fragmentary nature of the literature in this research topic reflects the need for studies that are more focused on the role of psychosocial variables to develop more effective preventive interventions which plan the collaboration of different professional figures. The communication and the exchange among different disciplines are necessary and fundamental steps to effectively prevent excess of weight problems among adolescents.

Finally, our hope is that health promotion among young people becomes a real priority in our society. Future generations will only be healthy if health promotion becomes part of the culture of broader society and not only a response to emerging health problems.

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