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THE INFLUENCE OF SOCIO-ECONOMIC STATUS ON THE RISK OF BEING OVERWEIGHT OR UNDERWEIGHT IN ADOLESCENTS IN LUXEMBOURG

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Abstract

Factors indicating risks for future health and processes pertaining to the development of illnesses have come into the focus of social research. Ecological human development models and life course approaches to illness and health provide a theoretical understanding of the fundamental causes of ill health and the different spheres, which influence health. The sociological understanding of the stratification of society by (socio-economic) status constitutes the theoretical backdrop for understanding uneven distributions of health resources and health strains. Socio-economic health inequalities are observed in many countries including very wealthy countries such as Luxembourg. Social-psychological perspectives on processes of social cognition and social comparison in combination with theories on collective health lifestyles and beliefs highlight the processes through which social stratification is embodied into health inequalities, even in wealthy contexts. The theoretical model of the pathways through which socio-economic status influences health that underlies this thesis draws on all of the aforementioned disciplinary perspectives. Differentiating between objective and subjective conceptions of socio-economic status seems particularly important in wealthy contexts and is therefore also part of the theoretical model that underlies this thesis.

As foundations for adult health and illness are laid during childhood and youth, socio-economic inequalities during these life phases can be all the more consequential and it is crucial to investigate and understand them thoroughly. While results on socio-economic health inequalities from empirical studies for childhood and adulthood are consistent across different health domains, results for adolescence are less consistent and vary for different health domains, different conceptions of socio-economic status and different national and regional contexts. Considering the lack of studies and literature on socio-economic health inequalities among adolescents in Luxembourg and using overweight and underweight as examples, this thesis empirically investigates socio-economic health inequalities among adolescents in Luxembourg. The 5 research questions of this thesis focus on the prevalence of overweight and underweight, the influence of socio-economic status on them, the distinct influences of objective and subjective socio-economic status on overweight and underweight, the influence of socio-economic status on additional weight-related health concerns and the relations between health relevant factors and socio-economic status.

The method used for the empirical investigation is a statistical analysis of data collected in Luxembourg in the context of the Health Behaviour in School-Aged Children (HBSC) study between 2006 and 2014. Descriptive statistical analyses are used for the presentation of the epidemiology of overweight and underweight, while logistic regression and hierarchical logistic

regression are used for the analysis of the influence of socio-economic status on overweight, underweight, weight-related health concerns and health relevant factors.

The results of the statistical analysis and their interpretation reveal that overweight and underweight are equally crucial health concerns as both affects around 14% of adolescents in Luxembourg. An inverse relation between socio-economic status and overweight and underweight is observed. An increase in socio-economic status is on one hand associated with a decrease in the risk of being overweight, but on the other hand, it is associated with an increase in the risk of being underweight. The influences of objective and subjective socio-economic status on overweight and three health relevant factors are confirmed to be distinct and independent from each other. The differentiation between objective and subjective socio-economic status is thus relevant for health inequalities among adolescents in Luxembourg. The relations between socio-economic status and the weight-related health concerns body image and weight reduction behaviour are opposite in direction when the effects of overweight and underweight are held constant in the models. Although an increase in socio-economic status is associated with a decrease in the risk of having a negative body image, it is also associated with an increase in the risk of engaging in weight reduction behaviour among adolescents in Luxembourg. One psycho-social and five behavioural health relevant factors are related to overweight and these relations tie in with the theoretical model. The statistical relations observed between health relevant factors and underweight are more complex and need further empirical and theoretical investigation.

Based on the discussed results, this thesis concludes that the theoretical model aids the understanding of health inequalities among adolescents in Luxembourg, but applies differently to different health concerns and needs to take potential inverse effects of socio-economic status into account. This thesis contributes to the scientific knowledge through the identification of underweight as an important health concern among adolescents in wealthy countries and through the confirmation of the relevance of the differentiation between objective and subjective socio-economic status for health inequalities in adolescents. The implications of the results for policy and prevention should be an increased awareness of the need to target prevention programmes to specific risk groups and the need to take the risk of underweight into account by shifting the focus from the prevention of overweight to the encouragement of heathy behaviour.

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Overview of Contents

Table of Contents

1 Introduction: Defining the research interest

Health inequalities in youth and more specifically socio-economic inequalities in the risk of being overweight or underweight among adolescents in Luxembourg will be investigated in this thesis. The considerations on which this research focus is based on are described in the following and the four defining elements of the research interest are introduced: Adolescence, socio-economic health inequalities, Luxembourg as unique study context and potentially health compromising weight status (overweight and underweight).

The definition of health has long moved beyond the absence of physical illness. Today, a holistic approach including positive health, mental health and wellbeing has become prevalent in western thinking and policies (WHO, 1946). The focus has moved from curing diseases to preventing illness and promoting health (WHO, 1986). This evolution ties in with the historical decrease in acute conditions and the rise of chronic illness. With this evolution, factors and processes contributing to the development of future illnesses as well as factors indicating risks for future health have come into focus. At the same time, the growing focus on prevention increases the relevance attributed to adolescence as an influential period for health in later life.

While youth is defined as the sociological life phase spanning from early adolescence to young adulthood, the medical definition of adolescence extends from the onset of puberty until full physical maturity. Although the brain develops until the mid-20s, a common definition of adolescence in relation to health includes adolescents from the age of 10 to the age of 19 (Viner et al., 2015; WHO, 1986). When health inequalities in youth are discussed in this thesis, it is with reference to this definition of adolescence. The empirical focus of this thesis is on adolescents aged from 11 to 17.

Health inequalities are the differences in health that can be traced to socio-demographic characteristics of people, whether it is age, gender, race or socio-economic standing (Bartley, 2004). In times of a growing divide between rich and poor, differences in health that are linked to socio-economic resources are perceived as unjust. This moral judgement would describe socio-economic inequalities in health as inequities (Kawachi, Subramanian, & Almeida-Filho, 2002). Socio-economic health inequalities do not only concern the strata of a population that is battling poverty, but entire populations. Socio-economic health inequalities have been observed in many countries including very wealthy countries such as Luxembourg. While age,

gender, race and cross-sectional health inequalities are important, this study strongly focuses on socio-economic health inequalities. As foundations for future health and illness are laid during childhood and adolescence, inequalities during these life phases can be all the more consequential because their effects carry into adulthood (Dragano & Siegrist, 2009; Elgar & Currie, 2016; Graham & Power, 2004). It is therefore crucial for every society to investigate and understand health inequalities in adolescence. For Luxembourg, little empirical information on health and health inequalities in adolescence is available.

It is impossible to infer reliable predictions of the situation in Luxembourg from international studies because Luxembourg presents highly specific demographic, social and cultural characteristics that are likely to influence the health situation of adolescents. The cultural tissue of the Luxembourg population is unique. In terms of cultural and historical developments, Luxembourg only started to develop a national cultural identity in the second half of the 19th century. Before this, its cultural position between French and German influences was unclear, and the country identified as being both French and German (Pauly, 2019). The current cultural fabric is characterised by a very high percentage of foreigners from varied socio-economic backgrounds. In comparison to other countries, the size and the heterogeneity of the population of foreigners are unique. Ongoing migration towards Luxembourg mixes 1st to 3rd generation migrants from different countries and socio-economic status is not as closely linked to migration status as in other countries. Thus, it cannot be assumed that results from other countries can simply be transposed onto the Luxembourg context.

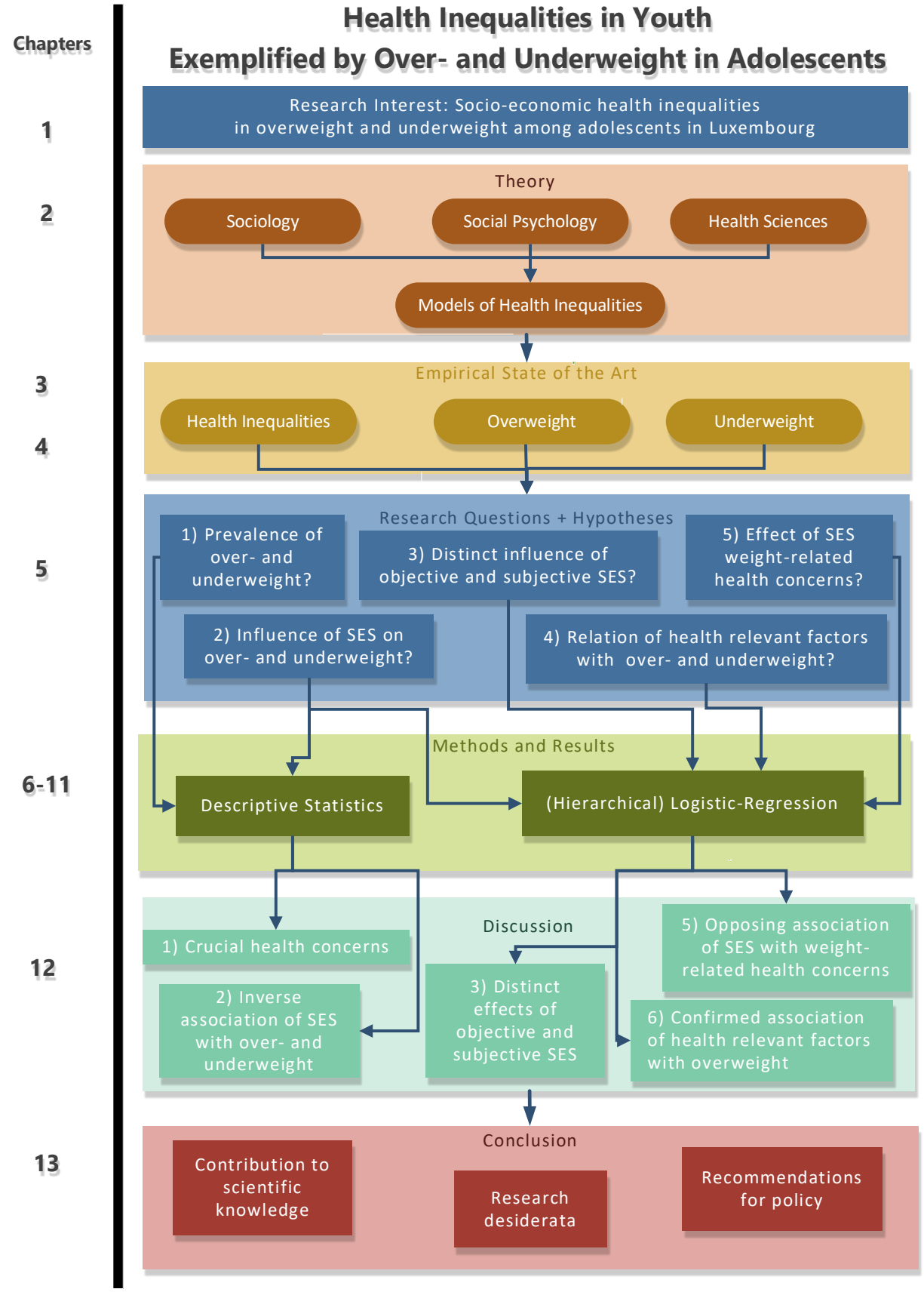
With regards to socio-economic research, Aline Muller, the head of the Luxembourg Institute of Socio-Economic Research' (LISER) recently called Luxembourg a 'unique laboratory for researchers' (Greis, 2019). Luxembourg has a high overall standard of social security, health care and affluence, with a pronounced gap between the advantaged and disadvantaged population. The 2013 Growing Inequalities Impacts (GINI) report states that inequality with regards to employment, wage and education in Luxembourg has increased since 1985 (Fusco, 2013). Luxembourg is an ideal country to study socio-economic health inequalities in a context of very high overall living standards.

Considering the lack of studies and literature available on health inequalities among adolescents in Luxembourg, an empirical investigation is needed to add to the scientific knowledge. To allow for a clear interpretation of the results, this thesis focuses its empirical study on the exemplary health concern of potentially health compromising weight status (overweight and underweight), rather than overall or composite health. In the context of this thesis overweight and underweight are thus defined as weight status, that present potential (future) weight-related health risks at opposite ends of the weight spectrum.

Overweight during childhood and youth has been identified as an important risk factor for obesity, which in turn is linked to severe diseases (cardio-vascular as well as metabolic) and even premature death in later life (Lobstein, Baur, & Uauy, 2004). As a consequence, overweight and factors influencing overweight have been studied for most developed as well as developing countries (Ezzati, Di Cesare, & Bentham, 2018; Monteiro, Wang, & Popkin, 2002; NCD-RisC, 2017). Underweight as a risk factor for health in children and youth has, on the other hand, been studied as a risk factor for physical health problems related to (severe) malnutrition (e.g. stunting, wasting and premature death) in so-called developing countries (Onis, Blössner, Borghi, Frongillo, & Morris, 2004). While these phenomena mostly concern young people in developing countries, there are also health risks related to underweight for adolescents with less severe malnutrition as encountered in more affluent countries, and underweight has been described as ‘important overlooked phenomenon in developed countries’ by some scholars (Lazzeri et al., 2014, p. 2213).

With an overarching research interest in health inequalities in youth, this thesis therefore investigates the influence of socio-economic status on the risk of being overweight or underweight in adolescents in Luxembourg. A classic structure was chosen for this thesis and is visualised in Figure 1. It starts with a presentation of the theoretical background and the description of the underlying theoretical model in chapter 2, before reviewing the international scientific literature on socio-economic health inequalities in youth as well as overweight and underweight in chapters 3 and 4. Chapter 5 presents the five research questions and the hypotheses that guide the choice of the methods as described in chapter 6. The results from the empirical analyses are described in chapters 7, 8, 9, 10 and 11. The results from the empirical analysis are interpreted and discussed with regard to the theoretical model in chapter 12. Finally, chapter 13 offers some concluding remarks on the contribution to the scientific knowledge, the future research desiderata and the implications for policy and prevention.

Figure 1: Overview of Contents



Legend: Socio-economic status is abbreviated as SES in this figure.

2 Theoretical understanding of health inequalities and youth in different disciplines

To establish the theoretical background on which the perspective on health inequalities in youth of this thesis is based, theoretical perspectives from three disciplines (sociology, social psychology and health science) are reviewed. The wide scope of the research interest – 'health inequalities among adolescents' – defined for the theoretical model and the review of the literature poses a challenge, but a necessary one. A literature review with a narrow definition of the research interest did not yielded sufficient information to inform this thesis because Luxembourg is a context that is not well documented scientifically. With such a wide research interest, a comprehensive review of the literature is neither advisable nor feasible. The following review of theoretical and empirical knowledge thus represents a thematic rather than a systematic review (Collins & Fauser, 2005). While principles of relevance similar to those of systematic reviews are applied, this literature review does not strive or claim to be comprehensive. Rather, this literature review provides an exemplary selection of relevant theoretical and empirical knowledge that aid the understanding and contextualising of socio-economic health inequalities among adolescents in Luxembourg.

The following sections describe relevant elements from the theoretical foundations of three disciplines that were identified in the literature to inform this thesis. The first section is dedicated to the discipline of sociology, the second to the discipline of social psychology and the third to health sciences, including medicine and public health. Each section detects relevant theoretical building blocks for the understanding of health inequalities in youth. In the final section, interdisciplinary models of different pathways through which socio-economic factors can influence health are reviewed.

2.1 Sociological perspectives on health inequalities and youth

As described in the introduction, the age span of individuals considered as youth or adolescents for the empirical analysis of this thesis is based on the definition of adolescence

that is commonly used in the health field (Viner et al., 2015). The understanding and conceptionalisation of youth, however, draws additionally on a sociological understanding of this life phase. In sociology, youth is conceptualised as a separate life stage and moratorium or as a transitional phase. Attention is drawn to the specific developmental challenges (e.g. the development of autonomy from parents, friendship networks, sexual and amorous relationships) and the influence of institutional contexts during this life phase (Willems et al., 2015).

In relation to health, the sociological and macro-economic perspective expands the understanding of health and illness by taking influence factors above the individual biological and medical level into account and considering associations between health and macro-economic factors (such as income inequality, unemployment rates or public spending on family benefits). This perspective recognises the associations between health and macro-economic factors as more than aggregations of health inequalities on the individual level (Lynch, Smith, Kaplan, & House, 2000; Pförtner et al., 2014; Rathmann et al., 2016; Wilkinson & Pickett, 2007; Wilkinson & Pickett, 2009). This perspective also stresses that societal contexts have specific sets of factors at the country or society level (economic structure, policies, laws) that influence health. From this perspective, contexts are not interchangeable and present unique sets of influential macro factors that shape socio-economic inequalities in health in specific ways.

In line with this perspective, this thesis builds on the fundamental theoretical assumption of a social stratification of society and thus the understanding that access to resources is not equal (Bartley, 2004; Bauer, Bittlingmayer, & Richter, 2008a; Graham, 2007). The notion of a stratified society dates back to the founding fathers of sociology (Karl Marx, Emile Durkheim and Max Weber), but has evolved since then. The initial concepts of ‘class’ and ‘socio-economic position’ imply a rather rigid hierarchy of social classes and describe an individual's attributed position within this rigid hierarchy of social classes as predominantly defined by the individual’s relation to material and financial capital (Richter, 2005). While this structure-centred conception of the stratification of society is still relevant, it has been complemented by perspectives that take human agency and intersectionality into account.

The concept of socio-economic status bridges structure and agency and conceptualises an individual's position in a vertically (e.g. socio-economic status) and horizontally (e.g. gender, regions) stratified society as social status. Social status is defined by the access to multi-dimensional (economic, cultural and social) capital and is enacted by individuals in their interactions (Bock-Rosenthal, Doehlemann, Biermann, Grohall, & Kühn, 2004; Bourdieu, 1989; Richter & Hurrelmann, 2009b).

From this perspective, the concept of ‘class’ evolves towards institutionalisations of socio-economic status into habitus. Shared lifestyles, beliefs, values and behaviour patterns can be interpreted as expressions of socio-economic identity and habitus (Bauer et al., 2008a; Bourdieu, 1989). Bourdieu (1984) for example describes that the motivations for certain behaviours can be purely individual psychological reasons (curiosity, pleasure, experimentation etc.), individual lifestyle or recreational purposes. Behaviours can also be regarded as rites of passage, signs of adulthood or rebellion. But most relevantly, behaviours can express peer group solidarity and condense into group lifestyles. People with similar behaviours form groups and the behaviours may be strengthened further. Sharing a common habit, like smoking, may add to a sense of togetherness and may help to create distinction from other groups (Bourdieu, 1984). If these groups are formed by people with similar socio-economic status, the institutionalisation of socio-economic status into habitus or a shared lifestyle is completed.

This adds a pathway of influence of socio-economic status on people’s lives to the more traditional focus on the material implications of socio-economic status on people’s lives through the level of resources or education that are available to them. Socio-economic status thus also influences people’s beliefs and behaviours through specific beliefs and behaviours that are shared among people with similar socio-economic status. These collective behaviours and beliefs can no longer be described as individual behaviour patterns, but need to be seen as collective behaviour and belief patterns or collective lifestyles (Abel, Abraham, & Sommerhalder, 2009; Cockerham, 2005). Since these collective lifestyles that are shared among people with similar socio-economic status encompass health relevant behaviours and beliefs, they play a crucial role in the (re)production of socio-economic health inequalities (Abel et al., 2009; Koivusilta, Rimpelä, & Rimpelä, 1999).

This process ties in with theories on the embodiment of norms and values. Though it is a fundamental feature of all human life, the body and its health has been at the side-lines of sociological theory until sociologists like Turner (1984), Featherstone, Hepworth and Turner (1991) or Shilling (1993) condensed and assembled previous social theories acknowledging the body. They pointed to the central position of the body between nature, culture and society. Body weight or shape and the norms and values surrounding it (such as ideal images of bodies portrayed in advertising or the changing norms about the perfect figure for female and male bodies) exemplify the body as object and carrier of social and cultural values and norms. From this perspective, bodies are carriers of meaning and identity and are shaped by health norms and health beliefs. These are, in turn, part of the aforementioned collective lifestyles that are shared among people with similar socio-economic status. This process could be described as the embodiment of socio-economic status into socio-economic health inequalities.

As far as the influence of socio-economic status on adolescent health is concerned, the family seems to play a particularly important role. In his economic model of child development, Becker (1981) postulated that families with more economic resources are generally able to invest more into their offspring's development and health (in the form of better food, safer neighbourhood etc.). In addition, parents and siblings are agents of socialisation. Socialisation describes the process by which societal norms and values, which include institutionalised habitus or health relevant collective lifestyles, are passed on to children and adolescents by socialisation agents (e.g. parents, teachers and peers). The social environment of adolescents thus socialises adolescents into health relevant collective lifestyles, passes health relevant beliefs on to them and encourages certain behaviours (Koivusilta et al., 1999).

With respect to socio-economic status, youth has been described as a period in life during which both parents' or families' socio-economic status and the developing own socio-economic status influence health and health behaviour (Glendinning, Hendry, & Shucksmith, 1995; Richter, 2005). Young people have, however, not finished their education, they do not yet hold jobs, they do not yet have a personal income and cannot dispose autonomously of their wealth. The so-called 'triumvirate' (occupation, education and income) of essential facets of the socio-economic status of adults are thus not yet developed in adolescents (Diemer, Mistry, Wadsworth, López, & Reimers, 2013, p. 81). This gives rise to conceptual challenges for the definition of socio-economic status in youth, and it is difficult to determine whether a young person's own social position, the socio-economic status of the parents or the combined resources at the household level are most relevant for the social position of the young person (Currie, Molcho et al., 2008). An additional conceptual challenge to be considered is the multidimensional nature of socio-economic status. As expression of the current social position of a person in society, socio-economic status can, for example, be influenced by and composed of several dimensions: Occupation, education (or other forms of cultural capital) and economic resources (affluence, income, economic opportunities). The economic resources available to a family are a key characteristic of the socio-economic situation in which young people grow up and can be described by several distinct concepts such as poverty, income and wealth (Diemer et al., 2013; Duncan & Magnuson, 2003). Economic resources are a key dimension of the socio-economic situation of families and thus seem directly linked to the socio-economic status of adolescents in Luxembourg. A family's human or cultural capital (e.g. parental education) is also a dimension of adolescent socio-economic status and higher levels of parental education tend to translate into more stimulating home environments and more verbal and supportive child-parent communication (Duncan & Magnuson, 2003). In Luxembourg however, the translation of education into socio-economic status could however be inhibited for the large proportion of the adult population with a migration background who were not

educated in Luxembourg and might face problems with the conversion and acknowledgement of foreign degrees. Given the link between the (educational) status needed to access a specific occupation and the status of the occupation of a person, parental occupational status as dimension of adolescent socio-economic status might be similarly influenced and thus conceptionally unclear in Luxembourg.

This concludes the description of theoretical and conceptual considerations rooted in the discipline of sociology, that inform this thesis.

2.2 (Social) psychological perspectives on health inequalities

In addition to sociology, this thesis also draws on social psychological perspectives on health inequalities. These bridge individual aspects (such as emotions and health behaviour) and macro aspect (such as social stratification).

The highly influential ecological model of health and child development was developed by Bronfenbrenner, a social psychologist. It stipulates that health outcomes and health behaviours in adolescence and childhood are not only influenced by individual internal factors on the micro level, but also by external factors at the micro, meso and macro level and the interaction between these (Bronfenbrenner, 1977). Bronfenbrenner's ecological model suggests that socio-economic status impacts child development through multiple processes and at multiple levels (individual, family, local area / school, national) (Bronfenbrenner, 1979). The influence of external factors on adolescent health and health behaviour that are described in the ecological model of health and child development increases the need to assess whether specific constellations of macro-structural determinants (political, economic, education, health and welfare systems) of individual countries such as Luxembourg result in different patterns of health and health inequalities in adolescents (Bronfenbrenner, 1979; Viner et al., 2012).

Social-psychological theories on social cognition (Conner & Norman, 2005) and social comparison processes (Schnittker & Mc Leod, 2005), for example, expand the understanding of socio-economic status to include the perceptions of socio-economic status.

Individual interpretations of the social environment play an important role in the explanation of human behaviour (Miebach, 2010). Social cognition theory states that human behaviour is best understood through the perceptions of the social environment. This perspective includes models such as the health belief model (Conner & Norman, 2005). Social cognition theories

tie in with the Thomas theorem, 'If men define situations as real, they are real in their consequences' (Thomas & Thomas, 1928, pp. 571–572) and stress the importance of the individual's perceptions of reality. Since this also applies to socio-economic status, it is thus necessary and important to consider people's subjective perceptions of their socio-economic status.

The social psychological process of social comparison and its role for the development of identity (including one's perceived socio-economic status) is also relevant for the understanding of socio-economic health inequalities. Socio-economic status and the associated available resources are reference points for social comparison processes. The subjective perception of socio-economic status in comparison to personal reference groups is thus an important aspect of socio-economic status (Schnittker & Mc Leod, 2005).

Psychological stress has been identified as a factor that contributes to socio-economic health inequalities. Social and economic resources that are available through socio-economic status are among the resources that help in coping with stress and attenuating the negative effects of stress on health (Koivusilta et al., 1999). At the same time, low socio-economic status can cause stress such as status anxiety, perceived deprivation through social comparison (Schnittker & Mc Leod, 2005) or the strain of coping with life without the necessary resources (Mackenbach, 2006; Peter, 2009; Richter & Hurrelmann, 2009b). Stress can lead to unhealthy stress coping strategies and behaviours (e.g. smoking) (Bauer et al., 2008a; Mulatu & Schooler, 2002; Richter, 2005).

A specific psychological view on stress, social norms and health inequalities is 'the culture of affluence' and 'the psychological costs of material wealth' as described by Luthar (Luthar, 2003, 2003; Luthar, Barkin, & Crossman, 2013). In reference to the concept of the 'culture of poverty'[1] by Lewis (1969), Luthar (2003) postulates the existence of a 'culture of affluence' in which increased financial means in combination with more achievement pressure and absent parents can put adolescents with high socio-economic status at risk for unhealthy behaviours (such as alcohol consumption). According to Luthar (2013), youth in affluent contexts might be more vulnerable today than in previous generations.

This concludes the description of theoretical and conceptual considerations rooted in the discipline of social psychology, that inform this thesis.

[1] This concept was criticised widely for 'blaming the victim', but it offers some interesting opportunities to deconstruct the culture of poverty (or affluence) into different components (such as values, symbolic boundaries and cultural capital) Small, Harding, and Lamont (2010).

2.3 Medical and health science perspectives on health inequalities and youth

The social determinants of illness, the social gradient of health and the life course perspective on health and illness are concepts and perspectives from the medical or health sciences that are relevant for the theoretical perspective of this thesis on socio-economic health inequalities in adolescents (Kuh, Ben-Shlomo, Lynch, Hallqvist, & Power, 2003; Marmot, 2005, 2009; Starfield, Riley, Witt, & Robertson, 2002; Viner et al., 2015).

The perspective of the social determinants of health provides a theoretical understanding of the fundamental causes of ill health and the different spheres which influence health. Research on the causes of socio-economic health inequalities in medicine and public health sciences led to a call to extend health research above and beyond primary biological risk factors of illnesses and to take into account the so-called social 'causes of the causes' of illness (Marmot, 2005, p. 1101). According to the fundamental causes theory, these causes of the causes put people at risk of developing biological factors that are considered risk factors for ill-health (Link & Phelan, 1995). Research on health inequalities has thus concentrated on the empirical analysis of health inequalities in mortality, morbidity and the associated risk factors. This includes the further investigation of the social gradient in health. The social gradient in health describes the fact that a person is less likely to die prematurely or to suffer from ill health, the higher their socio-economic status (Marmot, 2005; Starfield et al., 2002). Though this perspective of taking upstream social determinants of health into consideration now dates back a couple of decades, some work still has to be done to firmly establish this perspective in the medical domain and to ensure it is taken into consideration in preventive strategies (Braveman & Gottlieb, 2014).

It is specifically with regard to the explanation of the social gradient in health and health inequalities in affluent countries that relative socio-economic status has come into focus (Pickett & Wilkinson, 2015b; Wilkinson & Pickett, 2007; Wilkinson & Pickett, 2009).This postulates that levels of available socio-economic resources are mostly relevant in comparison to those available to other reference groups and in relation to the overall variance of levels of available resources across society. It is the relatively low position within the societal hierarchy that can, independently of the absolute level of available resources, cause negative feelings (feelings of being put down, left out and lacking control over one's life), stress and psychological strain (Elgar, Xie, Pförtner, White, & Pickett, 2017; Marmot, 2005; Solar & Irwin, 2005).

Adolescence is generally a life phase of relatively good health and few health problems in comparison to other life phases, but it is of crucial relevance in a life course perspective of health (Burton-Jeangros, Cullati, Sacker, & Blane, 2015; Dragano & Siegrist, 2009; Viner et al., 2015). According to this perspective, the risk and protective factors affecting early childhood development cumulate and continue to influence health during youth. The effects of the influences in early childhood become evident in youth and health risk factors start to be detectable (Elgar & Currie, 2016). In addition, certain factors such as peer influences or school environment particularly affect health during this phase of life (Dragano & Siegrist, 2009). Some health problems and illnesses in adulthood have their roots in adolescence. Health-related habits and behaviours develop during youth and solidify into life-long habits and lifestyles that might increase risks of morbidity and mortality in later life. Health inequalities in adolescence can, therefore, be all the more consequential and have been shown to cause ongoing and accumulating health inequalities in adulthood and old age (Dragano & Siegrist, 2009; Elgar & Currie, 2016; Graham & Power, 2004).

2.4 Models of the influence of socio-economic status on health

After the description of the different theoretical elements from the various disciplines that inform this thesis in the previous sections, an interdisciplinary topical perspective is adopted in this section. Scholars have bridged and combined disciplinary perspectives on socio-economic influences on health by translating them into pathways and combining these pathways into theoretical models. An integrative (in terms of disciplines) and simplified model of the influence of socio-economic status on health will be postulated as the theoretical model for this thesis at the end of the section.

2.4.1 Pathways of the influence of socio-economic status on health

When it comes to explaining the processes through which socio economic status influence health, research on health inequalities has drawn on material, psycho-social and cultural-behavioural explanations (Bartley, 2004). Theoretical models of health inequalities centre around these three traditional aetiological explanatory dimensions: material, psycho-social and cultural-behavioural (Bartley, 2004; Bauer, Bittlingmayer, & Richter, 2008b; Bock-Rosenthal et

al., 2004; Graham, 2007; Richter & Hurrelmann, 2009a; Weyers, Dragano, Richter, & Bosma, 2010).

Explanations focusing on material aspects often stand inspired by structure-centred or functionalist perspectives on society. They argue that health inequalities are linked to differences in financial resources (income, wealth) and the associated differences in material and physical aspects of living (such as housing and working conditions, access to health prevention and care). Socio-economic resources are used to avoid material and physical hazards and risk factors as presented, for example, by low quality housing (dampness, contamination, unsafe neighbourhood etc.) or burdening working conditions (mental and physical strain, exposure to toxins etc.). While individual material risk factors may not be consequential, material factors are linked in a system and the exposure to several combined factors could contribute to socio-economic health inequalities. A lack of resources due to a low socio-economic position can thus translate into increased exposure to a multitude of material and physical risk factors, which accumulate to affect health negatively (Bartley, 2004; Bauer et al., 2008a; Øversveen, Rydland, Bambra, & Eikemo, 2017; Richter & Hurrelmann, 2009b; Solar & Irwin, 2005, 2010).

Psycho-social explanation models integrate structure- and agency-focused sociological approaches and consider the negative health effects of increased psychological strain and stress as mediators of the effects of socio-economic status on health. A low individual or family socio-economic status and the associated low level of available resources can increase the levels of stress and psychological strain in several ways: People with low socio-economic status face increased everyday challenges and earlier as well as more frequent negative life events (such as death and accidents of loved ones or own accidents) with few available resources (Mackenbach, 2006; Peter, 2009; Richter & Hurrelmann, 2009b). In addition to biological negative effects of chronic stress and negative feelings, psycho-social models argue that stress can lead to unhealthy stress coping strategies and behaviours (e.g. smoking) (Bauer et al., 2008a; Mulatu & Schooler, 2002; Richter, 2005). Last but not least, a low position in the social hierarchy can directly induce low levels of confidence and negative feelings such as feelings of inferiority, subordination or lack of control (Bartley, 2004; Øversveen et al., 2017).

Cultural-behavioural explanations tie in with agency focused, constructivist and (symbolic-) interactionist sociological perspectives and trace health inequalities back to institutionalised habitus and collective lifestyles. They stress that individual or family socio-economic status is actively produced and reproduced in daily interactions and shapes identities, beliefs and behaviours (Bartley, 2004; Bauer et al., 2008a; Graham, 2007; Øversveen et al., 2017; Richter & Hurrelmann, 2009b). In addition to aspects concerning general life orientations, these collective beliefs and norms shared by people with similar socio-economic status include

beliefs about the causes, prevention and remedies of illness as well as norms about health relevant behaviours (see (Bartley, 2004; Bauer et al., 2008a; Hradil, 2009; Mackenbach, 2006; Richter & Hurrelmann, 2009b). Even in the case of universal health norms that are shared across all levels of socio-economic status (such as e.g. the idealisation of thinness and stigmatisation of fatness in women), the urge to conform to these norms and to take action in case of non-conformity with these roles can differ by socio-economic status and cause health inequalities. For example, women with high socio-economic status might feel that they need to diet and might start to diet at a lower threshold of overweight than women with low socio-economic status (Wardle et al., 2004).

In a context like Luxembourg, with its very high overall living standards and very low levels of absolute poverty, the material pathways through factors such as damp living conditions, health hazards at school, substandard food or low physical activity due to unsafe neighbourhoods are probably less important than in other contexts. Psycho-social and cultural-behavioural pathways could on the other hand be more relevant in a society with as high social inequality and relative poverty as Luxembourg.

2.4.2 **Aspects of socio-economic status**

In explaining the processes and mechanisms of health inequalities, there is a further relevant and to some extent linked question: Which aspect of the unequal distribution of resources that the social stratification of society engenders impacts on health? Different aspects of socio-economic status that might influence health have been identified as the objective socio-economic status and the subjective socio-economic status.

For objective socio-economic status, absolute and relative aspects are differentiated: the influence of absolute levels of available resources on health links to all three explanation dimensions, but resonates most with material explanations. The absolute level of resources available and thus the available resources themselves bears on health by limiting or increasing the possibilities to enhance living and working conditions and avoid hazards. Additionally, low absolute levels of available resources can aggravate a misbalance between challenges and resources, which in turn induces stress and prevents the adoption of healthy behaviours and lifestyles (Bartley, 2004; Solar & Irwin, 2005, 2010).

While the influence of absolute levels of available resources on the health of population groups with low socio-economic status is very well documented and constitutes a key factor in understanding health inequalities in countries with low overall affluence, it offers little insight on the explanation of the existence of differences in health linked to medium and high levels

of available resources and the existence of social gradients in countries with high and even very high overall affluence (Bartley, 2004; Marmot, 2005; Rambotti, 2015). It is specifically with regard to the explanation of the social gradient in health and health inequalities in affluent countries that relative levels of available resources have come into focus (Lynch et al., 2000; Pickett & Wilkinson, 2015b; Wilkinson & Pickett, 2007; Wilkinson & Pickett, 2009). These mainly tie in with psycho-social explanations and postulate that levels of available resources are mostly relevant in comparison to those available to other reference groups and in relation to the overall variance of levels of available resources across society (Lynch et al., 2000). It is the relatively low position within the societal hierarchy that can, independent of the absolute level of available resources, cause negative feelings (feelings of being put down, left out and lacking control over one's life), stress and psychological strain (Elgar, Xie, Pförtner, White, & Pickett, 2016; Marmot, 2005; Solar & Irwin, 2005, 2010). In addition to absolute material resources, the relative position in society has an impact on health.

Subjective aspects of socio-economic status tie in with psycho-social and cultural-behavioural explanations of health inequalities. Subjective aspects[2] represent an individual's perception of his or her place in the socio-economic structure (Singh-Manoux, Adler, & Marmot, 2003, p. 1322) or an individual's perception and personal experience of the absolute and relative levels or amounts of available resources at their disposal (Demakakos, Nazroo, Breeze, & Marmot, 2008). Subjectively perceived socio-economic status can influence health by strengthening the identification with and adherence to collective lifestyles and their associated health beliefs and behaviours, but subjective socio-economic status also has similar psycho-social consequences to absolute or relative socio-economic status (Bartley, 2004). As Lynch and colleagues warned, it is important not to focus on the perception of socio-economic status in a 'decontextualized psycho-social approach' but to continue to take structural and material factors into account when investigating health inequalities (Lynch et al., 2000, p. 1202).

2.4.3 Models of the influence of socio-economic status on health including multiple pathways

Interdisciplinary models combine material, psycho-social and cultural-behavioural explanations of socio-economic health inequalities into complex theoretical models of the

[2] Subjective social status can and has in the past been defined as the social class one identifies with. This presupposes the existence of defined social classes (working class, owning class etc.) that share values, beliefs and attitudes. It supposes that 'people internalise class-related worldviews and economic cultures that prescribe certain behaviours according to their class status'. The class identified can be another class than the class that one 'should' economically belong to Diemer et al. (2013, p. 105).

influence of socio-economic status on health (e.g.: (Macintyre, 1997; Mackenbach, 2006; Mielck, 2005; WHO, 1986). The models from Steinkamp , Elkeles and Mielck and Mackenbach (2006) can be summarised as follows: The influence of socio-economic status on health is not direct, but mediated through material, behavioural and psycho-social risk factors. The three groups of risk factors are closely interlinked and prone to influence each other. The models thus include a direct effect (material factors influence health) and indirect effects (materiel factors influencing behaviours, which in turn influence health) (Richter & Hurrelmann, 2009b). In comparison, Mielck (2005) argues that social inequality not only causes differences in health-related burdens, coping resources and behaviour, but also in medical care. Unequal provision, access and quality of health care services not only influence health when an illness is already present, but also when a new illness occurs. In Mielck's model, the balance between the burdens and resources in combination and interrelation with the differences in behaviour and medical care influence health and can cause socio-economic health inequalities (Mielck, 2005).

Although these explanatory models have been criticised for their lack of theoretical sophistication, tautological tendencies, intrinsic causal inference, underestimation of selection processes, lack of capacity to determine the mechanisms and processes behind socio-economic health inequalities and failure to reflect the persistence of health inequalities and social structuration in itself (Mackenbach, 2017; Øversveen et al., 2017; Regidor, 2006), they have proved valuable for the understanding of socio-economic health inequalities and the interpretation of empirical results on socio-economic health inequalities.

Building on the above-mentioned models and empirical results, Lampert and Schenk (2014) summarise a similar causal model for socio-economic health inequalities in youth. They argue that the central and key effect is the causal influence path by which the socio-economic situation of the household influences the living conditions and life chances of the adolescents, which in turn influence their health-related behaviour and personality. On their part, adolescent health-related behaviour and personality then cause health differences, for example, in illnesses, health complaints, injuries, mental health and subjective health. A secondary and negligible influence path is the feedback reaction on all of the above via health selection.

The relationship between health and socio-economic status is most often described and understood as socio-economic status influencing health. But health can also influence socio-economic status through processes of selection that lead to downward social mobility of people affected by ill health and upward social mobility of people enjoying good health (Bartley, 2004; Mielck, 2005; Richter & Hurrelmann, 2009b; Sobal & Stunkard, 1989; WHO, 1986). Selection processes can start in childhood and adolescence (e.g. through the influence of health on educational achievement and orientation towards education (Koivusilta, Rimpelä, Rimpelä, &

Vikat, 2001; WHO, 1986), but the effect of socio-economic status on health is considered to be pivotal, while the feedback reaction of health to socio-economic status through selection processes is considered a secondary negligible mechanism in adolescence (Lampert & Richter, 2009). For these reasons, the direction of observed associations between socio-economic status and health or health relevant factors is always consider to be an influence of socio-economic status on health in this thesis.

Figure 2 summarises the model of the different pathways of the influence of socio-economic status on health in adolescence as it is described in this section and as it is retained as the theoretical model of health inequalities in youth for this thesis. The next chapter will review existing empirical findings to assess whether this theoretical model of socio-economic health inequalities in adolescents has been explored or confirmed in empirical studies.

Figure 2: Theoretical Model of the Influence of Socio-economic Status on Adolescent Health

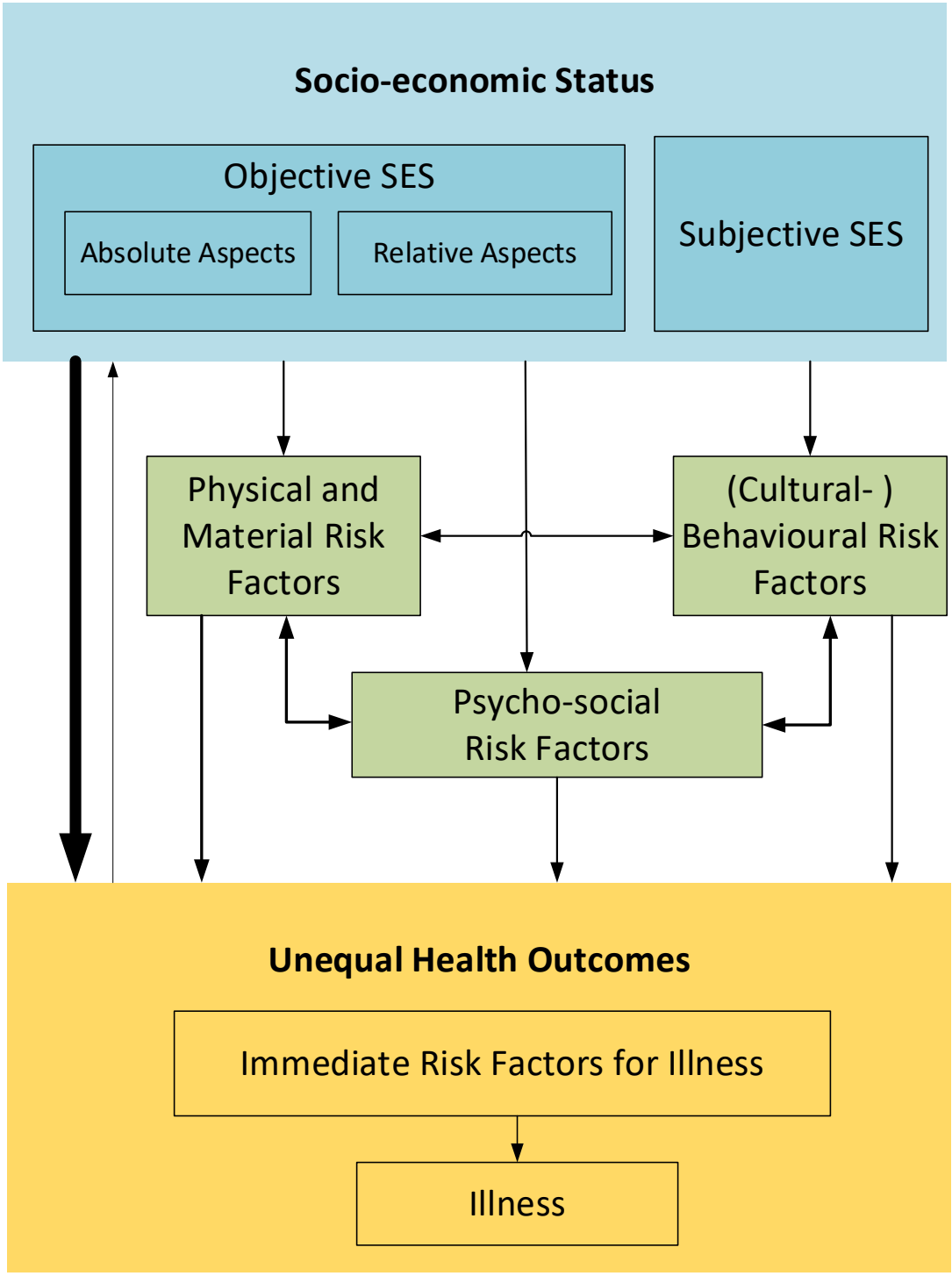


Figure summarising the models from Steinkamp (1999), Elkeles and Mielck (1997) and Mackenbach (2006)

3 Review of empirical findings on socio-economic health inequalities in youth

As shown in the previous chapter, the understanding of socio-economic health inequalities of this thesis ties in with the theoretical perspectives of different scientific disciplines. In addition to the theoretical relevance of the perspective, its relevance for describing and understanding tangible phenomena in existing societies is important. This chapter will therefore assess whether the described theoretical understanding of health inequalities has been explored or confirmed in empirical studies. In a first step, this chapter describes the published, confirmed empirical findings on health inequalities among adolescents in societies similar to Luxembourg. The goal of this first step is to review the available international empirical knowledge and to identify findings and domains that are relevant for the understanding of health inequalities among adolescents in Luxembourg. The specific population and the specific context under study are of utmost importance in empirical studies. Therefore, the second section of this chapter describes the empirical knowledge that is available on socio-economic health inequalities among youth in Luxembourg and assesses whether these empirical results are sufficient to confirm or deny the relevance of the theoretical understanding of this thesis for the specific population and context under study.

3.1 Associations between socio-economic status and health in youth

Within the body of research analysing the relationship between socio-economic status and health, research on the effect of the lack of access to a minimum of economic resources on wellbeing and health is especially developed. Many studies confirmed a detrimental effect of experiencing economic or material hardship, poverty or deprivation on the health and development of children and adolescents (Duncan & Magnuson, 2003). The theoretical understanding and the context under study in this thesis however suggest that a sole focus on the effects of low socio-economic status on health is not sufficient and that the effects of high socio-economic status on health also need to be considered. In the following, only literature

reporting the overall effects of socio-economic status on adolescent health is therefore reviewed.

For youth, socio-economic inequalities have been observed in health domains pertaining to the social environment (such as parent-child communication and support, perceived school performance, peer support), health outcomes (such as life satisfaction, self-rated health, overweight), dietary behaviours (intake of fruit and vegetables, skipping breakfast), levels of physical activity and tooth brushing (Inchley et al., 2016). A majority, but not all of these socio-economic inequalities identify positive effects of higher socio-economic status and negative effects of low socio-economic status on adolescents' health.

This so called "health gradient", whereby health tends to be better with increasing socio-economic status, has been confirmed for many aspects of health, health behaviours and wellbeing in children and adolescents and for different measures of socio-economic status (Elgar et al., 2017; Starfield et al., 2002). Studies linked higher socio-economic status, for example, to more consumption of fruit in European countries and North America (De Clercq et al., 2017; Vereecken, Inchley, Subramanian, Hublet, & Maes, 2005), less consumption of soft drinks in Northern, Western and Southern European countries (De Clercq et al., 2017; Vereecken et al., 2005)[3], less exposure to bullying in European countries and North-America and Israel (Due, P. et al., 2009), more smoking (Pförtner, Rathmann, Moor, Kunst, & Richter, 2016), worse self-rated health in European and North American countries (Moor et al., 2014; Richter, Moor, & van Lenthe, 2012; Torsheim et al., 2004), lower emotional symptoms in northern European countries (Nielsen, L. et al., 2015), fewer multiple health complaints in most European and North American countries (Moor et al., 2015); (Holstein et al., 2009) and to higher multi-morbidity in France (Chau, K., Baumann, M., & Chau, N., 2013). When it comes to the effect of socio-economic status on risk behaviour such as drinking alcohol, using cannabis, fighting, or physical injuries (with the exception of smoking cigarettes), the results are not consistent and a defining influence of socio-economic status on these behaviours cannot be confirmed (Inchley et al., 2016; Pförtner et al., 2016; Richter & Lampert, 2008; Wild & Aleman-Diaz, 2013).

In their systematic review of the literature on socio-economic status and health behaviours, Hanson and Chen (2007) made the same observations. They conclude that 'low socio-economic status was associated with poorer diets, less physical activity and greater cigarette

[3] Higher socio-economic status is however linked to more consumption of soft drinks in Central and Eastern Europe Vereecken et al. (2005)

smoking', while 'there was no clear pattern of association between socio-economic status and alcohol consumption or marijuana use' (Hanson & Chen, 2007, p. 263).

In line with the theoretical model underlying this thesis, Richter, Moor and Van Lenthe (2012) analysed the role of different groups of factors for socio-economic inequalities in adolescent health in Germany. For self-rated health material, psychosocial and behavioural factors individually accounted for 30-50% of the inequalities. In the combined analysis including all three groups of factors, 80% of the inequalities were accounted for. Both the systematic review of the international literature by Moor, Spallek and Richter (2017) and the empirical analysis of data from adolescents from 28 countries by Moor and colleagues (2014) confirm the contribution of material, psychosocial and behavioural factors to socio-economic inequalities in self-rated health. They found both direct effects of the factors and interrelated effects (such as indirect effects of material factors through psychosocial and behavioural factors). Thus, the theoretical model underlying this thesis has been adequately investigated and confirmed for the self-rated health of adolescents.

Even though there are only few studies focusing on and confirming negative effects of high socio-economic status on children's or adolescent's health, there are indications that such effects exist in specific domains of health. Researching the health risks of affluent adolescents in upper middle or upper class contexts in the US for the past two decades, Luthar and colleagues for instance consistently found that children and adolescents with higher socio-economic status show a higher prevalence of certain health risks than children with low socio-economic status (Luthar, 2003; Luthar et al., 2013, 2013; Luthar & Latendresse, 2005; Lyman & Luthar, 2014). In several studies they found that youth from upper middle or upper class contexts have a high risk of showing maladjustment through internalising symptoms (such as depression, anxiety, somatic symptoms), externalising symptom (delinquency) and substance abuse. The results for adolescents from upper middle class contexts were similarly bad or even worse than the results of adolescents from inner-city contexts. These health risks were linked to achievement pressures (perfectionism and overemphasis of accomplishments) and isolation from adults (physical and emotional distance from parents) (Luthar, 2003; Luthar et al., 2013; Luthar & Latendresse, 2005; Lyman & Luthar, 2014). Some results of these studies indicate that, in specific contexts, there are more similarities than differences between youth at the extremes of the socio-economic continuum. Subgroups with multiple behaviour problems (negative values, substance use, delinquency, peer envy and low interest in academics) can be identified among adolescents at both socio-economic extremes (Luthar & Latendresse, 2005; Racz et al., 2011).

It is important to note that prevalence of health risks does not equate negative health consequences. While adolescents with high socio-economic status show a comparable

prevalence of certain health risks, it is plausible that they have diverse safety nets (such as access to high quality treatment) that help them to avoid 'substantive damage to their life prospects' (Luthar & Latendresse, 2005, p. 51) and that they do not necessarily suffer the same consequences as adolescents with low socio-economic status.

In their systematic review, Hanson and Chen (2007) doubt the relevance of these results for the overall picture of health inequalities in youth. They conclude that, overall, high socio-economic status should be considered as a protective factor despite the documented association of high socio-economic status to some negative health behaviours in studies by Luthar and colleagues (2002; 2005), as this effect was not consistent across studies from different authors. For the present thesis, which focuses on a specific context with very high living standards, it is however vital to take the possibility of such unexpected associations into account.

In summary and in comparison to childhood and adulthood, the empirical results and meta-analysis show more complex, varied, fragmented or unexpected associations between social inequality and health in youth (for an overview see, e.g. Hanson & Chen, 2007; Richter, 2005; Richter & Hurrelmann, 2009a) to which material, psycho-social and behavioural factors contribute substantially (Moor et al., 2017). On one hand, the associations between socio-economic status and health vary according to the analysed health outcomes or behaviours as well as according to socio-demographic characteristics such as gender (Richter, Kruse, & Steckling, 2010). On the other hand, some of the variation (Moor et al., 2017) can be explained by the multifaceted nature of socio-economic status and different conceptualisations of measurements of socio-economic status. The significance, strength and direction of the influences of socio-economic status on the health and health behaviour during adolescence and youth thus varies according to several factors:

1) The observed health phenomenon: i.e. mortality, morbidity, physical and/or mental health outcomes or health related behaviours;
2) individual socio-demographic characteristics such as sex and age (Richter et al., 2010);
3) the dimensions of socio-economic status: i.e.: income, education, affluence or social capital and
4) the conceptualisation of the differences within these dimensions: i.e. absolute, relative or subjective aspects (Elgar et al., 2013; Elgar et al., 2017; Elgar, McKinnon et al., 2016).

The first (observed health phenomenon) and second (socio-demographic characteristics) reasons for these variations are context specific and the available empirical knowledge on Luxembourg will be reviewed in the next section. The international empirical knowledge

concerning the third (dimensions of socio-economic status) and the fourth (conceptualisation of these dimensions) of these reasons for variations will be reviewed in following.

In terms of the different dimensions or facets of socio-economic status (i.e.: income, education, wealth, occupation or social capital), differences between the causal pathways, the operating levels and the interactions with other social determinants exist (Braveman et al., 2005). Several studies and overviews (e.g. Duncan & Magnuson, 2003) have explored the relevance of different dimensions of socio-economic status for adolescent health: Some studies analyse young people's own educational status (educational track and/or school performance) and confirm its relevance for different aspects of student health (Koivusilta et al., 1999; Koivusilta et al., 2001; Koivusilta, Rimpelä, & Kautiainen, 2006; Richter & Lampert, 2008). The majority of studies use parental education, parental occupation or household income as an approximation of the socio-economic status of the adolescents (Currie, C. et al., 2008; Hanson & Chen, 2007). Higher parental education, parental occupation and family or household income have been linked to negative health behaviour and negative self-rated health, but differences in the statistical significance and strength of the association of these dimensions with the different aspects of adolescent health were revealed (Currie, C. et al., 2008; Hanson & Chen, 2007). In a context like Luxembourg, with its very high proportion of young people with migration backgrounds, an accurate description of the education that parents received in foreign countries or the exact description of the occupation of the parents can pose a challenge for a considerable proportion of adolescents. As alternative to these dimensions of socio-economic status, several studies (including the two most comprehensive large-scale studies of adolescents, HBSC and the Programme for International Student Assessment (PISA) rely on the affluence or wealth of the family / household to approximate the socio-economic status of adolescents. Using indexes of family or household wealth and affluence, these studies have shown clear associations between this dimension of socio-economic status and adolescent health (Currie, C. et al., 2008, 2008; Schleicher & Belfali, 2016; Wardle, Robb, & Johnson, 2002).

Absolute, relative and subjective socio-economic status

In addition to varying with the dimensions of socio-economic status, the review of the existing literature indicates that the relation between adolescent health and socio-economic status varies with the conceptualisation of the differences within these dimensions: i.e. absolute, relative or subjective aspects of socio-economic status (Elgar et al., 2013; Elgar et al., 2017; Elgar, McKinnon et al., 2016).

The differentiation between absolute and relative conceptualisations of affluence has received much attention. Absolute aspects of affluence represent the level or amount of available resources itself. The influence of absolute aspects of socio-economic status on the health of population groups with few socio-economic resources is well documented, and they constitute key factors in understanding health inequalities in countries with low overall affluence. However, they only offer little insight with regard to the persistence of the social health gradient for medium and high levels of socio-economic status and the existence of social gradients in countries with high or very high overall affluence (Bartley, 2004; Marmot, 2005; Rambotti, 2015).

This is why relative aspects of socio-economic status have come into focus. They represent the comparative level of available resources in comparison to specific reference groups or in comparison to the levels of available resources across a whole society (Elgar et al., 2017; Marmot, 2005; Solar & Irwin, 2005, 2010). Wilkinson and Pickett (2007; 2009) established relative aspects as important aspects of social inequality with regard to health inequalities by arguing and reconfirming (2015a, 2015b; 2007) that relative deprivation contributes to the influence of levels of income inequality on the prevalence of health. The relevance of socio-economic inequalities for adolescent health have, for example, been confirmed for perceived health (Torsheim, Currie, Boyce, & Samdal, 2006) and life satisfaction (Levin et al., 2011). The influence of relative wealth or affluence has also been verified for adolescents (Due, P. et al., 2009; Elgar et al., 2015; Holstein et al., 2009; Nielsen, L. et al., 2015).The results from Elgar and colleagues (2013), for example, suggest that rank affluence and relative deprivation are more closely related to psychosomatic symptoms than absolute affluence. In addition, they are uniquely related to these symptoms (after accounting for absolute differences in affluence). On the other hand, country differences in absolute affluence do not seem to be related to self-rated health or the consumption of fruit and soft drinks for European and North American countries according to the results of studies by Torsheim and colleagues (2004) and Vereecken and colleagues (2005).

In addition to absolute and relative conceptualisations of objective socio-economic status, subjective aspects of socio-economic status have been taken into account. They are often referred to as subjective social status or perceived family wealth (Adler, Epel, Castellazzo, & Ickovics, 2000a; Hoebel, Maske, Zeeb, & Lampert, 2017; Jackman & Jackman, 1973; Nielsen, F., Roos, J. M., & Combs, R. M., 2015; Nobles, Weintraub, & Adler, 2013; Singh-Manoux, Marmot, & Adler, 2005).

Subjective social status has been described as a distinct facet of socio-economic status and as a mediator between objective indicators of socio-economic status (employment, occupational class and wealth) and health (Demakakos et al., 2008; Karvonen & Rahkonen,

2011). In a study on the role of subjective social status on health in old age, Demakakos and colleagues (2008) found that subjective social status full or partially mediated the association between education and occupational class and different measures of health. They interpret their findings as 'evidence that subjective social status is a means through which education and occupational class influence people' and hypothesise that objective aspects of socio-economic status are 'transformed to personal experience and self-perceptions about own social standing, which in turn translate into health and disease' (Demakakos et al., 2008, p. 335).

Youth is a phase of increasing importance of peers and a transitional phase between family and own social status. During this life phase the young person's own position in the local social hierarchy (which they experience on a daily basis) as well as their perception of this position might be more influential, that their families position in the overall societal social hierarchy (see Karvonen & Rahkonen, 2011). Karvonen and Rahkonen (2011), for example, suggest that subjective social status measures a facet of the socio-economic position that is different and separated from that measured by objective measures of socio-economic status (such as parental occupation or education) and that it has an independent relation with the health of young people.

In European and North American countries, higher subjective social status has been statistically significantly linked to different adolescent health outcomes including better general and mental health (Quon & McGrath, 2015), better self-rated health (Goodman, Huang, Schafer-Kalkhoff, & Adler, 2007; Karvonen & Rahkonen, 2011; Quon & McGrath, 2015), fewer multiple health complaints (Karvonen & Rahkonen, 2011; Moor et al., 2015), fewer psychiatric symptoms (Goodman et al., 2001; Karvonen & Rahkonen, 2011) and less overweight and obesity (Goodman et al., 2001). Parallel to these studies confirming links between subjective social status and some adolescent health aspects, other studies did not confirm significant relations between subjective socio-economic status and BMI, blood pressure, heart rate and cortisol levels (Chen & Paterson, 2006) as well as metabolic biomarkers and substance use behaviours (Quon & McGrath, 2015).

Quon and McGrath's (2014) meta-analytic findings are similar to the results of the individual empirical studies described here and also conclude that subjective socio-economic status is positively related to some aspects of adolescent health. The meta-analysis indicates that general, mental and self-rated (or perceived) health are related to subjective social status in adolescence, while substance use, BMI and biomarkers of health are not or only inconsistently related to subjective social status (Quon & McGrath, 2014).

There are few studies specifically analysing the difference between objective and subjective conceptualisations of socio-economic status in relation to health (Adler, Epel, Castellazzo, & Ickovics, 2000b; Goodman et al., 2003; Hoebel et al., 2017; Jackman & Jackman, 1973; Ritterman et al., 2009; Singh-Manoux et al., 2005). With regard to adolescent health, some studies control for the conceptualisation of socio-economic status but do not focus on it. Most of the aforementioned studies confirm a relation between adolescent health and subjective socio-economic status when objective measures of socio-economic status are controlled for and thus confirm that the effect of subjective socio-economic status on adolescent's health is independent of the effect of objective socio-economic status ((Goodman et al., 2001; Goodman et al., 2007; Karvonen & Rahkonen, 2011; Quon & McGrath, 2015, 2015). But the results are not homogenous. De Clercq and colleagues (2017), for example, found that perceived family wealth (a measure of subjective socio-economic status) had no statistically significant independent effect on healthy food intake, while family affluence (a measure of objective socio-economic status) had a positive effect.

The analysis of covariates in Quon and McGrath's (2014) meta-analysis of the influences of subjective socio-economic status on adolescent health concludes that the effects of subjective socio-economic status that they found are independent and unaffected by objective socio-economic status. It thus seems that subjective socio-economic status is independently associated with some but not all aspects of adolescent health.

The review of the international empirical findings on health inequalities in youth presented in this chapter leads to the conclusion that the relation between SES and adolescent health is varied and diverse. The health phenomenon under study and individual socio-demographic characteristics are identified as important factors. In addition, different dimensions and conceptualisations of socio-economic status are unique and influence which relations are observed (Braveman et al., 2005); (Macintyre, McKay, Der, & Hiscock, 2003). To avoid obscuration or distortion of the results on associations between health and socio-economic status, investigations of health inequalities should, where possible, take multiple dimensions or conceptualisations of socio-economic status into account and recognise that measures of socio-economic status are not interchangeable (Braveman et al., 2005). Further studies including both objective and subjective aspects of socio-economic status are needed to complete the international empirical contribution to the understanding of health inequalities in youth. Since the relation between socio-economic status and adolescent health is so varied, it is impossible to infer a hypothesis or an understanding of the situation in Luxembourg.

3.2 Socio-economic health inequalities in youth in Luxembourg

In the following section, the available empirical findings on the relation between socio-economic status and health in adolescents in Luxembourg are reviewed. Empirical findings on potentially relevant factors identified from the international literature in the previous section are of specific interest.

Studies analysing and confirming the existence of socio-economic health inequalities among adults in Luxembourg are abundant (see e.g. Direction de la Santé & Luxembourg Institute of Health, 2017b, Direction de la Santé & Luxembourg Institute of Health, 2017a; Lorentz & Tchicaya, 2005, 2006, 2007, 2008; Origer, Le Bihan, & Baumann, 2014; Tchicaya, 2006; Tchicaya, Demarest, & Lorentz, 2011; Tchicaya & Lorentz, 2011, 2011). Research on socio-economic inequalities in the wellbeing of adults provides an indication of the relevance of the differentiation between absolute and relative socio-economic status for Luxembourg. According to Klein and Dickes (2011), there is an association between life satisfaction and relative income but not absolute income. This underlines the importance of using several measures of socio-economic status in studies in Luxembourg.

The review of the international scientific literature and the publications of the relevant national institutions[4] uncovered very few studies analysing health inequalities in adolescents in Luxembourg.

Two studies focusing on adolescent health in Luxembourg published reports between 2002 and 2006. Their results were reported by age, gender and educational track, but not by socio-economic variables (Bös et al., 2006; Henschen & Wagener, 2005; Wagener, Henschen, & Petry, 2005; Wagener & Petry, 2002). The reports of the HBSC pilot study in Luxembourg in 2002, for example, described the socio-economic characteristics of their sample and the influences of these on the educational path and aspirations of the students[5], but they did not empirically relate socio-economic status to any health phenomena (Wagener & Petry, 2002).

[4] The University of Luxembourg, the Luxembourg Institute of Socio-Economic Research (LISER), the Luxembourg Institute of Health (LIH), the Institut national de la statistique et des études économiques du Grand-Duché de Luxembourg (STATEC) and the relevant Ministries (Health, Education and Family).
[5] Wagener and Petry (2002) concluded that ‘es ist davon auszugehen, dass der sozioökonomische Status einer Familie in unserer Gesellschaft den Bildungsweg der Kinder in einem erheblichen Masse beeinflusst’.

The HBSC collects data every four years, and Luxembourg's findings have been included in the international report of participating countries since 2006. The reports include information on the bivariate relations between the health indicators and family affluence for each participating country (Currie et al., 2012; Currie, C. et al., 2008; Inchley et al., 2016).

Table 1 summarises the statistically significant differences in the prevalence of health aspects according to family affluence in Luxembourg from the 2014 international HBSC study (Inchley et al., 2016). For more than a third (i.e. 16 of 39) of the health indicators, statistically significant differences were found for at least one gender. For the vast majority of these (i.e. 14 of 16), the identified socio-economic health inequalities indicate better results on the health indicators for adolescents with higher socio-economic status compared to adolescents with lower socio-economic status. This is the case for most health aspects and behaviours that have a potential influence on the student's energy intake / outtake balance (breakfast consumption, fruit consumption, soft drink consumption, physical activity) or indicate a misbalance (being overweight, negative body image). There are, however, also two health indicators that show opposite relations between family affluence and health: Girls with higher family affluence feel more pressured by school work than girls with lower family affluence. In addition, adolescents with higher family affluence have a higher prevalence of having been drunk on two or more occasions than adolescents with lower family affluence. This is, however, the only indicator concerning the consumption of psychoactive substances (alcohol, tobacco and cannabis) that shows health inequalities. The results from the international HBSC study 2014 thus indicate the existence of health inequalities in certain, but not all health areas for adolescents in Luxembourg.

Table 1: Statistically Significant Bivariate Relations between Family Affluence and Adolescent Health in Luxembourg from the international HBSC 2014

Indicator	Boys	Girls
Eating Breakfast Daily	+	+
Eating Fruit Daily	+	+
Soft drink Consumption		+
Overweight and Obesity	+	+
Body Image	+	
Moderate to Vigorous Physical Activity		+
Oral Hygiene	+	
Perceived Family Support	+	+
Perceived Peer Support	+	+
Electronic Media Communication – Social Media Contact with Friends	+	+
Life Satisfaction	+	+
Being a Victim of Bullying at School		+
Multiple Health Complaints	+	
Body Image	+	
Having Been Drunk on Two or More Occasions	-	-
Pressured by School Work		-

Legend		
No Significant Difference	Higher socio-economic status = Better Health	Higher socio-economic status = Worse Health

Source: (Inchley et al., 2016), statistically insignificant differences for 23 indicators not included in the table, results -for 11-, 13- and 15-year-olds except for cannabis use, sexual and contraceptive behaviour which were only assessed for 15-year-olds

In 2014 and based on the extended national sample of the Luxembourg HBSC study, the national report summarises the relations between family affluence and different health aspects for adolescents in Luxembourg as shown in Table 2. These results show health inequalities by family affluence for nearly all of the 16 health variables that where studied (Heinz et al., 2018). For two-thirds of these variables, the adolescents with low family affluence had the worst results, while the adolescents with high family affluence had the best results. For these health aspects, a higher family affluence translates into better health. As in the international report, the health aspects and behaviours that have a potential influence on the student's energy intake/outtake balance (breakfast consumption, fruit consumption, physical activity, watching TV) or indicate a misbalance (being overweight) are positively related to family affluence. For the psycho-social aspects of adolescent's health in Luxembourg, the bivariate results reveal a

similar, but less clear pattern: While adolescents with higher family affluence have better health results for four aspects (quality of family communication, life satisfaction, being bullied and liking school), they exhibit higher levels of feeling pressured by schoolwork and no differences are observable for class climate (Heinz et al., 2018). As far as the consumption of psycho-active substances is concerned, no pattern of prevalence according to family affluence was identified. The results from the national HBSC study 2014 thus confirm and complement the results from the international HBSC study. The findings indicate strong and positive relations between family affluence and health factors concerning the energy balance of adolescents, they indicate mostly positive results with few negative exceptions for psycho-social factors and are mostly non-significant with a few negative exceptions for indicators concerning the consumption of psychoactive substances.

Table 2: Summary of bivariate relations between family affluence and adolescent health from the national HBSC 2014

Students, who…	**Low**	**Medium**	**High**
have breakfast on every school day			
eat fruit daily			
are overweight			
are physically active (2 hours or more per week)			
brush their teeth twice daily			
report a high quality of communication of their family			
report a high life satisfaction			
have been bullied twice or more often in the last months			
like school			
have frequent health complaints (at least two health complaints multiple times a week)			
watch TV frequently (2 hours or more per day)			
drank alcohol in the last month			
used cannabis in the last month			
feel highly pressured by schoolwork			
smoke frequently (at least once a week)			
report a positive class climate			
Legend			
Best result	Medium result or no significant difference	Worst result	

Source: (Heinz et al., 2018), translated and rearranged by author

In addition to these studies, the literature review found one in-depth study analysing the relation between socio-economic status and the health of children or adolescents in Luxembourg through multivariate analysis. Lorentz and Tchicaya (2011, 2014) analysed data gathered in 2007 about 1,587 children and adolescents via the PSELL/EU-SILC household panel[6]. Bivariate analyses revealed differences in the prevalence of the overweight of children and adolescents by parental education level, disposable household income ('niveau de vie') and parental occupation. These could be first indications of socio-economic health inequalities among adolescents, but the difficulty in the interpretation of this study lies in the focus of the study (effect of parental overweight) and the age range that spans from childhood into adolescence (Tchicaya & Lorentz, 2011, 2014).

Beyond the cited analyses published or supported by national institutions, a small number of empirical studies on health inequalities among adolescents in Luxembourg have been published in the international scientific community. The identified international publications including Luxembourg are mainly based on the international HBSC data, where Luxembourg is one of many countries that are compared regarding the international prevalence of health risks according to socio-economic status.

Holstein and colleagues (2009), for example, found that the odds of adolescents in Luxembourg having two or more daily health complaints are, for adolescents with low socio-economic status, 1.85 (1.33-2.57 CI-95) times those of adolescents with high socio-economic status[7]. Moor and colleagues (2015) report that, in Luxembourg, the relative risks of adolescents with low subjective socio-economic status to suffer from multiple health complaints was 1.32 in 2006 and 1.34 in 2010. Vereecken and colleagues (2009) found that the odds of adolescents with low objective socio-economic status to eat breakfast daily[8] are 0.71 (0.62-0.84 CI-95) times those of adolescents with high socio-economic status. Pförtner and colleagues (2016) found no statistically relevant differences in the odds of smoking weekly between adolescents with different objective socio-economic status in Luxembourg. As these exemplary studies show, the empirical knowledge on health inequalities among adolescents in Luxembourg that can be derived from international publications is fragmented (one health indicator per study) and limited in depth (only one conceptualisation of socio-economic status per study).

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[6] The data collected in the PSELL/EU-SILC household panel is obtained from an adult contact person in the household rather than from the children or adolescents themselves.
[7] The odds for adolescents with medium objective socio-economic status were 1.30 (1.04-1.62 CI-95) times those of adolescents with high socio-economic status (Holstein et al. (2009)).
[8] Which is in turn linked to less smoking, less alcohol misuse, less television viewing, less soft drink consumption, less dieting and higher rates of fruit and vegetable consumption for adolescents in Luxembourg (Vereecken et al. (2009)).

Chzhen and colleagues' international study (2016, p. 11) analysed health inequalities in 31 countries (including Luxembourg) by concentrating on the lower half of the health distribution (and thus the extent to which adolescents 'fall behind the average person'). The relative inequality at the lower half of the distribution for Luxembourg was higher than the international average for self-reported health, healthy eating and life satisfaction. Physical activity and unhealthy eating was around the international average. In the ranking by a composite health measure, Luxembourg ranked as the country with the seventh highest inequality of adolescent health. These results indicate that systematic inequalities in adolescent health in Luxembourg do indeed exist. The fact that the study excluded Luxembourg as an 'influential outlier' from some of the calculations is, however, an indication that the relation between socio-economic status and adolescent health in Luxembourg cannot be inferred from results from other countries but needs to be empirically considered on its own (Chzhen et al., 2016, p. 22).

In summary, the available empirical knowledge on socio-economic inequalities in adolescent health in Luxembourg are not sufficient to formulate a hypothesis or conclusion on heath inequalities in youth in Luxembourg. There is a lack of information on the association between adolescent health and socio-economic status in Luxembourg for all relevant factors that have been identified in the extant international literature. Most blatantly lacking is empirical knowledge on the relation of adolescent health and socio-economic status when other factors (e.g. socio-demographic characteristics) are controlled for in multivariate analysis and on the role of different aspects, dimensions or conceptualisations of socio-economic status for adolescent health. To date, no empirical knowledge on the role of subjective conceptualisations of socio-economic status for adolescent health in Luxembourg exists even though this would seemingly be of particular interest for a context with such a high overall standard of living.

The review of the available international and national empirical information on health inequalities among adolescents was unable to allow a conclusion on the pertinence of the theoretical understanding of this thesis for health inequalities. While the theoretical model seems relevant in many countries, this review identified a need for empirical studies including and comparing objective and subjective aspects of socio-economic status to confirm this relevance. Moreover, the review of the empirical literature describing the situation in Luxembourg revealed an overall lack of studies and empirical knowledge on health inequalities in youth in Luxembourg. In the face of this lack of information, it is currently impossible to deduce the relevance of the theoretical model and to infer reliable information on the health inequalities among adolescents in Luxembourg in general or for specific health domains (such as weight status. Therefore to determine whether enough international and national empirical knowledge is available to at least conclude on the relevance theoretical model on health

inequalities with respect to health inequalities in adolescent weight status, the scope of the review will be reduced to this single health domain in the next chapter.

4 Review of empirical findings on overweight and underweight in youth

As for every empirical exploration of a theoretical model, the abstract and broad concepts need to be translated into specific observable phenomena. This study applies focuses on weight status among adolescents in Luxembourg as observable phenomena on which it applies the theoretical model of health inequalities presented in chapter 2. Weight status seems to be the most appropriate focus of this study as it is a health phenomenon that is currently changing around the world (NCD-RisC, 2017) and that has immediate consequences for well-being as well as potential health consequences across the whole life-course (Viner et al., 2015). Especially underweight can be described as 'important overlooked phenomenon in developed countries' (Lazzeri et al., 2014, p. 2213). At the same time socio-economic inequalities in weight status exist in most countries and regions and there is thus reason to believe that socio-economic inequalities also exist in the weight status of young people in Luxembourg (Due, P. et al., 2009; Olds et al., 2011) . Socio-economically influenced habitus, health beliefs, values and norms of adolescents and parents might be 'embodied' in body weight and shape. Since this thesis analyses health inequalities, the focus is not on body shape, body weight or weight status in general, but on body weights that indicate a potential health risk.

In the context of this thesis overweight and underweight are thus defined as weight status, that represent potential (future) weight-related health risks at opposite end of the weight continuum or spectrum (Flegal, Graubard, Williamson, & Gail, 2005; Kopelman, 2007). Even with abundant biological information (skinfold thickness, waist circumference, body fat to muscle ratio etc.) the medical definition of absolute cut offs for body shapes and weights that do or do not represent an immediate or future health risk is difficult (Lobstein et al., 2004). When the body shapes of a large number of people need to be evaluated with limited available information, the Body-Mass-Indexes (BMI) is commonly used to categories body weight according to (un)healthiness (Lobstein et al., 2004). According to the WHO for example adults with a BMI under 18,5 are to be considered underweight, while adults with a BMI of 25 or higher are to be considered overweight (WHO, 2004). Biological aspects changing body shape and body composition in adolescents (such as pubertal growth spurts or changes in body composition) are taken into account by adapted cut-off points for children and adolescents (Cole & Lobstein, 2012).

In this section the empirical knowledge about the potential consequences, aetiology, prevalence and relation of SES to overweight and underweight in adolescents is reviewed. In the first section, the empirical knowledge available for overweight is reviewed, while the second section reviews the information that is available for underweight. Some empirical studies do not differentiate between different weight status and but refer to overall body shape or BMI. Because most of these studies have a theoretical and thematic orientation towards overweight, their results are reviewed in the section on overweight even if their results are also relevant for the understanding of underweight. The section on underweight only describes empirical results that have specifically been tested for underweight. Within the sections on overweight resp. underweight, the empirical knowledge from developed resp. industrialised countries is described first, before the specific information that is available about adolescents' overweight and underweight in Luxembourg is presented.

Establishing the consequences and aetiology of overweight and underweight are crucial for the evaluation of the relevance of overweight and underweight. The empirical findings about potential consequences of overweight and underweight are reviewed and factors contributing to them or protecting from them are identified to understand their aetiology. It can however be difficult to establish causality when it comes to health risks and factors associated with them. Often the causality between physical, behavioural and psycho-social factors associated with specific health risks are not uni-directional, but bi-directional or even circular: A (e.g. lack of physical activity) might be causing B (e.g. overweight) and B (overweight) might at the same time be causing A (lack of physical activity) to become chronic or increase. This chronification or increase in A (lack of physical activity) can in turn cause B (overweight) to become chronic or increase further and so forth (see (Mulatu & Schooler, 2002). There is no absolute distinctions between the consequences and contributing factors of certain health risks. While some factors can be identified as being mostly consequences or contributing factors, most factors are both. Consequently, the goal of this review of the empirical findings is to find factors that are associated with overweight and/or underweight rather than to identify the exact causality or to classify them as consequences or causes.

4.1 Review of empirical findings on overweight

The empirical knowledge about overweight, its consequences, aetiology, prevalence and relation to socio-economic status among adolescents in industrialised countries and Luxembourg are reviewed in the following section. In the categorisation of opulent body shapes that pose a potential risk to health, many studies differentiate between different degrees of

severity of overweight by subdividing overweight into overweight (defined as BMI of 25-29.9 in adults[9] by the WHO), obesity (defined as BMI of 30-34.9 in adults by WHO and sometimes referred to as obesity class I) and morbid obesity (defined as BMI above 35 in adults by WHO and sometimes referred to as obesity class II) (WHO, 2004). Since obesity indicates severe forms of overweight and has more immediate and severe physical consequences, some studies concentrate on the causes and health consequences of obesity (See for example Campos, Saguy, Ernsberger, Oliver, & Gaesser, 2006; Inchley, Currie, Jewell, Breda, & Barnekow, 2017). The theoretical model of health inequalities retained for this thesis however specifically includes social, psychological and behavioural factors that might already be influential at a low level of overweight. The differentiation between overweight and obesity is therefore not crucially relevant for this thesis and the empirical knowledge is not systematically presented separately for obesity and less severe overweight.

4.1.1 Associated health risks and associated factors of overweight

The health risks linked to overweight and obesity are not immediate, but often only start to become apparent years after overweight or obesity were developed. A lot of risks and consequences associated to overweight or obesity in adults are therefore not (yet) apparent in adolescents (Lobstein et al., 2004). The fact that the overviews such as Lobstein, Baur and Uauy's (2004) identified several negative implications that were associated with overweight and obesity in adolescents is therefore all the more relevant:

In terms of physical health, overweight has been linked to asthma in both sexes, menstrual problems and early menarche in girls and delayed maturation in boys (Lobstein et al., 2004). At the same time overweight can be a predecessor of obesity, which has in turn been identified as a risk factor for several serious physical health concerns. The negative physical health aspects that are associated with obesity in children or adolescents range from type 2 diabetes, high blood pressure, insulin resistance, sleep-disordered breathing (apnoea or hypopnoea), fatty liver disease to raised cholesterol and serum triglyceride levels (Biro & Wien, 2010; Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007; Lobstein et al., 2004; Thompson et al., 2007). In addition to these immediate physical health concerns, overweight and obesity in childhood and adolescence can entail health problems later in the life course and increases

[9] For the categorisation of weight status in children and adolescents age centile curves based on these BMI cut-offs for adultes are used (Cole and Lobstein, 2012; Cole, Flegal, Nicholls, and Jackson, 2007).

the risk of obesity, certain types of cancer, cardio-vascular disease, hypertension, sleep apnoea, osteoarthritis and premature death in adulthood (Biro & Wien, 2010; Freedman et al., 2007; Mamun et al., 2009).

In addition to the risks to the physical health, overweight and obesity can have social consequences for the concerned children or adolescents. The stigmatisation of overweight and obesity by general society exposes some overweight or obese children and adolescents to discrimination and negative stereotyping (Lobstein et al., 2004). The empirical results indicating a reduced number of friends among and a higher risk of being bullied in overweight girls compared to non-overweight girls are an indication that the social consequences of overweight and obesity might affect the social peer circle of children and adolescents (Lobstein et al., 2004; Mikolajczyk & Richter, 2008). The communication with parents does not seem to be related to overweight (Al Sabbah et al., 2009). The social and economic consequences of overweight in adolescence pertain into young adulthood resulting in lower likelihood of being married and lower educational and economic attainment (Gortmaker et al., 1993).

Overweight and obesity can have a negative psychological impact both by itself and via the social reactions the children and adolescents are exposed to. In terms of the wellbeing and psychological health, adolescents' overweight and obesity can result in lower life quality and psychological challenges (such as body dissatisfaction, negative body image or low self-esteem) (Al Sabbah et al., 2009; Lobstein et al., 2004; Ojala, Tynjälä, Välimaa, Villberg, & Kannas, 2012). Based on the 2005/2006 HBSC survey in Luxembourg, Willems and colleagues (2010) reported that 60.5% of girls and 46.8% of boys were unsatisfied with their bodies and had a negative body image.

Through the associated physical, social and psychological health risk, overweight can thus compromise the present and future health and wellbeing of adolescents. In addition to the consequences of overweight, factors that contribute to overweight are of interest to understand the aetiology and possible ways in which factors might be influencing overweight. In addition to biological and familial factors that influence children's and adolescents' weight, the review of Lobstein, Baur and Uauy's (2004) identified factors that relate to the energy balance (energy intake – energy expenditure) as possible contributors to overweight.

On one hand, this includes factors influencing the energy balance through energy intake. The energy density in terms of the energy content of food in relation to their content in micronutrients play an important role in determining the energy intake (Lobstein et al., 2004). In children and adolescents, the consumption of food with high levels of fat or carbohydrates (particularly sugar) such as fast food and sugary soft drinks are associated with an overall higher energy density of the diet, while the consumption of food with high levels of

micronutrients and low levels of fat and carbohydrates such as fruits and vegetables are associated with an overall lower energy density of the diet. In addition eating patterns (regular meals, snacking) and portion size seem influence the overall energy intake (Lobstein et al., 2004).

On the other hand, the energy balance is influenced through energy expenditure. The energy output is determined by the level of physical activity. High levels of physical activity such as sports, walking or cycling indicate increased energy expenditure and have a potential protective effect against children and adolescents' overweight. High levels of inactivity or sedentary behaviour such as television viewing or video and computer games are indicators of decreased energy expenditure which potentially increases the risk of being overweight (Lobstein et al., 2004).

It is important to note that health behaviours tend to cluster in the sense that people have overall healthier or less healthy lifestyles that are expressed in several health behaviours. Studies in adults have shown a tendency for factors contributing to overweight and underweight to aggregate into 'common lifestyle risk factor clusters' (Schuit, van Loon, Tijhuis, & Ocke, 2002, p. 219). These clusters of unhealthy behaviour or unhealthy lifestyles are not yet detectable in adolescence in relation to overweight: Smoking and alcohol consumption are for example not associated to overweight (Dupuy et al., 2011). On the other hand such risk factors clusters were detected in relation to dieting, which is associated with alcohol, cigarette and cannabis consumption in adolescent girls in the US (Crow, Eisenberg, Story, & Neumark-Sztainer, 2006).

Recent international studies based on surveys with adolescents confirm these associations of overweight with potentially contributing factors to a certain extend for adolescents: For most of the 34 countries in Janssen and colleagues' (2005) study, overweight adolescents showed lower physical activity levels and longer TV viewing times than normal weight adolescents. At the same time, fruit intake, soft drink consumption and time on computer were not associated to overweight. Haug and colleagues (2009) found that overweight was negatively related to breakfast consumption and moderate to vigorous physical activity in 41 countries. In France Dupuy, Godeau, Vignes and Ahluwalia (2011) found that eating breakfast daily, moderate to vigorous physical activity as well as vigorous physical activity are negatively associated to overweight. TV viewing was not associated for boys, but negatively associated for girls. Fruit and vegetable consumption, computer and videogames were however not associated with overweight.

In the literature, the indications for an association with adolescent overweight seem thus strongest for breakfast consumption, physical activity and TV watching. The associations of

overweight with fruit and vegetable consumption or computer and videogames that Lobstein, Baur and Uauy's (2004) described were not as consistently detected in empirical analysis based on survey with adolescents. In line with the life style theory TV viewing seems to be an indicator for a wider life style, but does not seems to have a unique effect that is statistically significant in multivariate studies controlling for direct measures of physical activity and energy density of the diet (Lobstein et al., 2004).

4.1.2 International prevalence of overweight

After an alarming worldwide increase of the number of overweight and obese people, there has been some evidence in recent years, that the proportions of children and youth[10] presenting overweight or obesity has levelled off and plateaued at least for some countries and some subpopulations (Olds et al., 2011; Rokholm, Baker, & Sørensen, 2010). While this means that the situation might stop worsening for some subgroups, it should by no means be interpreted as a reason to believe that the obesity epidemic is no longer relevant. Obesity rates in youth continue to be at alarming levels. Continuously high and rising levels of prevalence of overweight and obesity in adolescents are observed by many studies for Europe and Luxembourg (Haug et al., 2009; Inchley et al., 2016; Inchley et al., 2017; Janssen et al., 2005; Olds et al., 2011; Lioret et al., 2009).

In their description of the prevalence for overweight and obesity in youth from 34 countries, Janssen and colleagues (2005) recognise a geographical pattern. While North- American, British and southern western European countries show proportion above 15% of overweight young people and Eastern European countries show proportions underneath of 10%, proportions between 10 and 15% a typical for Nordic countries, the western part of south east Europe and countries from western Europe (Austria, Belgium, France, Germany, Netherlands and Switzerland).

4.1.3 Overweight and socio-economic status

International socio-economic inequalities in the BMI of adolescents have been confirmed in recent years and trend analysis show persistent or increasing levels of socio-economic

[10] As far as the prevalence of overweight and underweight and their relation with socio-economic status is concerned, this review will focus exclusively on adolescents and children because trends in overweight or underweight for children and adolescents are different to those of adults (Popkin, Conde, Hou, & Monteiro, 2006).

inequalities in BMI (Elgar et al., 2015; Lioret et al., 2009). In many developed countries, that the body mass index of young people tends has been confirmed to be smaller, the higher their socio-economic status is. Consistent with the so called 'health gradient', this relationship translates into a relatively lower risk of young people with higher socio-economic status of being overweight and thus into a positive effect of higher socio-economic status on health (Dupuy et al., 2011). In France, for example, a strong socio-economic gradient was observed for the rates of overweight (including obesity) adolescents in 1998/1999 and in 2006/2007 (Lioret et al., 2009). These results have been confirmed by the systematic review of Barriuso and colleagues (2015).

As seen in chapter 3.2 both the international and national reports of the 2014 HBSC study show health inequalities in the prevalence of many of the health and health behaviour factors that have been identified as associated to overweight (Heinz et al., 2018; Inchley et al., 2016). Statistically significant socio-economic differences have been identified for factors that have a potential influence on the student's energy in/outtake balance. Higher socio-economic status has been linked to more regular breakfast consumption, higher fruit consumption, less soft drink consumption, more physical activity and less sedentary activity (TV watching) and factors that indicate negative feelings towards their body shape such as less negative body image (Heinz et al., 2018; Inchley et al., 2016). Multivariate studies confirmed the positive effect of higher socio-economic status for example on healthy food intake (De Clercq et al., 2017), regular breakfast consumption (Vereecken et al., 2009), higher fruit consumption and lower soft drink consumption (Vereecken et al., 2005).

In adults, these factors have in addition to being strong predictors of overweight been identified as strong mediators of the indirect associations between socio-economic position and BMI (Borodulin et al., 2012).

4.1.4 **Overweight in Luxembourg**

With a prevalence of overweight of 32.4% (39.6% males, 25.4% females) and obesity 15.6% (16.8% males, 15.4% females) the prevalence of overweight and obesity in Luxembourg is worryingly high (Direction de la Santé & Luxembourg Institute of Health, 2017b). In summary, studies of the prevalence and associated factors of adult overweight and obesity in Luxembourg show indications of

- a higher prevalence of overweight and obesity among men;
- an increasing prevalence of overweight and obesity from the age of 26-24 to the age of 55-64;

- a rise in obesity over time (1995-2007);
- a higher prevalence of overweight and obesity among adults with lower SES and
- similar prevalence rates in comparison to neighbouring countries around the European average (Direction de la Santé & Luxembourg Institute of Health, 2017b, Direction de la Santé & Luxembourg Institute of Health, 2017b; Lorentz & Tchicaya, 2006; Tchicaya, 2006; Tchicaya & Dia, 2010; Tchicaya & Lorentz, 2012).

Studies about adolescent overweight and obesity are much less abundant. The reports of the HBSC pilot study in Luxembourg in 2002 analysed body image, but did not take self-reported body height and weight into account (Wagener & Petry, 2002). For 14-year-olds Bös and colleagues (2006) found a prevalence of overweight of 16.4% for girls and 20.8% for boys in 2004. Lorentz & Tchicaya (2010) found a prevalence of overweight of 19% for adolescents between 12 and 15 years of age in 2007. In contrast to the international empirical findings for adolescents (Inchley et al., 2016; Inchley et al., 2017), these two studies did not find statistically significant differences between boys and girls, but this could be due to their small sample size.

The reports from the international HBSC survey include prevalence rates of overweight in adolescents for Luxembourg since 2006 (Currie et al., 2012; Currie et al., 2008; Inchley et al., 2016). Table 3 shows the prevalence of overweight reported for Luxembourg in the international HBSC study. The prevalence differs considerably between the different waves and there seems to be an increase of the prevalence of overweight for boys between 2006 and 2014, but the information reported is not sufficient to determine whether this increase is statistically significant.

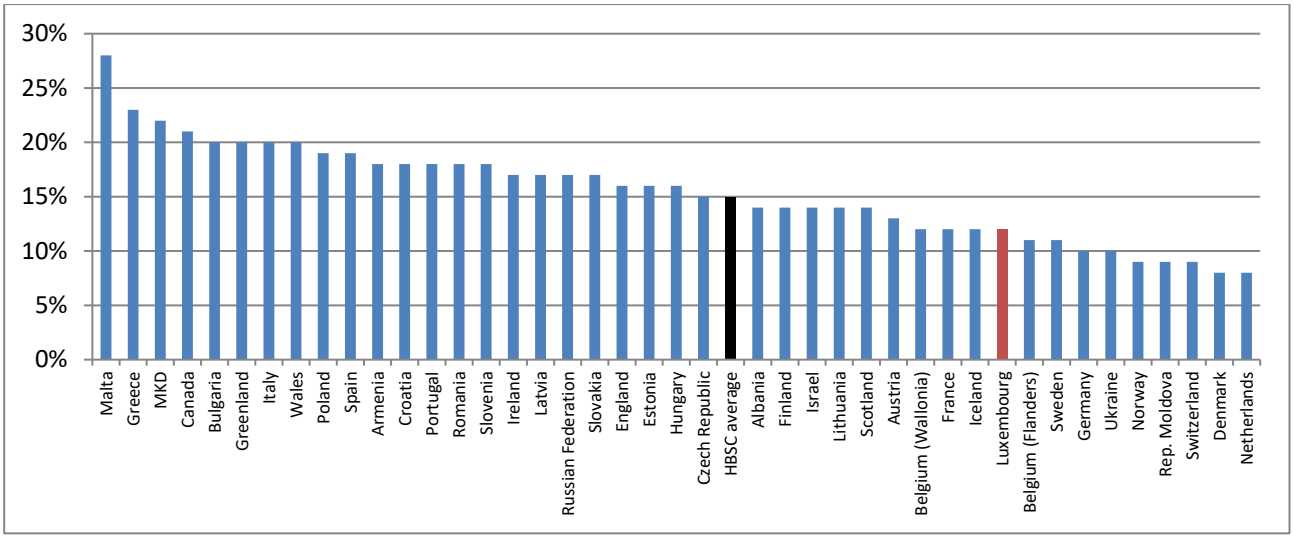
Table 3: Prevalence of Overweight and Obesity according to international HBSC

	Prevalence of Overweight (including Obesity)					
	11-year-olds		13-year-olds		15-year-olds	
	Boys	Girls	Boys	Girls	Boys	Girls
2014	26%	14%	23%	14%	21%	15%
2010	11%	11%	17%	11%	22%	12%
2006	14%	11%	15%	10%	16%*	9%

Source: (Currie et al., 2012; Currie et al., 2008; Inchley et al., 2016)

For 2014 and 2006[11], these results are marginally (1 or 2 percent points) below the average of all the participating countries. Figure 3 and 4 show the prevalence rate of overweight among 11- and 15-years-olds in Luxembourg in comparison to the rates of other participating countries (Inchley et al., 2016). Compared to the other participating countries, the 12% prevalence of overweight in 11-years-olds in Luxembourg is lower than the HBSC average, which is at 15%. For the 15-year-olds, the prevalence of overweight is similar to the HBSC average. In the international ranking, Luxembourg thus ranks among the countries with a prevalence below the HBSC average for the 11-year-olds, but for the 15-years-olds Luxembourg ranks among the countries with a prevalence above the HBSC average. While the prevalence of overweight seems to rise with age in Luxembourg, tendencies of decrease of overweight with age show in other countries.

Figure 3: Overweight of 11-year-olds in International Comparison

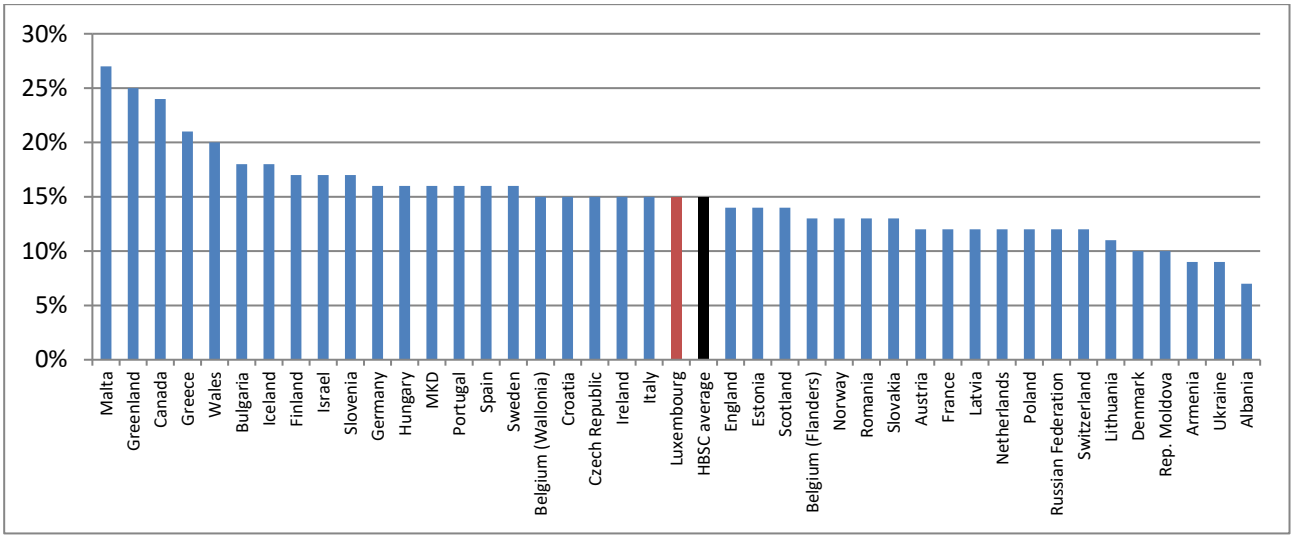


Source: Data from Inchley et al. (2016, p. 249), figure from Residori and colleagues (2017)

In 2014, the situation in Luxembourg was quite similar to the situation in other Western countries (Belgium (French and Flemish), Austria, Germany, Netherlands and Denmark) with the exception of France and Switzerland (Inchley et al., 2016). Similarly, Lorentz and Tchicaya (2006) observed that the rates of overweight for adults for Luxembourg are about medium for Europe and similar to the neighbouring countries Belgium, Germany and Netherlands.

[11] For 2010, the results are inconclusive. The prevalence of overweight is below the average for the 11-year-olds, at the average for 13-year-olds and above the average for 15-year-olds (Currie et al.,2012).

Figure 4: Overweight of 15-year-olds in International Comparison



Source: Data from Inchley and colleagues (2016, p. 249), figure from Residori and colleagues (2017)

Since 2015, the ministry of health provides the prevalence of overweight and obesity in its annual reports of activities (Ministère de la Santé, 2016, Ministère de la Santé, 2017, Ministère de la Santé, 2018). The published numbers concern the students examined by medical staff in the context of the school based health monitoring in the last year of their primary education (Clycle 4.2) and during their secondary education (see Table 4 for the numbers published for the school year 16/17 in 2018).

Table 4: Prevalence of Overweight and Obesity according to Ministry of Health

	Prevalence of Overweight and Obesity					
	Primary (4.2)			Secondary		
	Boys	Girls	Total	Boys	Girls	Total
School Year 2016-2017						
Number of students examined	2341	2087	4428	7048	7420	14468
Overweight (%)	12.5%	11.8%	11.9%	8.0%	8.8%	8.4%
Obesity (%)	4.9%	6.1%	5.5%	5.8%	5.0%	5.4%

Source: Ministère de la Santé, 2018)

The interpretation of the results by the ministry of health is inconsistent: While the annual report 2017 speaks of ‘the rising problem of obesity in our societies and the attempt to oppose this scourge’ in relation to the pupils of the secondary education (Ministère de la Santé, 2018, p. 80, Ministère de la Santé, 2018), the annual report 2016 speaks of a ‘very favourable evolution of the rates of obesity’ in relation to the students of the primary education and the comparison of

their rates of obesity between 2011/2012, 2014/2015 and 2015/2016 (Ministère de la Santé, 2017, p. 74). Unfortunately, no further detail concerning the population (e.g. the age of the examined students), the prevalence (e.g. by age), the method of observation (measured or reported) or the calculation (cut-off points used) are given (Ministère de la Santé, 2016, Ministère de la Santé, 2017, Ministère de la Santé, 2018). It is thus not possible to interpret these numbers in detail or to use them as definite references

For the prevalence of overweight in adolescents by SES, all three HBSC waves found that the prevalence of overweight was statistically significantly higher among adolescents with low family affluence (a measure of objective SES) than adolescents with high family affluence (Currie et al., 2012; Currie et al., 2008; Inchley et al., 2016). In 2014, Inchley and colleagues (2017) observed that Luxembourg had one of the highest differences between the prevalence of obesity in adolescents of low and high family affluence among European Countries.

In addition to these descriptive statistics, the present review found only one study that focused on overweight and SES in Luxembourg: Lorentz and Tchicaya (2010; 2014) analysed the relationship between children's, adolescent's and parental overweight or obesity and socio-economic factors on the basis of the 2007 PSELL/EU-SILC. As described in chapter 3.2, they found differences in the prevalence of the overweight of children and adolescents by parental education level, disposable household income ('niveau de vie') and parental occupation in bivariate analysis. In multivariate analysis of the effects on children and adolescents overweight and obesity controlling for parental BMI, they found independent effects of parental occupation on children and adolescent's BMI for the 5-15 year-olds (Tchicaya & Lorentz, 2011) and of parental education on the of 7-12 years-olds (Tchicaya & Lorentz, 2014). Though these results are from a sample including children as well as adolescents and seem slightly unstable due to the relatively small sample, they are an indication, that parental SES influences the risk of being overweight or obese of children and adolescents.

To summarise, the currently available information on the prevalence of overweight among adolescents in Luxembourg show varying prevalence, but do not include enough methodological information to interpret these differences. The majority of the information is only reported in overviews or summaries destined for the greater public (international reports of the HBSC study, national factsheets) and lacks the necessary depth to confirm results or understand processes behind the prevalences. There is thus not sufficient information, to paint a correct picture of the potential consequences, aetiology, prevalence and relation to SES of overweight in Luxembourg.

4.2 Review of empirical findings on underweight

Underweight has been much less investigated than overweight (Ali & Lindström, 2005; Lazzeri et al., 2014). Underweight represents slender body shapes that pose a potential risk to health. In the international literature, terms ranging from underweight to thinness to wasting and to mal- or undernutrition describe different stages and measurements for insufficient weight for height (Cole et al., 2007; Lazzeri et al., 2014). While other terms might be more precise, this thesis uses the term underweight to stress the conceptual and methodological closeness to overweight. In adults[12] a BMI from 17 to 18.49 is categorised as mild underweight, a BMI from 16 to 16.99 as moderate underweight and a BMI under 16 as severe underweight (WHO, 1995).

4.2.1 Associated health risks and associated factors of underweight

In adults underweight (BMI under 18.5) has been estimated to have caused 33,746 excess death in the US in 2000 (Flegal et al., 2005). Considering the low prevalence of underweight among adults in the US (0.7-2.4%) these results indicate an association between underweight and health risks. Underweight as a risk factor for health in children and youth has mostly been studied as a risk factor for physical health problems related to (severe) malnutrition (e.g. stunting, wasting and premature death) and childbirth. These phenomena mostly concern young people in developing countries. The health risks related to underweight in wealthy countries have not often been studied and the following review thus includes results from studies with young adutls (Lazzeri et al., 2014).

The health limitations or risks associated to underweight depend on the severity of the underweight. Some authors argue, that physical activity or work capacity in adults would only be expected to be restricted at a BMI of 17 or below, but this depends on the nature of the activity or work (Durnin, 1994). Psychological aspects linked to underweight such as (sensitivity to) weight-related teasing seem to already occur with less underweight and thus higher BMI

[12] For the categorisation of weight status in children and adolescents, age centile curves based on these BMI cut-offs for adultes are used (Cole and Lobstein, 2012; Cole et al., 2007)

values of 20-21 (Lundgren, Anderson, Thompson, Shapiro, & Paulosky, 2004). This thesis thus considers all levels of underweight.

Some studies suggest that underweight is linked to health concerns such as worse general health, worse psychosocial and mental health, more psychiatric diseases, higher risk of infection and infectious diseases, higher prevalence of sleep problems and lower health-related fitness (Sivertsen, Pallesen, Sand, & Hysing, 2014; Artero et al., 2010; Dobner & Kaser, 2018; Gulías-González et al., 2014; Schönbeck, van Dommelen, HiraSing, & van Buuren, 2015; Sormunen et al., 2019; Wake et al., 2013).

In terms of factors contributing to underweight, Lazzeri and colleagues (2014, p. 2211) discuss the possibility that an increase in underweight in some countries could be due to socio-cultural factors (increased value of thinness as ideal of beauty, 'morphological changes during puberty', lower levels of physical activity, or 'body dissatisfaction and unhealthy weight reduction behaviours and dieting'. Little is however known about the social processes contributing to underweight.

The processes influencing overweight give some indications of potentially influential processes, but different processes might well be at work. In general, a negative balance in the energy balance leads to a loss in weight, so the same bio-physical aspects that are relevant for overweight should be relevant for underweight (Lobstein et al., 2004).

There seems to be a link between psychological well-being and underweight for several dimensions. From their study on emotional eating, Geliebter & Aversa (2003) concluded, that 'undereating by underweight individuals when experiencing negative emotions may contribute to their low body weight'. In addition, underweight has been linked to teasing (Lundgren et al., 2004), which might also cause negative emotions. According to Ali & Lindstrom (2005, p. 324, 2005), eating disorders such as anorexia (whether nervosa or bulimia) 'may be considered as the most severe and ultimate cause of underweight' among young women in the industrialised world. But they also cite other less severe health concerns like psychosocial, psychological and emotional factors to be associated with underweight (Ali & Lindström, 2005).

4.2.2 International prevalence of underweight

Lazzeri and colleagues (2014) studied the prevalence underweight in 10 European countries and the US in 1998, 2002 and 2006. For boys, they found prevalence rates of underweight ranging between 3% (in Greece) and 20% (Flemish Belgium). For girls the prevalence of underweight ranges between 7% (Portugal) and 25% in (Flemish Belgium). There seems to be a certain geographic pattern in the prevalence of underweight among the ten countries in the

study. Western European countries neighbouring Luxembourg (Flemish Belgium, France and Germany) all show a comparatively higher prevalence of underweight (above 10% for boys and above 15% for girls). Northern countries (Sweden and Finland) and southern countries (Portugal and Greece) show a comparatively lower prevalence of underweight (below 10% for boys and below 15% for girls). The study also confirmed a higher prevalence of underweight for girls compared to boys and for 11-year-olds compared to 13- or 15-year-olds in most countries (Lazzeri et al., 2014).

The 2013/2014 HBSC study in Germany 15.1% of 11-, 13- and 15-year-olds are categorised as underweight. With 17.8% girls have a higher prevalence of underweight than boys with 12.6%. The proportion of underweight adolescents decreases with age for both genders (Richter & Kolip, 2015). For young adults (aged 18 to 34 years old), Ali and Lindström (2005) observed similar patterns and found underweight to be more prevalent in women than in men. In addition, they found the prevalence of underweight to decrease with age.

4.2.3 Underweight and socio-economic status

When it comes to underweight, an association between lower socio-economic status and a higher risk for child and adolescent underweight is described for developing countries. Much less scientific attention has been paid to the relation between socio-economic status and underweight in affluent countries. There has been some evidence that underweight is more prevalent among adolescents with a high socio-economic status than among adolescents with low socio-economic status in affluent countries (Martínez-Vizcaíno et al., 2015; Mikolajczyk & Richter, 2008; Richter & Kolip, 2015).

The 2013/2014 HBSC study in Germany for example concluded that adolescents with high family affluence (a measure of objective socio-economic status) are more often affected by underweight than adolescents with low family affluence (Richter & Kolip, 2015). 21.5% of the girls with high socio-economic status were categorised as underweight compared to 15.7% of the girls with low socio-economic status. A similar difference showed in boys: While 13.1% of the boys with high socio-economic status and 13.8% of the boys with medium socio-economic status were categorised as underweight, only 8% of the boys with low family affluence were categorised as underweight (Richter & Kolip, 2015).

4.2.4 Underweight in Luxembourg

The ministry of health provides prevalence of 'insufficiency of weight' in its annual reports of activities since 2015 (Ministère de la Santé, 2016, Ministère de la Santé, 2017, Ministère de la Santé, 2018). The published numbers concern the students examined by medical staff in the context of the school-based health monitoring during their secondary education (see Table 5). The rates seem very low in comparison to the indications of international prevalences described in the previous section. Unfortunately, no interpretation of the results and no further detail concerning the population (e.g. the age of the examined students), the prevalence (e.g. by age), the method of observation (measured or reported) or the calculation (cut-off points used) are given (Ministère de la Santé, 2016, Ministère de la Santé, 2017, Ministère de la Santé, 2018). Though the ministry of health does not provide any information about the cut-off points they used for their categorisation, it is probable that they used the cut-off points for extreme underweight (3 or 2 standard deviations below the mean weight for age) that the WHO uses as worldwide indicator of severe child malnourishment (Onis et al., 2004, 2004) and which are more adapted to contexts of poverty than contexts of affluence. In addition, and despite the considerable number of students questioned, the results jump quite considerably from one year to the other. It is therefore not possible to interpret these numbers in detail or to use them as definite reference.

Table 5: Prevalence of Underweight according to Ministry of Health

	Prevalence of 'Insufficiency of weight'		
	Secondary Educaiton		
	Boys	Girls	Total
School Year 2016-2017			
Number of students examined	7048	7420	14468
'Insufficiency of weight' (%)	0.55%	0.53%	0.54%
School Year 2015-2016			
Number of students examined	8931	8643	17574
'Insufficiency of weight' (%)	0.5%	1.3%	0.9%
School Year 2014-2015			
Number of students examined	8757	8653	17410
'Insufficiency of weight' (%)	0.4%	0.6%	0.5%

Source: (Ministère de la Santé, 2016, Ministère de la Santé, 2017, Ministère de la Santé, 2018)

4.3 Review of empirical findings on body image and weight reduction behaviour

This section provides an non comprehensive overview of the empirical findings on body image and weight reduction behaviour in adolescence as they are secondary topics of interest in this thesis. Body image and weight reduction behaviour are good examples of weight-related health concerns. Negative body image and weight reduction behaviour can be a consequence of being overweight, but negative body image and weight reduction behaviour can also contribute to the risk of being overweight. In addition to this twofold relation and irrespective of the actual weight status, negative body image and perceived overweight have been associated psychological outcomes such as low self-esteem and depressive mood (Almeida, Severo, Araújo, Lopes, & Ramos, 2012). Negative body image and perceived overweight have also been associated to health relevant behavious such as risk behaviours, weight reduction behaviours and skipping meals (Galanti et al. 2011; Lim & Kim; 2017; Isomaa et al. 2011; Bhurtun & Jeewon). Beyond this, weight reduction behaviour has a unique relationship with body image that is irrespective of BMI (Strong & Huon, 1998).

Dieting, as one form of weight reduction behaviour has been associated with extreme weight control behaviours (such as using medication or vomiting), body dissatisfaction and depression in overweight and non-overweight adolescents in the US (Crow et al., 2006). Dieting might thus be an indicator for distress and unhealthy behaviours. While weight reduction behaviour might be considered positive for health when healthy weight loss strategies are chosen in relation to actual overweight by adults and while overweight adolescents are more likely to be dieting than non-overweight adolescents in Germany, weight reduction behaviour because of erroneous perception of overweight in adolescents needs to be seen much more sceptically (Ojala, 2007; Bhurtun & Jeewon, 2013, Ojala 2012, Mikolajczyk & Richter, 2008). Due to the unhealthy weight reduction methods used by adolescents and the unhealthy reasons that motivate adolescents to engage in weight reduction behaviour, weight reduction behaviour is considered as health risk by this thesis (Bhurtun & Jeewon, 2013; Crow et al., 2006; Ojala et al., 2007; Ojala et al., 2012).

Willems and colleagues (2010) reported results about the body image of youth aged 13 to 18 years based on the 2005/2006 HBSC survey in Luxembourg. Their results confirm international results and show that boys are twice as likely as girls to think that they are (much) too thin (17.3% vs 8.2%). In total, 60.5% of girls and 46.8% of boys were unsatisfied with their bodies and had a negative body image according to their study.

Results from the international HBSC study show that in 2006, 2010 and 2014 Luxembourg ranks amidst the participating countries with the highest proportion of young people aged 11, 13 and 15 that think they are too fat both for boys and girls. As far as the proportion of 11-, 13- and 15-year-olds engaging in weight reduction behaviour is concerned, Luxembourg ranks among countries with quite high levels. At the same time, Luxembourg only ranks amidst the participating countries with the medium proportion for young people aged 11, 13 and 15 that are overweight or obese. In line with existing studies, the proportion of adolescents having a negative body image and the proportion of girls engaging in weight reduction behaviour substantially exceed the proportion of adolescents being classified as overweight. This confirms the occurrence of negative body image irrespective of actual weight status and points towards its role as risk factor for weight reduction behaviour (Bhurtun & Jeewon, 2013; Galanti et al., 2011; Ojala et al., 2012; Ojala et al., 2007; ter Bogt et al., 2006; Whitehead et al., 2017). In addition, the results show higher prevalence rates for negative body image and weight reduction behaviour in Luxembourg than in other European countries with comparable prevalence rates of overweight (Currie et al., 2008; Currie et al., 2012; ter Bogt et al., 2006; Whitehead et al., 2017).

In relation to SES, some studies found, that overweight children from a low socio-economic background are quite acceptant of their bodies (Wills, Backett-Milburn, Gregory, & Lawton, 2006) and that the physical esteem of children with low socio-economic status stabilises between the age groups of 6-12 and 12-19, while that of children with medium and high socio-economic status decreases (O'Dea and Caputi, 2001).

This overview of the empirical findings on body image and weight reduction behaviour in adolescents thus concludes, that negative body image and weight reduction behaviour are important weight related health risks with high prevalence which see, to concern adolescents irrespective of their actual weight.

5 Research questions and hypotheses

Substantial gaps in the existing scientific knowledge have been identified in the previous chapters. The empirical knowledge that is currently available on the different relations of the conceptual model that has been developed and presented in the previous chapters is not sufficient to allow for definite conclusions on health inequalities among young people in Luxembourg.

On one level, there are gaps in the overall scientific and empirical knowledge on health and health inequalities in youth:

A. There is very little (empirical) knowledge on underweight in developed countries, whether concerning its prevalence, the factors influencing it or its aetiology.
B. There are relatively few studies that simultaneously take the effects of both objective and subjective aspects of socio-economic status on health in adolescence into account in comparison to studies exploring absolute and relative aspects of socio-economic status.

On a second level, there are gaps in the knowledge and understanding of the situation in Luxembourg:

C. There is little knowledge on health inequalities in adolescence in Luxembourg, both in terms of empirical results and specifically adapted theoretical models.
D. There is little empirical knowledge on overweight in adolescents in Luxembourg and very little empirical knowledge on underweight in adolescents in Luxembourg.

At the same time, meaningful inferences from other countries and contexts are not possible because of the specific demographic characteristics of the adolescent population in Luxembourg and the specific context.

To generate scientific knowledge that contributes towards closing the identified gaps, the most promising strategy seems the adding of empirical knowledge by testing the conceptual model for specific health concerns in adolescents in Luxembourg. The chosen examples of health concerns are potentially health compromising weight status at both ends of the weight spectrum: overweight and underweight. The empirical analysis of this thesis will thus focus on the influence of the socio-economic status of young people on their risks of being overweight or underweight in Luxembourg. To guide the analysis, this broad research interest has been translated into several precise research questions pertaining to the gaps in the existing scientific knowledge.

Potentially severe consequences of overweight and underweight have been identified in the international literature (see chapter 4). To evaluate the importance and urgency of this health concern in Luxembourg, the scope and the potential evolution of the health phenomena under study needs to be identified. A thorough examination of the prevalence of overweight and underweight is thus the first step in the present study, and the first research question that needs to be addressed is:

1. a) What is the prevalence of overweight and underweight among adolescents in Luxembourg, and is there an ongoing evolution of the prevalence?

The first step towards understanding health inequalities among adolescents in Luxembourg through the example of overweight and underweight is thus to analyse and describe the prevalence of overweight and underweight in detail. From a theoretical point of view, this question does not yet concern the relations between the different factors and elements described in the theoretical model, but the description of one of the elements of the theoretical model, namely the health concern under study. It concerns the evaluation of the scope, magnitude and urgency of overweight and underweight as health concerns and, thus, the importance of the example that was chosen to apply the theoretical model to.

As seen in chapter 4, the empirical findings on the prevalence of overweight among different groups of adolescents in Luxembourg vary and need to be confirmed. At the same time, there is a lack of information on the prevalence of underweight among adolescents in Luxembourg (see chapter 4). The currently available information lacks the depth and differentiation which is needed to confirm the prevalence of overweight and asses the prevalence of underweight among different subgroups of adolescents in Luxembourg. An explorative analysis of the prevalence of overweight and underweight among adolescents in Luxembourg is thus advised.

For the interpretation of the prevalence as well as the assessment of the severity of the situation and the urgency of taking (further) action, it is important to analyse the evolution over time and to determine whether the prevalence of overweight and underweight is currently evolving or stable. For overweight, there seems to be a trend towards a substantial slowing down of the rise or even stabilisation of the prevalence among adolescents in many developed countries (see e.g. O'Dea et al., 2011, 2011; Olds et al., 2011; Rokholm et al., 2010). Considering these international empirical studies, it is expected that an evolution of the prevalence of overweight can only be observed over a period of two or more decades. As far as underweight is concerned, the empirical results are not conclusive and do not allow for the formulation of a hypothesis.

To assess a health concern, it is also important to determine whether the health concern under study is only prevalent in specific subgroups of the population or whether several subgroups

are at risk of the health concern. A sub-question of the first research question thus explores the prevalence of overweight and underweight in different socio-demographic groups:

1. b) What is the socio-demographic distribution of overweight and underweight in Luxembourg?

An examination of the prevalence of overweight and underweight by socio-demographic characteristics of the population enables the identification of possible risk groups. The fundamental socio-demographic characteristics of gender and age have been identified as potentially relevant variables for the analysis of health inequalities in adolescents by several international empirical studies (Inchley et al., 2016; Inchley et al., 2017).

For the prevalence of overweight by gender, the international empirical knowledge gives a strong indication that the prevalence of overweight is higher among boys than among girls (see chapter 4). On the basis of these international empirical studies a similar relation between overweight and gender is hypothesised for Luxembourg, even if previous studies for Luxembourg were not able to confirm such a relation between the prevalence of overweight and gender in their small samples.

For underweight, the international empirical findings for affluent countries presented in section 4.2 indicate that the proportion of underweight adolescents is higher among girls than among boys. It is therefore hypothesised that girls are also more likely than boys to be underweight in Luxembourg. In addition, the international literature indicates that the prevalence of underweight decreases with age. The hypothesis is that the prevalence of underweight among adolescents also decreases with age in Luxembourg.

Even though socio-demographic characteristics are relevant in light of intersectionality, gender and age are not the main focus of the study and their relation with overweight and underweight are not explored in further depth (Zhang & Wang, 2004). Instead, the research focus is turned towards the central interest of this thesis, namely socio-economic status as a source of health inequalities. In a second step, this study explores in detail whether there is a relationship between socio-economic status and the health risk under study. The relevance of the theoretical model of this thesis for the example of overweight and underweight is based on the existence of socio-economic health inequalities that it can contribute explanations for. The second research question to be explored is therefore whether there is an influence of socio-economic status on the risk of being overweight and underweight:

2. Are there socio-economic health inequalities in adolescent overweight and underweight, and how does the influence of socio-economic status on overweight and underweight compare?

Since the international and national literature reviewed in chapters 3 and 4 indicates that the existence of health inequalities in adolescence varies according to health domains and contexts, it is necessary to analyse the specific relationship between socio-economic status and the risk of being overweight and underweight among adolescents in Luxembourg. At first glance, this research question appears straightforward, but the international literature on health inequalities in youth shows that many factors need to be taken into account. First, the relation needs to be studied separately for overweight on one hand and underweight on the other hand, to allow similarities or differences in influence of socio-economic status on both health risks to be identified. In addition, the international literature indicates that both objective and subjective aspects of socio-economic status could be relevant in a context of high overall affluence, such as Luxembourg (Goodman et al., 2003; Quon & McGrath, 2014). To avoid missing a potentially relevant relation, the research question is therefore explored for objective as well as subjective socio-economic status.

Based on international empirical findings (Due, P. et al., 2009; Inchley et al., 2016) it is hypothesised that there is a relationship between socio-economic status and overweight among adolescents in Luxembourg. For many so-called developed countries it has been confirmed that the body mass index of young people tends to be smaller, the higher their socio-economic status is (Ali & Lindström, 2005; Elgar, Xie et al., 2016). This relationship translates into a relatively lower risk of young people with higher socio-economic status of being overweight in so-called developed countries. Most likely, the relationship between socio-economic status and overweight among adolescents in Luxembourg is a negative statistical relation. This implies that low socio-economic status is linked to a high prevalence of overweight, while high socio-economic status is linked to a low prevalence of overweight. For underweight at the other end of the weight status spectrum there is, however, not enough information in the reviewed literature to formulate a hypothesis about the existence or direction of a potential relationship with socio-economic status (Lazzeri et al., 2014).

If the answers to the second research question confirm the existence of a relation between socio-economic status and overweight or underweight, the next area of interest is the multifaceted nature of socio-economic status and thus a further understanding of one of the key elements of the theoretical model of this thesis. The theories and literature reviewed in chapters 2, 3 and 4 suggest that the differentiation between objective and subjective aspects of socio-economic status is relevant for adolescent health inequalities in a context of high overall affluence, but growing relative inequality. The third research question therefore asks whether a distinct and unique relation between objective as well as subjective aspects of socio-economic status and the health concerns under study exists:

3) Are the influences of objective and subjective socio-economic status on overweight and underweight unique and distinct?

From a socio-cognitive theoretical point of view and as postulated in chapter 2, both objectively available resources as well as the subjective perception of available resources have a unique impact on material, psycho-social and behavioural aspects of human health. The international literature reviewed in chapter 3 suggests that subjective aspects of socio-economic status have a significant effect on some aspects of adolescent health even if objective socio-economic status is controlled for (Chen & Paterson, 2006; Elgar, McKinnon et al., 2016; Goodman et al., 2007; Karvonen & Rahkonen, 2011; Quon & McGrath, 2014, 2015). There are, however, very few studies that focus on the importance of this differentiation for understanding adolescent health (De Clercq et al., 2017; Diemer et al., 2013; Richter & Lampert, 2008). Research on adults' well-being in Luxembourg (Dickes & Berzosa, 2010; Dickes & Klein, 2011) also shows differentiated effects of socio-economic status. The hypothesis regarding the third research question therefore is that objective and subjective socio-economic status have unique, distinct effects on adolescent overweight and underweight in Luxembourg. Though unique, the effects of objective and subjective socio-economic status are predicted to be quite similar.

The relation between socio-economic status and adolescent health beyond the physical health aspect of overweight and underweight is also of interest for the description and understanding of health inequalities among adolescents in Luxembourg. Since the importance, strength and direction of the influence of socio-economic status on adolescent health varies according to the observed health phenomena (see literature review in chapter 3), it is important to consider additional aspects of health to explore the effects of socio-economic status on adolescent health (De Clercq et al., 2017; Elgar et al., 2017; Holstein et al., 2009; Inchley et al., 2016; Moor et al., 2014; Moor et al., 2015; Nielsen, F. et al., 2015; Pförtner et al., 2016; Richter et al., 2012; Richter & Lampert, 2008; Starfield et al., 2002; Torsheim et al., 2004; Vereecken et al., 2005). The fourth research question thus explores if and how objective and subjective socio-economic status are associated with body image (as an example of psychological health outcomes) and weight reduction behaviour (as an example of health behaviours):

4) Are there socio-economic inequalities in weight-related health concerns among adolescents in Luxembourg, and which role does overweight, underweight and the differentiation between objective and subjective socio-economic status play for these?

For this research question, the focus thus shifts from overweight and underweight to weight-related health concerns, namely body image as a psychological health outcome and weight reduction behaviour as a health behaviour. The analytical strategy for this research question is explorative as the available previous empirical results are not sufficient to reach conclusions

about the expected results or to formulate specific hypotheses (see chapter 4). The exploration is particularly interested in uncovering differences and similarities between objective and subjective socio-economic status as well as the possible influences of overweight and underweight on the effects of socio-economic status on weight-related health concerns. The results of the explorative analyses are interpreted in line with the theoretical model of this thesis (chapter 2) and the varied relation between socio-economic status and adolescent health revealed in the literature review (chapters 3 and 4). From this perspective and with the identification of potential starting points for further studies and research in mind, the results of the explorative analyses are assessed for indications of possible indirect effects of objective and subjective socio-economic status on weight-related health concerns that are mediated through underweight or overweight.

In addition to the differentiation between objective and subjective socio-economic status and with future research in mind, the theoretical model of this thesis includes relations between health relevant factors and overweight and underweight. These health relevant factors are of interest, because they might contribute to overweight and underweight in adolescents. Health relevant factors thus include the factors identified as associated or contributing factors of overweight and underweight in chapter 4. In addition, the theoretical model includes indirect influences of socio-economic status on adolescent health through health relevant factors (Bartley, 2004; Bauer et al., 2008b; Graham, 2007; Richter & Hurrelmann, 2009a; Weyers et al., 2010). The analysis of the indirect influences of socio-economic status on adolescent health through health relevant factors with the data currently available for Luxembourg is beyond the scope of a single PhD thesis. To identify potential starting points for future research, it is however of interest to explore the relation between individual health relevant factors and overweight and underweight on one hand and individual health relevant factors and socio-economic factors on the other hand. The last research question is thus:

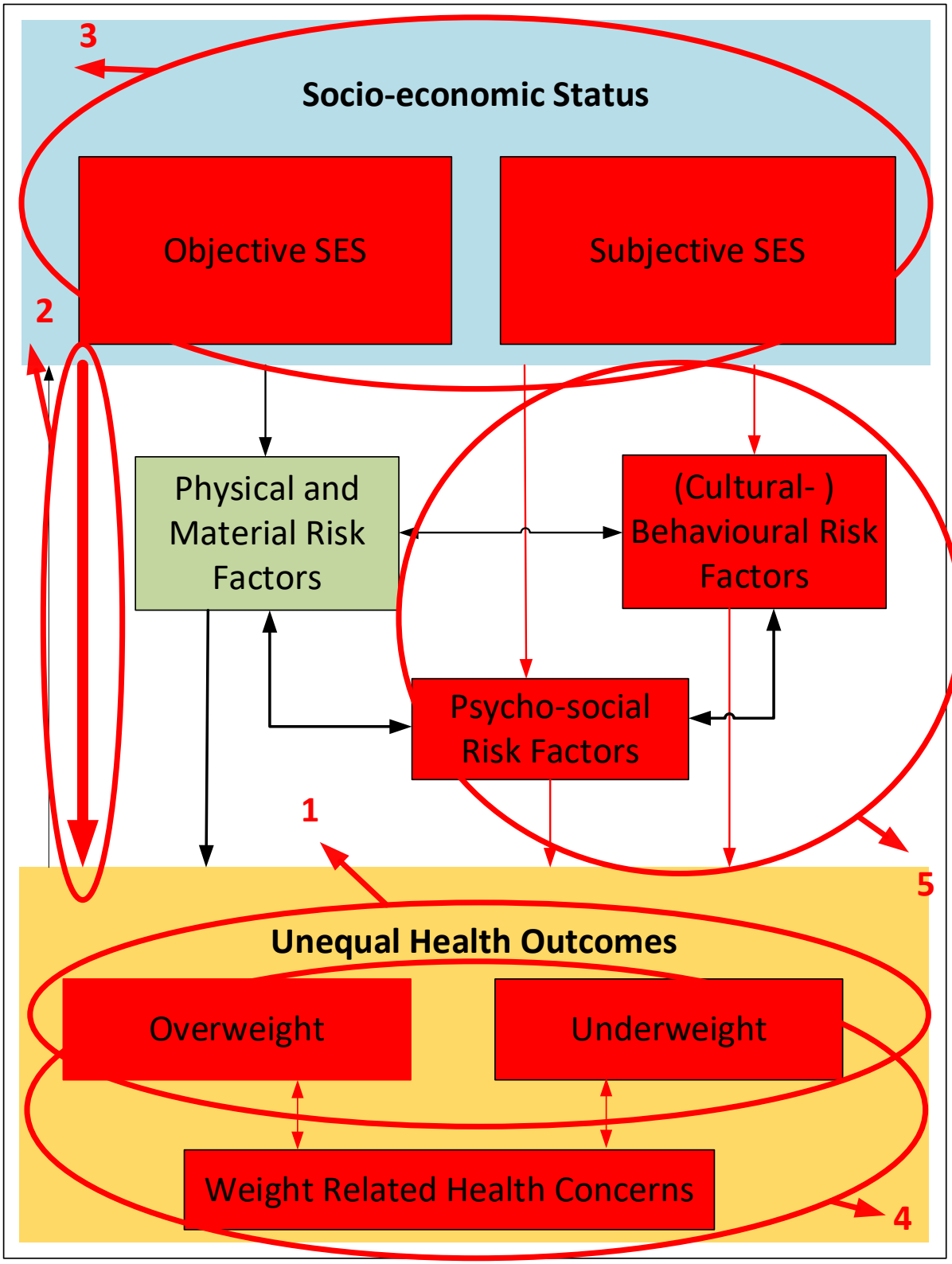
5) Which health relevant factors are associated with overweight, underweight and socio-economic status?

The literature review identified three groups of factors that could be relevant for indirect socio-economic status influences on adolescent health: material, psycho-social and cultural-behavioural factors (Due et al., 2011; Marmot & Wilkinson, 2001; e.g. Moor et al., 2017; Weyers et al., 2010). The review of the empirical findings on overweight and underweight identified several health relevant factors that are or are not related to overweight or underweight in other countries (Dupuy et al., 2011; Haug et al., 2009; Janssen et al., 2005; Lobstein et al., 2004), but it does not allow for an informed hypothesis concerning the associations of health relevant factors with adolescent overweight and underweight in Luxembourg. The analytical strategy for the analysis of the association between health relevant factors and overweight, underweight

and socio-economic status is thus explorative and all available health relevant factors will be included. The information gathered through this exploration aids the understanding of the processes leading to overweight and underweight and allows for a comparison of the associated health relevant factors of overweight and underweight. In addition, valuable starting points for future studies and future research can be identified through this exploration.

To visualise the relation between the theoretical model presented in section 2.4 and the research questions, Figure 5 highlights the elements of the theoretical model of socio-economic health inequalities that are explored by the five research questions presented in this chapter.

Figure 5: Elements of the Theoretical Model of Health Inequalities Explored by the Research Questions



Legend: The red elements represent the elements of the theoretical model of health inequalities that are explored by the research questions.

6 Method

The refined research questions defined in the previous chapter call for an original empirical exploration for adolescents in Luxembourg. The methods used for an empirical exploration determine the nature and quality of the answers that can be discovered in relation to the research question. This chapter therefore describes and discusses the methods used for the empirical analysis by this thesis. In a first step, the data and sample on which the analysis for this thesis are based are described. In a second step, the operationalisation of the key concepts into observable measures is discussed. Last, the strategy for the statistical analysis of the data is presented.

6.1 Data from the Health Behaviour in School-aged Children study

The international Health Behaviour in School-aged Children (HBSC) study is a research cooperation that realises a cross-national study examining the health, well-being and health behaviours of adolescents every 4 years. Since 1983, it collaborates with the World Health Organisation (WHO). Today, the study surveys around 200,000 adolescents from 45 countries and regions in Europe and North America per wave. The survey aims to further the understanding of adolescents' health in their social context and focusses on social determinants of health; health behaviours and self-reported health status (Currie et al., 2012; Heinz et al., 2018; Heinz, Kern, Residori, & Willems, 2017). Table 6 summarises the domains addressed in the questionnaire.

Luxembourg participates in the HBSC study since 1999. This thesis analysis data collected for three HBSC waves in 2006, 2010 and 2014. The data collected for the 2018 HBSC study is not yet available and the data from the pilot study in 1999 is excluded from the analysis because of significant differences in sampling and methodology between the pilot and the follow-up studies (Henschen & Wagener, 2005; Wagener et al., 2005; Wagener & Petry, 2002).

Table 6: Domains of the HBSC survey

Socio-demographic variables (e.g. age and gender) and socio-economic context
Subjective health: Self-assessed health, health complaints, body image, life satisfaction
Dieting habits, weight and height
Oral hygiene
Injuries
Bullying and involvement in fights
Physical activity
Relationships with family and peers
School environment
Sexual behaviour
Use of psycho-active substances: Alcohol, tobacco and cannabis

Translated by the author from (Heinz et al., 2017)

Each wave of the HBSC study is approved by the national research ethics board ('Comité national d'éthique de recherché' and the treatment and storage of the data is notified to the national commission in charge of data protection ("Commission nationale de protection des données") (Heinz et al., 2017; Inchley et al., 2016). The international HBSC study protocol was followed to guarantee student anonymity, parents' and adolescents' right to refuse participation and scientific soundness (Wild & Aleman-Diaz, 2013). With the authorisation of the Minister for Education, the self-completion questionnaires was administered by teachers in classrooms. Consent at the school level is described as informed consent for the 2006 wave, no consent necessary for the 2010 wave and passive consent for the 2014 wave in the national documentation. Parental agreement for their children's participation in the study was ensured by preliminary information letters enabling parents to refuse the participation of their children. Adolescents were informed about their right to refuse participation in the study on the first page of the questionnaire. Considering the varied languages spoken by adolescents in Luxembourg (Dickes & Berzosa, 2010), a bilingual German-Franco version of the questionnaire was developed and used.

Schooling is compulsory in Luxembourg until the age of 16. The school system in Luxembourg includes three forms of education: Primary, general secondary and technical secondary. Primary education includes four cycles[13], which children visit from the age of 4 to the age of 11. Secondary education is visited by adolescents from the age of 12 and has two educational

[13] The four cycles of primary education are: Cycle 1 for 4- to 5-years-olds, cycle 2 for 6- to 7-years-olds, cycle 3 for 8- to 9-years-olds and cycle 4 for 10- to 11-year-olds. An optional pre-school class, for 3-year-olds is offered free of charge (Kurschat (2014).

tracks: The general secondary track prepares students for further tertiary education. The technical secondary track includes trainings of various levels that prepare students for unqualified employment, professional life or further tertiary education (Kurschat, 2014).

In Luxembourg, the HBSC survey is only carried out in private and public schools that teach according to the national curriculum. Private and international schools that do not teach according to the national curriculum, special needs schools as well as schools in neighbouring countries teaching students from Luxembourg do not participate in the HBSC study. In the school year 2013/2014, 3,541 of the students in Luxembourg (10%) were enrolled in primary schools excluded from the HBSC study (see Table 7). In the same school year, 5,358 students (29.5%) in general secondary education and 128 students (0.5%) in technical secondary education visited schools that do not teach according to the national curriculum. In terms of the study population, students from the primary education and technical secondary education are thus well represented in the HBSC study in Luxembourg. Students from the general secondary education are less well represented with 3 out of 10 students in this educational track being taught in schools that do not participate in the HBSC study. Adolescents visiting schools that do not teach according to the national curriculum, do however not represent a random selection of adolescents, but disproportionally include adolescents of foreign nationality and adolescents from families with a high social status.

Table 7: Students by school type in the 2013/14 school year

School type and cycle	Students taught according to the Luxembourg curriculum	Students not taught according to the Luxembourg curriculum	Total number of students
Primary education (cycle 2-4)	31,894 (90.0%)	3,541 (10.0%)	35,435
General secondary education	12,832 (70.5%)	5,358 (29.5%)	18,190
Technical secondary education	26,998 (99.5%)	128 (0.5%)	27,126
Total	71,724 (888%)	9,027 (11.2%)	80,751

Source: According to data from Helfer, Lenz, Levy, & Wallossek (2015, p. 12), translated from (Heinz et al., 2017)

Sampling is a step in the generation of data that can lead to bias and determines the possibilities for the planning, implementation and interpretation of statistical analysis. The conception of the sample for the HBSC study was not realised by the author or colleagues available for questioning. The full reconstruction and documentation of the sampling procedure (including country specific deviations from the sampling instructions of the international

protocol) was therefore especially important to ensure the scientific quality of the statistical analysis and the interpretation of the results. The sampling procedure in Luxembourg generally followed the international research protocol of the HBSC study (Currie, Samdal, Boyce, & Smith, 2001; Griebler et al., 2009; Wild & Aleman-Diaz, 2013), but meaningful additions were made. The sampling procedure for the HBSC study in Luxembourg as reconstructed by the author and colleagues is therefore described in detail in the following (Heinz et al., 2017).

The international sampling procedure sets an absolute minimal number of adolescents to be sampled for each age category to ensure that enough adolescents aged 11, 13 and 15 are included in the sample to allow for statistical inference and complex statistical testing. The HBSC study in Luxembourg adds the 17-year-olds as target age category to the sampling as a large majority of young people continue their education after the end of obligatory schooling[14]. The international protocol aims at a 95%-confidence interval of prevalence that does not span more than 3% (Currie, Schnohr, Roberts, & Samdal, 2013; Roberts, Smith, & Samdal, 2009). Due to the small overall number of adolescents in a country as small as Luxembourg, this target is by far exceeded by the minimum of 1550 (2006 and 2010) and 1225 (2014) adolescents required per age category. The precision of the statistical inference obtained by these minimal target numbers is highly satisfactory for Luxembourg

The sampling unit in the HBSC study Luxembourg is not the individual student but entire classes of students. The study design thus implements a sampling by cluster. As a relatively high proportion of students in secondary education had to repeat grades until the reform of secondary education in 2011 (Kurschat, 2014), the age composition of school classes is heterogeneous in Luxembourg and a sampling of classes based on the specific age of the students impractical. The HBSC study thus chose to gather data from students aged from 10.5 to 17.5 and realised the survey in all grades between the fourth cycle of primary education and the second last grade of secondary education (Heinz et al., 2017).

The sampling for the HBSC study in Luxembourg is based on a full list of the study population, the ‘fichier élève. It includes all students in public schooling and is compiled by the ministry of education for administrative purposes. To guarantee the anonymity of the students, this list is not made available to the institutes handling and analysing the data. Instead, the drawing of the sample from this list as well as all other steps of the data collection requiring knowledge of the identity of the schools and classes in the sample is implemented by the ministry of education (in 2006 and 2010) and the ministry of health (in 2014). To enable a stratification of the sample, the study population is divided into subgroups according to the form of education

[14] Obligatory schooling was increased from 11 years of schooling (4- to 15-year-olds) to 12 years of schooling (4- to 16-year-olds) by the ‘Loi du 6 février 2009 relative à l'obligation scolaire’.

(primary, general secondary and technical secondary) and the grades. The number of classes to be sampled at random (single random sampling) from the different strata (grades within the education type) is based on class size and past response rates to ensure the minimum required number of students per age category respond. Data is gathered from all the students in the sampled classes irrespective of their age.

In summary, the samples for the different waves of the HBSC study in Luxembourg are stratified simple random cluster samples of students aged 11-17, with the form of education and grades as stratifying levels and the classes as clusters. The design effects or sampling effects that could arise from this study design are discussed and addressed in section 6.3.

The response rates of the entities sampled for the HBSC study in Luxembourg in 2006, 2010 and 2014 are highly satisfactory in comparison to other countries or similar studies. As shown in Table 8, the response rates range from 86.5% to 97.3% for the schools, from 74.3% to 93.9% for the classes and from 66.7% to 80.4% for the adolescents. These positive response rates are linked to the data gathering process (passive consent, teachers as trustworthy agents administering the survey) and the commitment of the ministry of education to hold the sampled schools and classes to participation. There is however no possibility to ensure that non-response was unbiased. In health-related surveys, the response rate can be lower in boys than in girls and among adolescents with negative health behaviour or poor school performance (Pietilä, Rantakallio, & Läärä, 1995).

Table 8: Response rates by entities (2006 - 2014)

Entity	**Number of responding entities**	**Response rates in% of the original sample**
2006		
Schools	141	86.5%
Classes	662	74.3%
Adolescents	9882	66.7%
2010		
Schools	139	88.0%
Classes	775	81.6%
Adolescents	1,1181	73.1%
2014		
Schools	146	97.3%
Classes	554	93.9%
Adolescents	7,757	80.4%

Source: HBSC-LU 2006, HBSC-LU 2010 and HBSC-LU 2014.

The quality of data that results from the data collection process is confirmed by the international HBSC data management centre and the raw data is cleansed to international HBSC standards. An adaptation of the international cleansing procedures and syntax are realised where necessary (weighting and age calibration) and applied to create the final data set[15]. Of the adolescents who responded by filling out a questionnaire, between 86.5% and 90.6%[16] provided complete and valid enough information to be included in the data analysis for this study. The proportion of the overall study population from which valid data was gathered is thus very high and ranges from 22.4% to 16.3%[17] for the different waves. This study can thus rely on data from one 5th to one 6th of the overall study population.

Overall, the sample and data on which the empirical analysis of this thesis is based are of high quality and allow for results that are meaningful beyond the individual adolescents included in the sample.

6.2 Operationalisation of key concepts

Before focusing on the empirical exploration of overweight and underweight in adolescents in Luxembourg and its relation with socio-economic status, appropriate operationalisations of these key concepts need to be identified. Given the abstract nature of theoretical concepts, the operationalisation of theoretical concepts into observable empirical measures always entails a certain loss of accuracy (Meyer, 2004). Nevertheless, the quality of the operationalisation of a theoretical concept into a measurement can among others be assessed through the validity (measuring what it is supposed to measure) and the reliability (reproducing the same results under the same circumstances) of the measurement (Meyer, 2004). In addition, theoretical, methodological, practical and political considerations can be used to evaluated the efficacy (measuring theoretical concepts as best as possible) and efficiency (being practically realisable) of a measurement (Meyer, 2004).

[15] For Luxembourg, each HBSC wave results in a national and an international dataset, representing different selections of the available data. The present study is based on the national dataset, because it includes substantially more students from Luxembourg, because the age range is much larger and because it includes relevant national variables that are not include in the international dataset. It needs to be noted, that the age categories in the national dataset represent students who are between x and x+11month, while the age categories in the international data set represent students, that are in average x,5-year-olds and can thus include students who are x-2 months old.

[16] The percentage of the returned questionnaires that were complete and valid enough to be included in the data set were 87.1% in 2006, 90.6% in 2010 and 86.5% in 2014.

[17] The percentage of the overall study population from whom valid data was able to be gathered was 20.8% in 2006, 22.4% in 2010 and 16.3% in 2014.

Operationalisations of the key concepts of this study are presented and evaluated in the following section. Information on validity of the measurements from international studies as well as results from the statistical analysis of the 2014 HBSC data for Luxembourg are used to assess the appropriateness of the different operationalisations. In addition to 'theory driven' considerations, the evaluation of the operationalisations includes 'data driven' aspects such as concentrating on measures available through the HBSC data. This is mainly due to practical reasons and the impossibility to include a separate pilot study in the thesis.

First, the operationalisation of socio-economic status is discussed in detail. Then the operationalisation of overweight and underweight, the additional weight-related health concerns and the health relevant factors are presented.

6.2.1 Operationalisation of socio-economic status

There are conceptual and methodological difficulties in the operationalisation of socio-economic status into measurements for adolescents. From the conceptual point of view, one major challenge is the fact the so called 'triumvirate' of socio-economic status (occupation, education and income), which are essential facets of the socio-economic status of adults, are not yet developed in adolescents (Diemer et al., 2013, p. 81). In addition, it is difficult to determine whether an adolescent's own social position, the socio-economic status of the parents or the combined resources at the household level are most relevant for the social position of a young person (Currie et al., 2008). The methodological difficulties are linked to the fact, that it is difficult to obtain the necessary depth of information from the adolescents in general, but especially from younger adolescents (Currie et al., 2008). It is therefore important to 'carefully relate choice of measurement of socio-economic status and subjective status to a study's purpose, the phenomena being investigated and the participants ability to respond accurately to the questions' (Diemer et al., 2013, p. 105).

To identify the most appropriate and meaningful conceptualisations of socio-economic status for the study of adolescent health inequalities in Luxembourg, the validity of different measurements of socio-economic status were evaluated during the preparation of the empirical analysis of this thesis. This section focuses on the conceptualisation of socio-economic status as economic resources and measures that were found to be relevant, valid and reliable for adolescents in Luxembourg, but Table 26 in the appendix provides an overview of the negatively evaluated conceptions and measures of socio-economic status.

Economic resources are linked to socio-economic status in two ways. On one hand, economic resources are a source and component of socio-economic status and contribute to a person's

standing in society. On the other hand, access to economic resources can be linked to previously acquired socio-economic status (i.e. education or social standing ensuring a better paid position). Economic resources are thus a good conceptualisation of the overall socio-economic situation in which adolescents grow up. Wealth is the most used and most appropriate aspect of financial resources to measure socio-economic in adolescents (Diemer et al., 2013; Duncan & Magnuson, 2003). Wealth is the totality of the assets of a family or household including immediately disposable assets (such as money) and tied up assets such as homes owned (Duncan & Magnuson, 2003). It is often operationalised in terms of its abundance (affluence) and the relevance of the family affluence for adolescents has been well confirmed both theoretically and methodologically (Currie et al., 2008). Wealth can be described as the current financial and material resources, but it also represents the accumulation of socio-economic advantages in the past and is an indication of future economic opportunities (Currie et al., 2008). Wealth and affluence thus provide 'a comprehensive and multigenerational assessment of a person's or family's economic resources' (Diemer et al., 2013, p. 87).

In line with the theoretical perspectives reviewed in chapter 2 and the empirical findings reviewed in chapter 3 and 4, this thesis takes objective socio-economic status as well as subjective socio-economic status into account. Measures for both objective and subjective aspects of wealth are thus presented and discussed in this section.

Objective socio-economic status

First, the measurement of the objective socio-economic status through the objective economic resources of the family is presented: The operationalisation of socio-economic status through home affluence scales or family wealth indexes is a widely accepted and used procedure (see (Schleicher & Belfali, 2016; Wardle et al., 2004). The Family Affluence Scale (FAS) is the measure of objective economic resources of families based on material markers that was developed for the HBSC study (Currie et al., 2008). The FAS is composed of a set of items 'which reflect family expenditure and consumption' and thus measures objective affluence (Currie et al., 2008, p. 1430, Currie et al., 2008, p. 1430).

The updated FAS III version contains six items on the number of available amenities: 'Does your family have a car, a van or a truck?'; 'Do you have your own bedroom for yourself?'; 'How many computers (including laptops and tablets, excluding smartphones or consoles) does your family own?'; 'Does your family have a dishwasher?'; 'How many bathrooms does your family have'; 'How many times did you travel abroad for holiday/vacation last year with your family?'

(Currie et al., 2012). To allow these individual items to represent the overall family affluence of the adolescents, they need to be aggregated into an encompassing family affluence score. The first step for the aggregation of an overall family affluence score from the individual items is the addition of the scores of the individual items. In accordance with the response categories 0 available resource is counted as 0, 1 available resource as 1, 2 available resource as 2 and more than three available resources as 3. The resulting overall family affluence score is a quasi-continuous variable ranging from 0 to 13 with no decimals values (Currie et al., 2008). In a further step, a measure of relative family affluence is calculated by ranking the adolescents according to their absolute family affluence score in their respective age and gender subgroups[18]. Since the FAS can be considered as an ordered rank measurement, SPSS's rank function was used to calculate this ranked variable representing relative family affluence. (Elgar et al., 2017; Schnohr et al., 2008; Torsheim et al., 2004). The continuous variable obtained by this procedure includes values ranging from 0.001 to 0.96 and is known as relative family affluence. As alternative method for the calculation a ranking of relative deprivation based on the 'Yitzhaki Index'[19] and adapted by Elgar and colleagues (2016, 2017) for the use with the FAS was tested, but did not improve the explanatory power of the models.

The validity and reliability of this measure has been confirmed by several studies: The updated FAS III version was validated by a qualitative as well as quantitative development and validation study by the international criterion and construct validity of the original FAS as a measure of objective wealth and absolute affluence was confirmed by several studies for many countries and the agreement between adolescents and parents seems to be highly satisfactory (Batista-Foguet, Fortiana, Currie, & Villalbí, 2004; Boyce, Torsheim, Currie, & Zambon, 2006; Currie, C. et al., 2008; Schnohr et al., 2008). The changing structure of families and the different possible interpretations of family (extended family vs nuclear family) could however constitute a challenge for FAS in the future (Hartley et al., 2016).

The proportion of missing data for the 6 FAS III items in the 2014 HBSC data is acceptable and ranges between 6.0% (469 of 7757 adolescents) for the item on the number of bathrooms to 6.5% (507 of 7757 adolescents) for the item on the possession of a dishwasher. The validity studies mentioned before show that in a wealthy context such as Luxembourg, some FAS

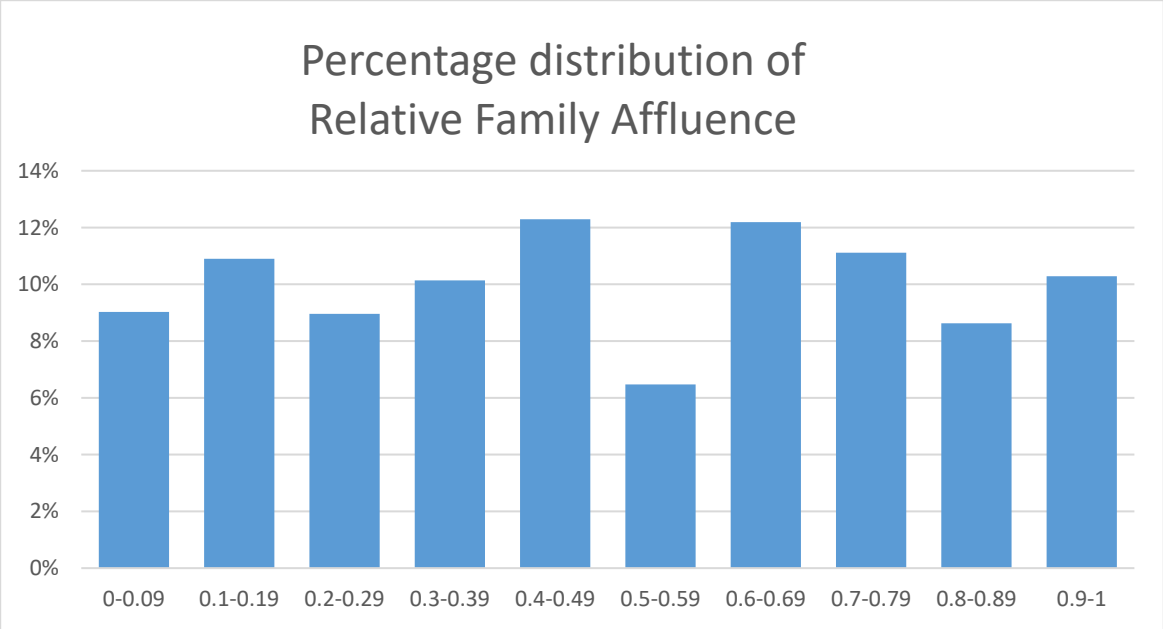
[18] The adjusting of the ranking for gender and age is important because differentiated item functioning was found for gender (tested with Chi Square) and age (tested with Spearman's Rho) for the 6 items retained for the FAS III scale (Schnohr et al.,2008).

[19] The Yitzhaki Index measures the average distance between the individual and the individuals of the reference group that rank higher than the individual, thus taking the rank of the individual into account as well as the distance that separates them from the top and controlling for the overall number of people in the reference group (Elgar et al. (2017); Yitzhaki (1979); Subramanyam, Kawachi, Berkman, and Subramanian (2009)).

items have higher variance and are thus more influential in differentiating the respondents. The elements are therefore not interchangeable and scores aggregated on the basis of less than 6 items for respondents are not comparable. Listwise deletion was used and none of the items were considered for respondents who had a missing value on any of the items. Since 91.7% (n=543 of 6571) of the respondents have valid data on all FAS items, the loss of information was acceptable.

Figure 6 illustrates the percentage distribution of the relative family affluence as measure of objective socio-economic status and shows the ability of this measure to differentiate at the lower as well as the upper end of the socio-economic spectrum.

Figure 6: Percentage Distribution of Relative Family Affluence



Source: HBSC-LU 2014, n =6028

For clearer graphic representations and the easier interpretation of results, the variable is reduced to a categorical variable for some analysis. Low, medium and high relative family affluence is attributed respectively to the lowest 20%, the medium 60% and the highest 20% of the adolescents (Inchley et al., 2016). Because of ranking equivalence, the categorisation of relative family affluence for Luxembourg into low, medium and high does not entirely match the ideal 20 – 60 – 20 distribution. With a 19.9% of the adolescents being categorised as having low family affluence, 61.2% as having medium family affluence and 18.9% as having high family affluence, the deviation is however minor and does not hinder meaningful interpretation of the results.

In conclusion, relative family affluence is confirmed as reliable and valid operationalisation of objective socio-economic status in adolescents in Luxembourg.

Subjective socio-economic status

The theoretical importance of including the adolescents' perception of their socio-economic status into the analysis was established in chapter 2 and the empirical findings reviewed in chapter 3 point towards a relation between subjective social status and health. In addition to the operationalisation of objective socio-economic status, the operationalisation of subjective socio-economic status is therefore discussed in the following. Subjective aspects represent an individual's perception of his or her place in the socio-economic structure (Singh-Manoux et al., 2003, p. 1322) or their perception and personal experience of the absolute and relative levels or amounts of available resources at their disposal (Demakakos et al., 2008).

The HBSC questionnaire includes a measure capturing the perception that adolescents have of the resources their family has at their disposal, thus capturing their perceived family wealth. The exact formulation of the single item on perceived family wealth is 'How well off do you think your family is? And the response categories include 'very well off'; 'quite well off'; 'average'; 'not so well off'; and 'not at all well off'[20]. Schnohr and collegues (2008) analysed the item on perceived family wealth in relation to the family affluence scale and concluded, that it is a valid item. Even though this item on perceived family wealth was initially included to operationalise affluence in one easy to answer question rather than to capture subjective social status, the item captures the respondents' perception of their families' affluence and can thus be seen as proxy for their subjective socio-economic status (Moor et al., 2015).

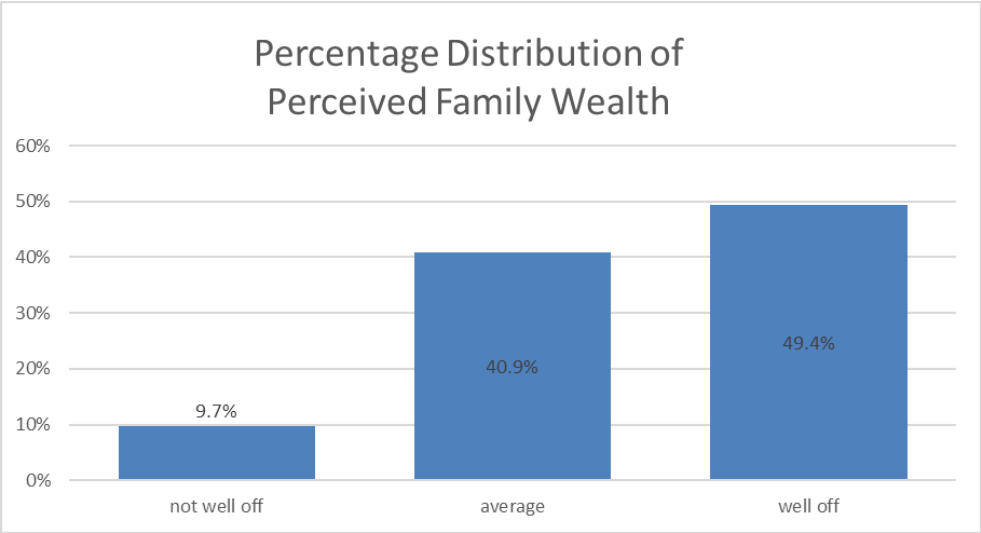
In the 2014 HBSC data, the proportion of missing data for the item on perceived family wealth is 5.5% (429 of 7757 adolescents) and the distribution of the missing values is neither biased by gender, age nor school type. Only 1.7% (750 of 7757 adolescents) of the adolescents think their family is 'not at all well off', but the differentiation of the item on perceived family wealth is still sufficient. Perceived family wealth is retained and confirmed as relevant, reliable and valid measure of subjective socio-economic status for adolescents in Luxembourg.

For graphic representations and the easier interpretation of the results, the variable is reduced to a variable with three categories for some analysis. Since the perception of the adolescents

[20] In Luxembourg, the item was asked both in German and French. In German, the item was "Was denkst du, wie wohlhabend (reich) deine Familie ist? - "Sehr wohlhabend", "Wohlhabend", "Mittelmässig wohlhabend", "Nicht sehr wohlhabend", "Überhaupt nicht wohlhabend".

is of specific interest, adolescents perceiving their family to be average or quite well off are not grouped together, even if this would result in a more even distribution. Figure 7 shows the percentage distribution of the categorical variable on perceived family wealth.

Figure 7: Percentage Distribution of Perceived Family Wealth



Source: HBSC-LU 2014, n =6240

Many categorical variables are dichotomised for the analysis in this study. This is a common procedure in social sciences to enable more sophisticated statistical analysis (such as logistic regressions) and to allow for an easier interpretation of the results. The dichotomisation of continuous (or graduated) variables such as perceived family wealth however has to been seen with caution (Cohen, 2011). It might seem prudent to dichotomise 5-er Likert scales for logistic regressions, rather than to treat them as continuous variables because they lack the necessary refinement in the graduation and it might seem that the dichotomised variable reflects the accuracy of the measurement better. Such a dichotomisation or grouping of variables however entails a substantial losses of information. As Cohen (2011) concludes: Dichotomisation comes at a cost. There is a considerable loss of variance and a variable's statistical power is reduced substantially. This loss of statistical power can mask small but important effects. Cohen (2011) thus specifically cautions against the dichotomisation of 4- to 6- point Likert type scales. This is the reason, why perceived family wealth is treated as continuous for the statistical analysis for this thesis.

Both the relative family affluence scale as operationalisation of objective socio-economic status and perceived family wealth as operationalisation of objective socio-economic status are valid, suitable and useful measures of socio-economic status. This review of the different available

operationalisations of socio-economic status in youth in Luxembourg thus shares the conclusion of Diemer and colleagues ‘that there is no single ‘best’ measure of socio-economic status or social status that will meet all needs’ (Diemer et al., 2013, p. 105) and advocates for the use of multiple measurements of different aspects of socio-economic status.

6.2.2 Operationalisation of overweight and underweight

Next to socio-economic status, weight status is a key concept in this thesis. A commonly used way to categories body weight according to healthiness is the Body-Mass-Index (BMI). The BMI relates body weight to height by dividing the weight in kilograms by the squared height in metres. For adults over 18 years, the BMI status is classified into ‘normal’ weight that does not pose a risk to health and weight that could pose a risk to health (overweight or underweight). Adults with a BMI under 18.5 are considered underweight, adults with a BMI between 18.5 and 24.9 are considered to be of normal weight and adults with a BMI of 25 or higher are considered overweight (WHO, 2004).

The rapidly changing body proportions during childhood and adolescence present a challenge for the evaluation of BMI during these life phases. There are two main international systems to categorise the BMI of children and adolescents: the extended International Obesity Task Force (IOTF) body mass index cut-offs for thinness, overweight and obesity and the WHO cut-offs for underweight, overweight and obesity (Cole et al., 2000; Cole et al., 2007; Cole, Bellizzi, Flegal, & Dietz, 2000; Cole & Lobstein, 2012). In the context of the KIGGS study, the Robert Koch Institute in Germany recently compared the results of categorising BMI according to the two classification systems (Schienkiewitz, Damerow, & Schaffrath Rosario, 2018). They found, that the prevalence of overweight was a third higher according to the WHO classification than according to the IOTF categorisation. For underweight, the prevalence according to the WHO classification was 6 times lower than that according to the IOTF classification (Schienkiewitz et al., 2018). These discrepancies are due to the fact, that the WHO classification only takes underweight into consideration, when it undercuts average weight by at least two standard deviations, while the IOTF classification takes less severe forms of underweight into consideration (Cole et al., 2000; Cole et al., 2007; Cole & Lobstein, 2012).

In section 4.2, it was established, that psychological and social consequences of underweight can occur from BMI’s as high as 20 - 21 (Lundgren et al., 2004). Since the exploration of underweight in the wealthy context of Luxembourg focuses on psychological or social rather than physical or (mal)nutritional consequences of underweight, it is appropriate to take less severe forms of underweight into account by using the IOTF classification system (Ali

& Lindström, 2005). The most recent IOTF categorisation equates the adult BMI cut-off points of 35 (morbid obesity), 30 (obesity), 25 (overweight) as well as 18.5, 17 and 16 (Thinness grade 1, 2 and 3) for children and adolescents (Cole & Lobstein, 2012)[21]. In contrast to the IOTF nomenclature, the term overweight describes all grades of overweight including obesity and morbid obesity in this thesis as long as it is not specified by the mention 'grade 1'. It is important to note that overweight and underweight are strictly mutually exclusive and can thus not be included in the same multivariate analysis models.

Self-reported height and weight rather than measured height and weight were used in the HBSC study to calculate the adolescents' body mass index (BMI). Self-reported weight has a lower refusal rate in comparison to measured weight and a bigger sample size can be included in the studies using self-reports due to the lower financial and organisational impact (Chau, N. et al., 2013). In addition, the validity of BMI classifications based on self-reported information in comparison to those based on measured height and weight were analysed by several studies which concluded that BMI classifications based on self-reported information are valid, even if overweight and obesity are marginally underreported (Brener, McManus, Galuska, Lowry, & Wechsler, 2003; Elgar, Roberts, Tudor-Smith, & Moore, 2005; Goodman, Hinden, & Khandelwal, 2000; Strauss, 1999). The advantages of self-reported weight and height thus outweigh the slight under-reporting of overweight and over-reporting of underweight that is observed for BMI based on self-reported weight and height in comparison to BMI based on measured weight and height (Chau, N. et al., 2013). To address possible notification mistakes from the students, extreme and unrealistic specifications were excluded.

In some countries, asking about weight can be awkward and adolescents can be reluctant to answer such questions. Problematic item specific missing values as high as 79% for 11-year-olds and 61% for 15-year-olds have for example been observed in the 2014 HBSC study in Scotland (Currie et al., 2015). In Luxembourg, the item specific response rate was however satisfactory and high proportions of respondents provided valid answers to the question about weight: 89.3% (6,460 of 7,233 adolescents) in 2014, 91.1% (8,668 of 9,516 adolescents) in 2010 and 91.7% (7,893 of 8,604 adolescents) in 2006. Since the calculation of BMI requires information on weight as well as height, listwise deletion was used and BMI was not calculated if either one information was missing[22].

[21] No difference in classification according to the initial (Cole et al., 2000; 2007) or the extended (Cole and Lobstein, 2012) IOTF cut-offs were observed.
[22] A negligible bias in the missing values for BMI by body image was detected and adolescents who think that their body is much too fat or much too thin slightly less often provide valid information for the calculation of the BMI.

Overall, the operationalisation of overweight and underweight through the BMI calculated from self-reported weight and height and classified according to the extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity is considered appropriate (Cole & Lobstein, 2012).

6.2.3 Operationalisation of weight-related health concerns and health relevant factors

For the operationalisation of the weight-related health concerns and the health relevant factors analysed in this thesis, measures used and recommended by the HBSC research network were considered (Currie et al., 2008; Inchley et al., 2016; Wild & Aleman-Diaz, 2013). The relevance and validity of these measures for adolescents in Luxembourg was checked by the author and the Luxembourg HBSC country team during the preliminary analysis of the 2014 HBSC data for the national report and the national factsheets[23] (Heinz et al., 2018). The measures for which the relevance and validity was established are presented in this section and were used for the definite analysis of the 2014 HBSC data for the present thesis, the national report and for the national factsheets (Heinz et al., 2018). Measures that were considered irrelevant, unreliable or invalid (i.e. family support, peer support or perceived health) were not included in the analysis and are therefore not discussed in this thesis.

For easier interpretation of the results on the health relevant factors, the responses of the respondents are summarised into dichotomous variables as is a common procedure in social sciences. The cut-off points for the dichotomisation are chosen in line with the cut of points that are established, used and recommended by the HBSC research network in collaboration with the WHO for the international HBSC report. These cut-off points are based on the recommendations of the WHO or other medical institutes for healthy behaviour that prevents present and future health concerns (Inchley et al., 2016; Moor et al., 2014; Wild & Aleman-Diaz, 2013). To confirm that the theoretically deduced cut-off points do not distort the results for the association of the health relevant factors with overweight and underweight, all analysis were calculated for several alternative cut-off point. The results from these analysis confirmed the relevance of the theoretical cut off points for the available data. In the following the retained operationalisations for the weight-related health concerns and the health relevant health factors are described.

[23] 17 factsheets based on the Luxembourg HBSC 2014 study are available under https://hbsc.uni.lu/.

Weight-related health concerns

In addition to overweight and underweight as example of a physical health outcome, this thesis focuses on body image as example of weight-related psychological health concern and weight reduction behaviour as weight-related health behaviour.

Body image

The perception of the body and thus the body image of the adolescents is measured using a single item for the present study. The HBSC measure of body image is closely linked to subjective weight perception and thus targets a specific aspect of the evaluation of one's body. The exact formulation of the item is 'Do you think your body is…?' and the response options are 'much too thin'; 'a bit too thin'; 'about the right size'; 'a bit too fat'; and 'much too fat'. The test-retest coherence of this item has been confirmed (Ojala et al., 2012). The data was dichotomised into to two variables identifying adolescents thinking that their body is a bit or much too thin or not on the one hand and identifying adolescents thinking that their body is a bit or much too fat or not on the other hand. As overweight is a key predictor of negative body image and likely to mediate or confound relations, analysis controlled for overweight and underweight will also be presented for this variable.

Weight reduction behaviour

Whether adolescents are currently engaging in weight reduction behaviour is also measured using a single item. The chosen item surveys current weight reduction behaviour, without specifying the duration or technique of the weight reduction behaviour. The item is formulated: 'At present are you on a diet or doing something else to lose weight?' with the response options: 'No, my weight is fine'; 'No, but I should lose some weight'; 'No, because I should put weight on'; and 'Yes'. The data was dichotomised into adolescents currently engaging in weight reduction behaviours or not. The test-retest coherence of this item has also been confirmed (Ojala et al., 2012). As weight reduction behaviour can be a healthy or unhealthy behaviour depending on the weight status as well as the method or strategy employed, analysis controlled for overweight and underweight will also be presented for this variable.

Health relevant factors

To try to explore possible directions for future research, the associations between health relevant factors and weight status are analysed for this thesis. The literature review identified three groups of health relevant factors: material, psycho-social and cultural-behavioural factors

(Due et al., 2011; Marmot & Wilkinson, 2001; Moor et al., 2017; Weyers et al., 2010), but only psycho-social and behavioural health relevant factors are included in HBSC study. In the following, the operationalisation of psycho-social health relevant factors is described first, before turning towards the description of the operationalisation of behavioural health relevant factors.

The four health relevant psycho-social factors identified as relevant and valid for adolescents in Luxembourg are school pressure, attitude towards school, class climate and family communication.

School pressure

School work is one of the major sources of pressure in adolescents and can cause considerable stress. Stress was identified in chapter 3 as a psychosocial factor that could contribute to health inequalities. The stress adolescents feel because of school work is measured using a single item in the HBSC study. The exact formulation of the item is ‘Do you feel stressed by school work?’ The response possibilities include ‘not at all’; ‘a little’; ‘some’; and ‘very’. Adolescents who report feeling ‘some’ or ‘very stressed by schoolwork are identify as suffering from school related stress, while adolescents who reported feeling ‘not at all’ or ‘a little’ stressed by schoolwork are considered not to be suffering from school related stress.

Attitude towards school

In addition to pressure by school work, the attitude towards school and thus how adolescents feel about school is an important indicator of their satisfaction with school. The attitude towards school is measured using a single item in the HBSC study. The exact formulation of the item is ‘How do you feel about school at present?’. The response possibilities include ‘I like it a lot’; ‘I like it a bit’; ‘I don’t like it very much’; and ‘I don’t like it at all’. Adolescents who report liking school ‘a lot’ or ‘a bit’ are identify as having a positive attitude towards school, while adolescents who report liking school ‘not at all’ or ‘not very much’ are identified as having a negative attitude towards school.

Class climate

The climate in their class or the perceived support from the students in their class is an important psycho-social factor that influences the health of adolescents. Class climate is measured using a single item in the HBSC study. The item presents the statement ‘Most of the students in my class are kind and helpful’ to the respondents by the item and asks them to indicate whether they ‘strongly agree’; ‘agree’; ‘neither agree nor disagree’; disagree’; or ‘strongly disagree’. If the respondents agree with the above statement, the class climate can be described as positive.

Family communication

Next to school and peers, the family constitutes the main social context in which adolescents grow up and which affects adolescents' life and health. Of the aspects of family life and relations for which measures are available in the HBCS data, only the operationalisation of family communication is identified as relevant and valid for adolescents in Luxembourg. The measure focuses on the quality of family communication and is a four item measure. Respondents are asked whether they 'strongly agree'; 'agree'; 'neither agree nor disagree'; disagree'; or 'strongly disagree' with the following statements about their family: 'I think important things are talked about'; When I speak someone listens to what I say'; 'We ask questions when we don't understand each other'; and 'When there is a misunderstanding we talk it over until it's clear'. For each statement, the response on the agreement scale is valued between 1 and 5 and respondents with an average agreement of 4.5 or higher are identified as having a good quality of family communication.

The health relevant behavioural factors identified as relevant and valid for adolescents in Luxembourg are daily breakfast, consumption frequencies of food and drink items, physical activity and sedentary activity.

Daily breakfast

Regular eating patterns are assessed through the number of schooldays on which the adolescents reported having breakfast. The adolescents are asked to indicate how often they usually have breakfast (more than a glass of milk or fruit juice) on school days. The response categories include 'I never have breakfast on school days', 'on one day', 'on two days', 'on three days', 'on four days' and 'on five days'. Adolescents are considered to have regular eating patterns if they report usually having breakfast on all five school days and thus having breakfast daily on schooldays.

Consumption frequencies

The energy density of the diet of the adolescents is approximated by the frequency of their consumption of four food and drink items. The frequent consumption of fruits and vegetables are indicators of a diet with low energy density while the frequent consumption of sweets and sugary drinks are indicators of a diet with high energy density (Lobstein et al., 2004). The adolescents are asked how often in a week they usually eat or drink fruits, vegetables, sweets (candy, chocolate) and sugary drinks (coke, lemonade…). For each item the adolescents are asked to indicate whether they eat or drink these items 'never', 'less than once a week', 'once a week', 'on 2-4 days per week', 'on 5-6 days per week', 'once a day' or 'several times per day'. Their answers are categorised into 'at least one a day' and 'less than daily' consumption.

Physical Activity

The level of physical activity of adolescents is assessed using the time per week adolescents report doing vigorous physical activity. Adolescents are asked how much time per week they are usually physically so active in their free time (outside school hours) that they get out of breath or sweat. The data was dichotomised into adolescents being vigorously active for two or more hours a week and adolescents who spend less than two hours per week being vigorously active.

Sedentary behaviour

The level of sedentary behaviour of the adolescents is assessed by the time per day adolescents report doing sedentary activities. Watching TV and PC / Gaming are the two kinds of sedentary activity included in this two item measure. Adolescents are asked how much time per day they usually spend 1) watching TV, videos (including YouTube or similar offers), DVDs or other screen entertainment and 2) playing on a computer, game console, tablet, smartphone or other electronic devices (excluding motion or fitness games). The data was dichotomised for both aspects of sedentary behaviour separately into adolescents who spend two or more hours a day with the sedentary activity and adolescents who spend less than two hours per days with the sedentary activity.

With the description of these measures for the weight-related concerns and health relevant factors, all the measures operationalising the key theoretical concepts of this thesis are described. A clear interpretation of the results is thus possible.

6.3 **Strategy for the statistical analysis**

In addition to the data and the operationalisation of the key concepts, the strategy for the statistical analysis is a crucial aspect of the methods used for the empirical analysis of this thesis. The following section thus describes the strategy for the statistical analysis and presents the procedures that are followed.

Weights are used to adjust for the different response rates in the different school forms (primary, secondary and secondary technical) and school grades. Because the random sample of clusters is stratified according to school type and grade, it is possible to calculate the relative weights to be applied to the clusters to reflect the distribution in the sample.

Design effects also need to be expected from the two staged sampling that involves both clustered as well as stratified sampling. The variance in a study with cluster sampling is lower

than the variance in the population, because the adolescents sampled within clusters are more similar to each other than randomly selected adolescents (Rohwer & Pötter, 2001) and the standard errors are increased. This so called ‘cluster effect’ is all the more relevant for the HBSC data, since adolescents within the cluster of a class have a certain influence on which class they are in, because they are subject to the same context influences and because they interact with and influence each other (Wears, 2002). This reduction of the reliability of the statistical inferences about the population from the sample that is caused by the clustered sample is however counter balanced by the inclusion of considerably more than 5% of the population in the sample (Heinz et al., 2017). There are thus several levels of corrections and the complex sample option of SPSS and Stata (SVY) were used to adjust the results to represent the population and to adjust the standard errors for the design effects linked to the sampling procedure.

The clustered sample violates the assumption of random sampling that many statistical tests are based on. Jacob Cohen (2011, p. 7) however concludes that: ‘There is abundant evidence throughout psychometrics and statistics, that the failure of the normality assumption, unless extreme, bears only marginally on the validity of the conclusions drawn’. There are two main reasons why the use of statistical tests relying on the assumption of random sampling is appropriate in the present analysis. First, the number of clusters (classes) is high (534 clusters in the 2014 HBSC data). Second, the complementary tendencies of the design effects on the standard errors and the low observed impact of the weights on the results, indicate that the size of the effects of the clustered sample on the reliability of the statistical tests can be expected to be marginal.

When it comes to the statistical significance of results of the statistical tests and thus the certitude with which the null hypothesis needs to be rejected before a relation can be assumed to exist, p-values under 0.001 were considered as highly significant (marked ***), values under 0.01 as significant (marked **) and values under 0.05 as marginally significant (marked*). If the p-value is above 0.05, the relation is considered not to be statistically significant (marked ns). For a relation to be considered highly significant, the estimated probability that the observed association are statistical artefacts of the sample that do not occur in the population thus need to be less than 1‰. For the relation to be considered significant, the estimated probability need to be less than 1% and for relations to be considered marginally significant the estimated probability need to be less than 5%. These cut off points are conclusive with the state of the art in statistical science and sociology, but their absolute nature does not reflect the digression, theoretical reasoning and fluidity that is necessary for the interpretation of statistical testing (Field, 2013). In large samples with a lot of statistical power, effects that are not important from a theoretical or practical perspective can be statistically significant (Field, 2013). These cut-off

points for statistical significance are thus an important tool and helpful guideline to describe relations between variables and to report results, but they are not the sole basis for the interpretation of the results. All statistically significant results that are reported in this thesis have been tested multiple times and have been checked for robustness, by retesting in models with different constellations of values and variables.

6.3.1 Uni- and bivariate analysis

In a first step, descriptive and summary statistics for the key variables are computed using edition 25 of the statistical program SPSS by IBM. Since a statistical analysis of the data collected from a sample is used to describe the overall population from which the sample was drawn, the results of this analysis are reported as point estimates of the effect sizes in the overall study population. By nature, these estimates are characterised by a certain level of imprecision. To report and illustrate this imprecision, the point estimators from the uni- and bivariate descriptive statistics are reported with their confidence intervals (CI). The CI indicates the estimated range of values that is likely to contain the 'true' value of a specific population parameter. This study reports 95% confidence intervals and thus the range of values that contains the effect in the study population with 95% certainty (Cumming & Fidler, 2010). In graphical representations, the 95% CI is represented by whiskers or transparent bands.

The association between pairs of variables are tested using the Pearson's chi-square test of independence because most of the variables are categorical variables. This test evaluates the hypothesis of independence of the variables in a contingency table by comparing the observed and expected frequencies. The rejection of the independence hypothesis establishes the association between the variables (Dorofeev & Grant, 2006; Field, 2013). The results reported for the Pearson's chi-square test on the contingency tables are always calculated on the 'raw' contingency tables (contingency tables of the unweighted and unadjusted data) (Dorofeev & Grant, 2006). To avoid the risk of reporting statistical significance on very small differences in cell frequencies, the percentages of the row distributions were checked and reported (Field, 2013). The Pearson's chi-square test of independence is used instead of tests based on likelihood ratio because the sample is large enough and it is more commonly used (and thus better known and understood by a larger group of people).

In case of statistically significant relations in the contingency tables, adjusted standardised residuals (also known as adjusted Perasons's residual) are used to break the association down and identify the driving aspect of the association behind the positive chi-square test (Field, 2013). The odds ratio are used as measures for the strength of the association. They express

the relation between the odds of being in one category and the odds of being in another category divided by both odds (Field, 2013).

6.3.2 Multivariate analysis: Logistic regression

In a second step multivariate statistical analyses are computed using the 14.2 version of the statistical program Stata.

Because of the nature of the variables included in the HBSC data, logistic regression is the method used for the analysis of the data. Most variables are categorical variables representing single item operationalisation of the concept that is measured. Specific assumptions go hand in hand with different statistical methods and influenced the choice of logistic regression as statistical methods. Linearity (ie a linear relation between the dependent and independent variable) is assumed for linear regression and is violated by categorical data. While some disciplines routinely use linear regression for binary variables if they are distributed close to evenly, logistic regression is considered the method of choice to analyses binary variables in sociology. The reason for this is that the logarithmic expression of the relations between the variables in logistic regression (more specifically the probability of a certain value occurring in the dependent variable when the independent variables are at certain values) only assumes a linear relation between the continuous predictors and the logit of dependent (outcome) variable (Field, 2013). In addition, a logit distribution of the probability of being overweight and underweight according to independent variables can be assumed. In a logit distribution, changes at the extremes of the independent variable (e.g. socio-economic status) have less influence than changes around the middle values of the independent variable.

In logistic regression, the two main challenges in the data that could lead to problematic results are incomplete information (i.e. not all combinations of all variables are observed in the data) and complete separation (no overlap between two of the variables). In both cases the standard errors are increased and false negatives more likely. Overdispersion on the other hand, decreases the standard errors and could lead to false positives (Field, 2013). This ties in with the assumption of independence (of errors), which is an important assumption of logistic regression (Field, 2013).

Before calculating the logistic regression models, two preliminary test are run. First, the intraclass correlation coefficient (ICC) is used to determine whether a multi-level analysis would be more appropriate for the analysis than a single level analysis. Scores at or below 0.06 for the intraclass correlation coefficient (ICC) at school and class level indicate that a single level analysis is appropriate for the analysis of the data (Hox, Moerbeek, & van de

Schoot, 2010). Second, the level of multicollinearity of the variables included in the different models is determined. The variables that are included simultaneously in a regression model cannot correlate to a high degree. If the variables correlate to a high degree, this multicollinearity leads to very large standard errors and finding significant effects becomes impossible. Multicollinearity is tested with the variance inflation factor (VIF), which is calculated for an ordinary least square regression (thus a linear instead of a logistic regression). The most common cut-off point of the VIF used as indicative of a high and thus problematic multicollinearity is 10 (Neter, Wasserman, & Kutner, 1989; O'brien, 2007). The VIF results are reported for the different models in the results chapters.

All cases that have missing values in the key variables both in terms of being key socio-demographic variable (such as gender, age) or being key to the analysis (socio-economic status, weight, height) have been excluded from the analysis through listwise deletion. The imputation of missing values is not an option because these variables are fundamental variables, because no information to base imputation on is available and because the theoretical model of this thesis supposes relationships between the variables that are not yet known.

The complex sample option 'Survey (SVY)' in Stata allows for adjustment of standard errors during the logistic regression. For logistic regression, this option is superior to the complex sample option in SPSS because it has more functions. The SVY options was thus used to adjust the standard errors of the logistic regression models for the design effects linked to the sampling procedure that were described in the beginning of this section.

For logistic regression and the interpretation of the influence of a change in the focal variables, the values at which all the other variables are kept is crucial (Hoetker, 2007). In this study, non-focal variables are always fixed at their observed value. It is not meaningful to fixing non-focal binary or categorical variables such as gender or body image at their fictional mean and reporting results for several models in which the non-focal variables are kept at different values (e.g. +- one standard deviation) would unnecessarily complicate the analysis and the presentation of the results.

For the statistical analysis itself, multiple logistic regression models are run for each of the different dependent variables to assess the respective impacts of the different independent variables. The models are adjusted for gender, age and, were relevant, health variables. Models including variables measuring objective and subjective aspects of socio-economic status are fitted to determine the unique effects of these on the dependent health variables (Long & Freese, 2014).

In hierarchical logistic regression, the comparison of the fit of different models to the data is crucial. The Akaike's Information Criterion (AIC) and the Bayesian Information Criterion (BIC) are chosen for the comparison of model fits, because they are likely hood-based approaches and, as such, allow for the comparison of non-nested models. They are calculated for models run on unadjusted and unweighted data and the smaller the value of the AIC and BIC is, the better the model fits. The AIC and the BIC does however include a penalisation for the inclusion of additional variables. The inclusion of an additional variable that does not increase explanatory power of a model thus results in a worse AIC and BIC value.

The results of the logistic regression are reported through the p-value of the F-test, the coefficients, the p-value of the coefficients and the odds ratios: Hoetker (2007) argues, that it is important to report the statistical significance of the overall model as well as the statistical significance of the individual variables: The F-test (Prob>F) tests whether the result for the overall model are statistically significantly different from the null hypothesis. The F-test is based on the likelihood ratio (LR) chi-square test and expresses the probability of the observed chi-square value occurring in case the null hypothesis were true. This test is not compatible with the STATA survey option and was thus computed for the unadjusted data (UCLA - idre, 2019).

In addition to the results from the F-test, the results of the logistic regressions are reported through the coefficients (with specific attention on the sign of the coefficient) and their p-value. Since these do not give any indication of the marginal effect of the variables, the odds ratios are also reported. The odds ratio represent the change in the odds of the dependent variable caused by a 1 unit change in the independent variable under study, if all other variables are held constant. The odds ratios do not represent probabilities and indicate the proportion, not the magnitude of the change (Hoetker, 2007; Long & Freese, 2014). Odds ratios are not comparable from one model to the other (Norton, Dowd, & Maciejewski, 2018). Values above 1 indicate increased odds of the event occurring and values below 1 indicate decreased odds of the event occurring. It is important to note, that increases and decreases in odds ratios are not symmetrical (Hoetker, 2007). Graphical illustrations of the effects of some variables were added to help with the intuitive understanding of the results. The graphics show the predicted probabilities or the estimated effects of Y on the probability of X.

It is important to note, that the chosen statistical methods and tests cannot exclude the existence or confirm the absence of a unique relationship between the independent variable and the dependent variable in the population. The statistical tests used in this thesis analyse the probability that the observed relation is observed in the data without the existence of such a relation in the population (the null hypothesis). If this probability is sufficiently low, the null hypothesis is rejected. With this rejection, the alternative hypothesis (the observed relation being observed in the data because there is a relation in the population) is deduced to be true.

While statistical testing as used in this study allows for the rejection of the null hypothesis and a confirmation of the alternative hypothesis, it does not allow for the rejection of the alternative hypothesis (Field, 2013). Several processes can prevent an effect that occurs in the population to be statistically significant in the sample (Type II error): Effects with a smaller effect size are more difficult to detect; effects are more difficult to detect in small samples and even mild correlations between independent variables (multicollinearity) can increase the standard errors and make it less likely to detect effects (Field, 2013). Even a small VIF of 1.15 that is considered non-problematic causes the standard error to be 1.07 times as large as it were without collinearity. This increase of the standard errors can prevent mildly significant effects in separate models to be identified as significant in the combined model.

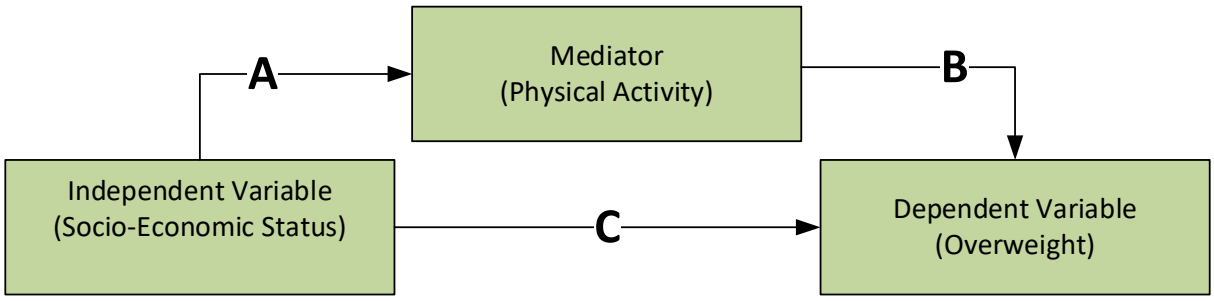
Multivariate logistic regression models test the direct relation between one independent explanatory variables and one dependent outcome variable (or one interaction between independent explanatory variables) for statistical significance, while holding the effects of all other independent variables in the model constant or at a specified value. In the field of health inequalities, indirect effects from independent variables through mediating or confounding variables are also of interest. The method of choice for the analysis of complex models with many direct and indirect relations would be Structural Equation Modelling (SEM). SEM allows for the testing of relations between variables and latent concepts while controlling for direct as well as indirect effects (Skrondal & Rabe-Hesketh, 2002). The possibility of a SEM analysis was examined in depth for this thesis. For SEM models to be valid, the saturation of the model (a specific proportion of the relation between known and to be estimated relations in the model) needs to be guaranteed. Multi-item indicators contribute to the saturation of SEM models (Skrondal & Rabe-Hesketh, 2002). Unfortunately, the HBSC data relies mainly on single item operationalisations, rather than multi-item indicators and the available multi-item indicators did not show the necessary validity for adolescents in Luxembourg. To build valid SEM models at the current level of development of the HBSC data for Luxembourg would entail levels of preliminary work (development and testing of combined indexes, collection of new data etc), that are beyond the possibilities and scope of a single PhD thesis.

Another method to analyse indirect relations and to determine the contribution of individual or groups of mediating variables to the relation between a dependent and independent variable, is the calculation of the percentage change in the odds ratio for the independent variable between models including and models excluding groups of mediating variables (Moor et al., 2014; Richter et al., 2012). Unfortunately, the sample size of the available data (5.000 - 6.000 adolescents) does not ensure enough statistical power for the application of this method.

While it is therefore impossible to analyse indirect relations with the data available for this thesis, it is possible to gain preliminary insights for future studies by combining separately

observed associations into interpretive theoretical models and thereby identifying interesting variables for future analyses of indirect effects. For an indirect mediated relation between 3 variables (for example socio-economic status, physical activity and overweight), three relations are of interest. First, the relation between the independent variable (socio-economic status) and the potential mediator (physical activity). This relation is identified as relation A in Figure 8. Second, the relation between the potential mediator (physical activity) and the dependent variable (overweight). This relation is identified as relation B in Figure 8. Third, the relation between of independent variable (socio-economic status) and the dependent variable (overweight). This relation is identified as relation C in Figure 8. While these relations cannot be tested simultaneously in the same model by this thesis, these relations can be explored in separate models. The results of these separate explorations can only give indications of hypothetical models, but reliable hypothesis based on empirical indications and theoretical understanding are a valuable extension of the currently available knowledge about health inequalities in adolescents in Luxembourg and can provide a starting point future studies and future research on health inequalities.

Figure 8: Relations Involved in Indirect Mediated Effects



7 Prevalence of overweight and underweight among adolescents in Luxembourg

Assessing the breadth and depth of a health risk is a crucial and by no means trivial step towards understanding a health phenomenon. As seen in section 4.1.4, the empirical findings on the prevalence of overweight among different groups of adolescents in Luxembourg vary and need to be confirmed. At the same time, there is a lack of information on the prevalence of underweight among adolescents in Luxembourg (see section 4.2.4). The available information lacks the depth, actuality and differentiation which is needed to confirm the prevalence of overweight and assess the prevalence of underweight among different sub-groups of adolescents in Luxembourg.

The first step of this empirical study is therefore to confirm the prevalence of overweight and to determine the prevalence of underweight among adolescents in Luxembourg. To complete the analysis of different weight status, the results for the prevalence of normal weight are also reported. In addition to a description of the overall prevalence of weight status in 2014, trends in the prevalence between 2006 and 2014 are described. Reporting trends over a period of time aids in the evaluation and contextualisation of the prevalence of overweight and underweight in Luxembourg. The prevalence of weight status is also described according to the socio-demographic characteristics of gender and age. This analysis allows us to identify sub-groups of adolescents that have higher risks of being overweight or underweight (so-called risk groups). In a final step, the prevalence of two weight-related health concerns (body image and weight reduction behaviour) are described.

The data and method used to generate the results presented in this chapter are described in detail in chapter 6, but a short summary is provided to facilitate the interpretation: The BMI, gender and age of adolescents are used to classify the adolescents into overweight, normal weight and underweight according to the IOTF weight status categories recommended by Cole and Lobstein (2012). The point estimators for the prevalence of these weight status categories in the studied population are reported. To address possible bias by the cluster sampling or differential response rates within the sample, the results are weighted using the SPSS complex sample option.

7.1 Prevalence and trends of overweight and underweight

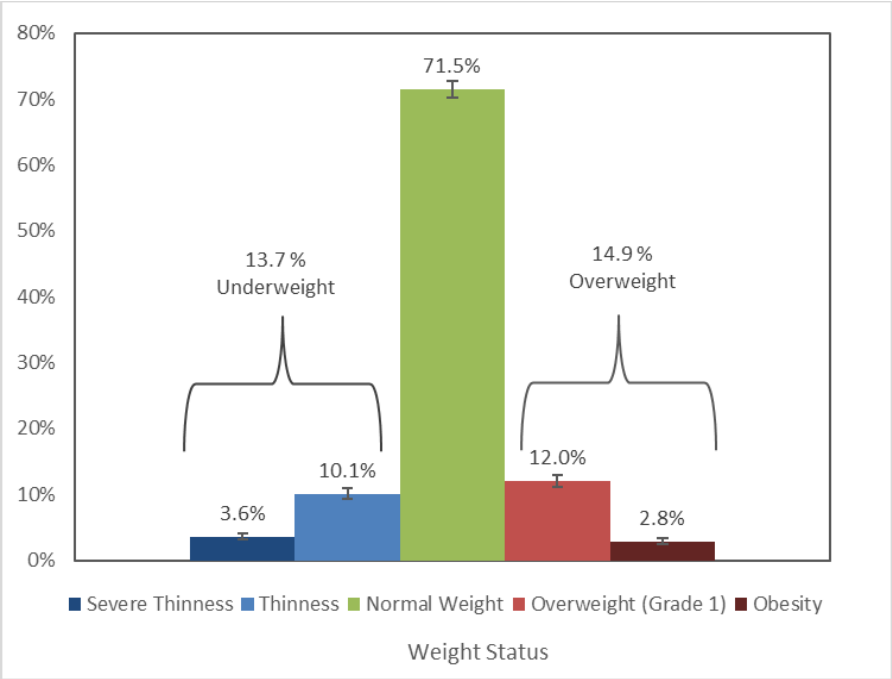
First, the prevalence of overweight, normal weight and underweight are reported. As shown in Figure 9, 71.5% (CI-95: 70.3-72.6%) of adolescents in Luxembourg were categorised as being of normal weight according to their BMI and the IOTF weight status categories. More than one in four adolescents report a weight that cannot be classified as normal for their age and height. Roughly one in seven adolescents (14.9% CI-95: 13.9-15.9%) have a BMI that is considered higher than normal for their age and are considered to be overweight. Another one in seven adolescents (13.7% CI-95:12.7-14.6) have a BMI that is considered lower than normal for their age and are considered to be underweight. The proportion of overweight adolescents in Luxembourg is thus similar to the proportion of underweight adolescents.

The prevalence of different degrees of severity of underweight and overweight is also analysed. For underweight adolescents, thinness (grade 1) and severe thinness (grades 2 and 3) are described separately as are overweight (grade 1)[24] and obesity (obesity and morbid obesity) for overweight adolescents. As shown in Figure 9, 3.6% (CI-95: 3.1-4.1%) of adolescents are categorised as severely thin and 2.8% (CI-95: 2.4-3.3%) of adolescents are categorised as obese. The differences between all categories of weight status are statistically significant.

When overweight and underweight are analysed in combination, more than one in 20 adolescents (6.4%; CI-95: 5.8-7.0%) are considered severely thin or obese because they have a BMI that is two or more categories above or below normal weight for their age. More than one-fifth (22.4%; CI-95: 20.5-24.5%) of the adolescents who are categorised as overweight or underweight are considered severely thin or obese.

[24] When the term overweight is not specified by the specific mention of "(grade 1)", it describes all grades of overweight including obesity and morbid obesity.

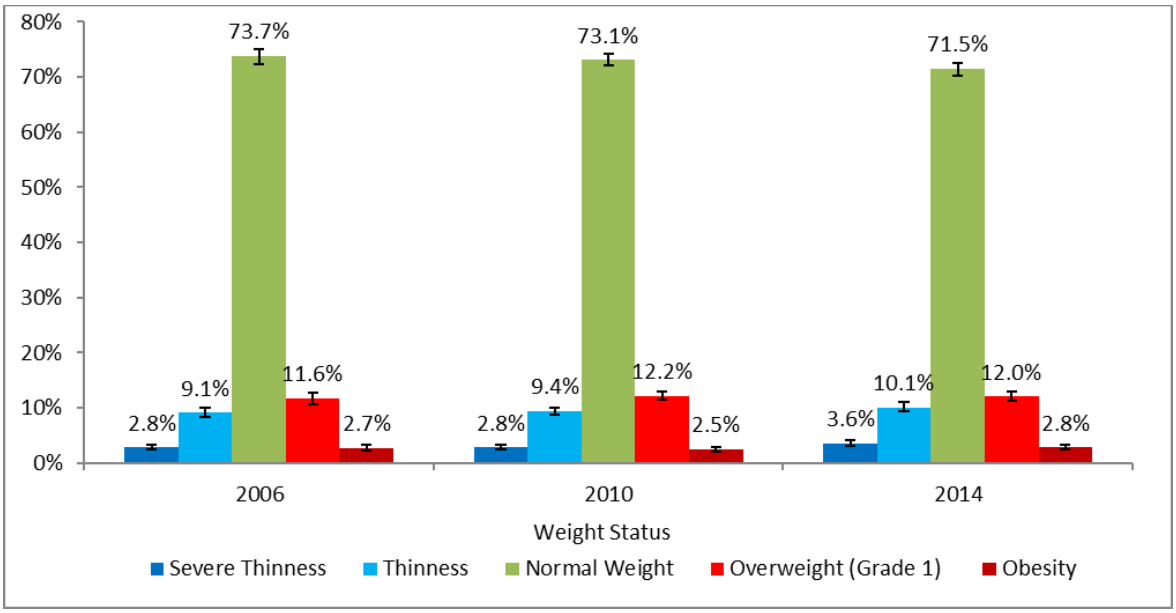
Figure 9: Prevalence of Weight Status of 11- to 17-Year-Olds



Source: HBSC-LU 2014, *n*=5,853, weighted, 95% CI

The comparison of the prevalence of weight status among 11- to 17-year-olds in Luxembourg in 2006, 2010 and 2014, as shown in Figure 10, reveals no statistically significant differences in the prevalence of overweight and underweight. A trend towards a decrease in the proportion of adolescents who are categorised as having normal weight seems to emerge. The proportion of adolescents that are categorised as being of normal weight drops from 73.7% in 2006 to 71.5% in 2014. As the 95% confidence intervals for these point estimators overlap (CI-95 2006: 72.4-75.0%, CI-95 2010: 72.1-74.2%, CI-95 2014: 70.3-72.6%), this decrease is not yet statistically significant. Preliminary analysis of the 2018 data do, however, suggest that the decrease continues and is statistically significant between 2006 and 2018. The separate analysis of the trends over time for girls and boys confirm these results for both genders (see Figure 39 and Figure 40 in the appendix).

Figure 10: Prevalence of Weight Status of 11- to 17-Year-Olds in 2006, 2010 and 2014

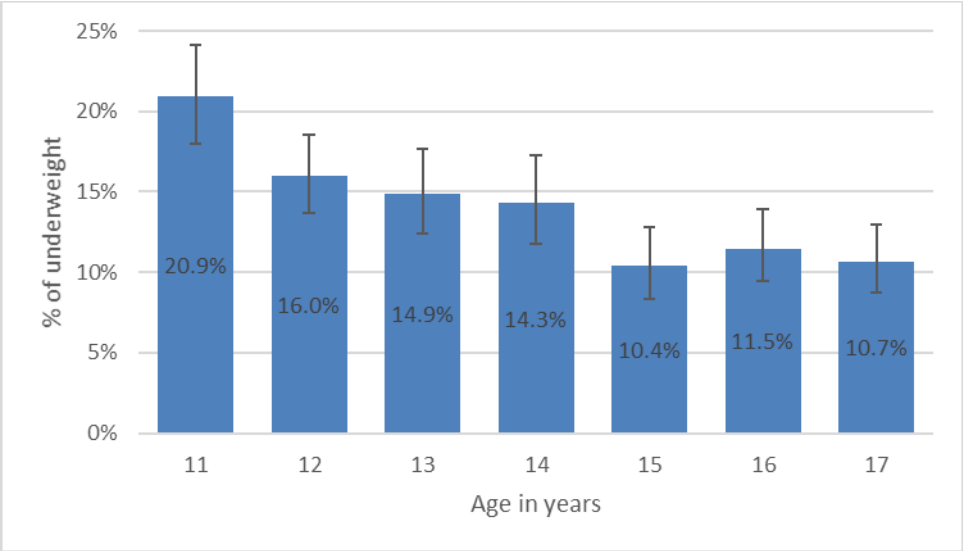


Source: HBSC-LU 2006, *n*=7,893; HBSC-LU 2010, *n*=7,858; HBSC-LU 2014, *n*=5,853, weighted, 95% CI

7.2 Prevalence by age

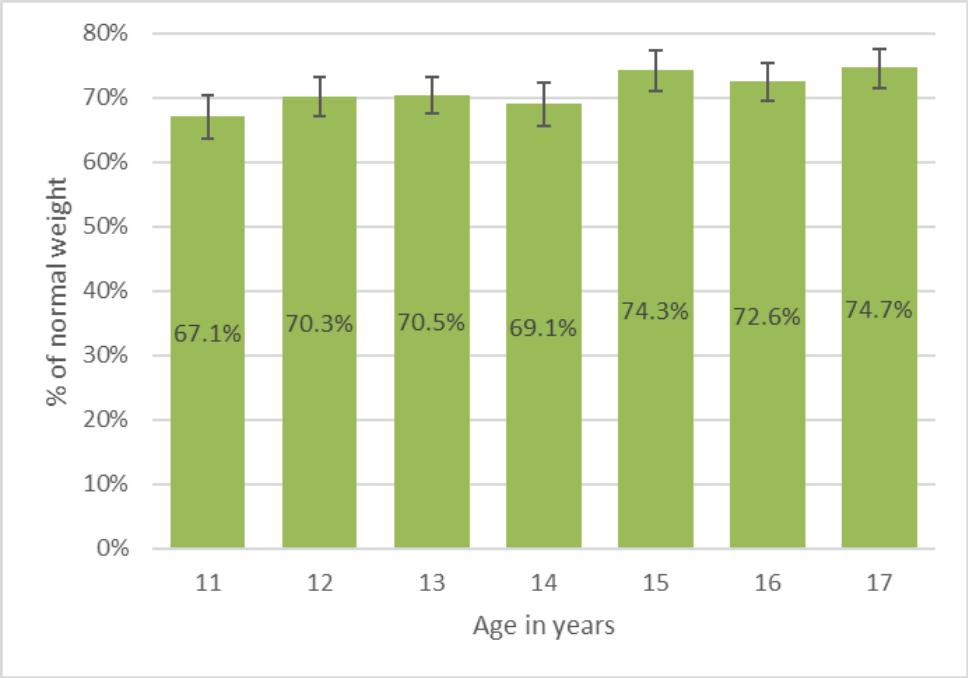
In a further step, the prevalence of underweight, normal weight and overweight among adolescents in Luxembourg are analysed by age. The results reveal a statistically significant relationship between weight status and age (X^2 (12, *n*=5,853)=56.6, *p*=.000) for both genders (Boys: X^2 (12, *n*=2,828)=42.5, *p*=.000 and girls: X^2 (12, *n*=3,025)=31.1, *p*=.002)). When examining this relationship in more detail, statistically significant differences are found for underweight (see Figure 11) and normal weight (see Figure 12), but not for overweight (see Figure 41 in the appendix). With increasing age, the prevalence of underweight decreases from one-fifth (20.9%; CI-95: 18.0-24.1%) of the adolescents at age 11 to one-tenth (10.7%; CI-95: 8.7-13.0%) of the adolescents at age 17. For the prevalence of normal weight, a statistically significant increase has been observed: Of the adolescents aged 11, only 67.1% (CI-95: 63.7-70.3%) are categorised as having normal weight, while 74.7% (CI-95: 71.4-77.7%) of the adolescents aged 17 are categorised as having normal weight.

Figure 11: Prevalence of Underweight of 11- to 17-Year-Olds by Age



Source: HBSC-LU 2014, *n*=5,853, weighted, 95% CI

Figure 12: Prevalence of Normal Weight of 11- to 17-Year-Olds by Age



Source: HBSC-LU 2014, *n*=5,853 , weighted, 95% CI

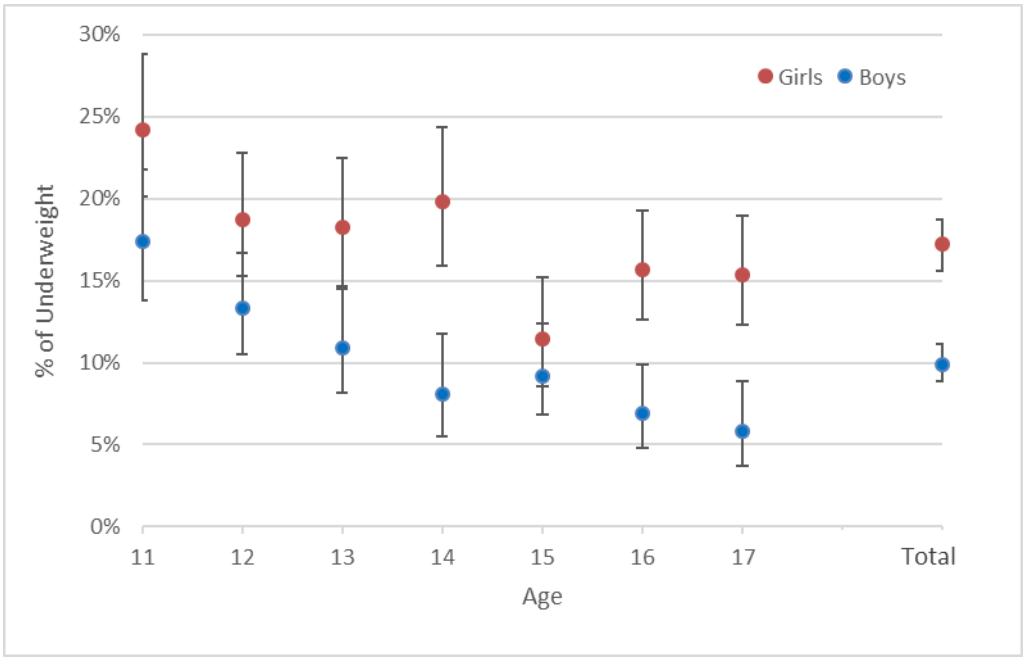
7.3 Prevalence by gender

The prevalence of weight status among adolescents in Luxembourg is analysed by gender in the next step and a statistically significant relation between weight status and gender is

revealed (X^2 (2, n=5,853)=88, p=.000). Statistically significant differences by gender are observed for the prevalence of underweight (see Figure 13) and overweight (see Figure 14), but not for the prevalence of normal weight. With 17.2% (CI-95: 15.8-18.7%), the proportion of girls who are categorised as underweight is higher than the proportion of boys at 9.9% (CI-95: 8.8%-11.1%). Girls are thus 1.7 times more likely to be underweight than boys (absolute adjusted standardised residuals of 8.2). The opposite, albeit less pronounced, relation is observed for gender and overweight: With 17.7% (CI-95: 16.2-19.4%), the proportion of boys who are categorised as overweight is higher than the proportion of girls at 12.2% (CI-95: 10.9-13.6%). Boys are thus 1.5 times more likely than girls to be overweight (absolute adjusted standardised residuals of 5.8). There is no statistically significant difference in the proportion of boys and girls who are categorised as normal weight: 72.4% (CI-95: 70.6-74.1%) for boys and 70.6 % (CI-95: 68.8-72.4%) for girls with absolute adjusted standardised residuals of 1.8.

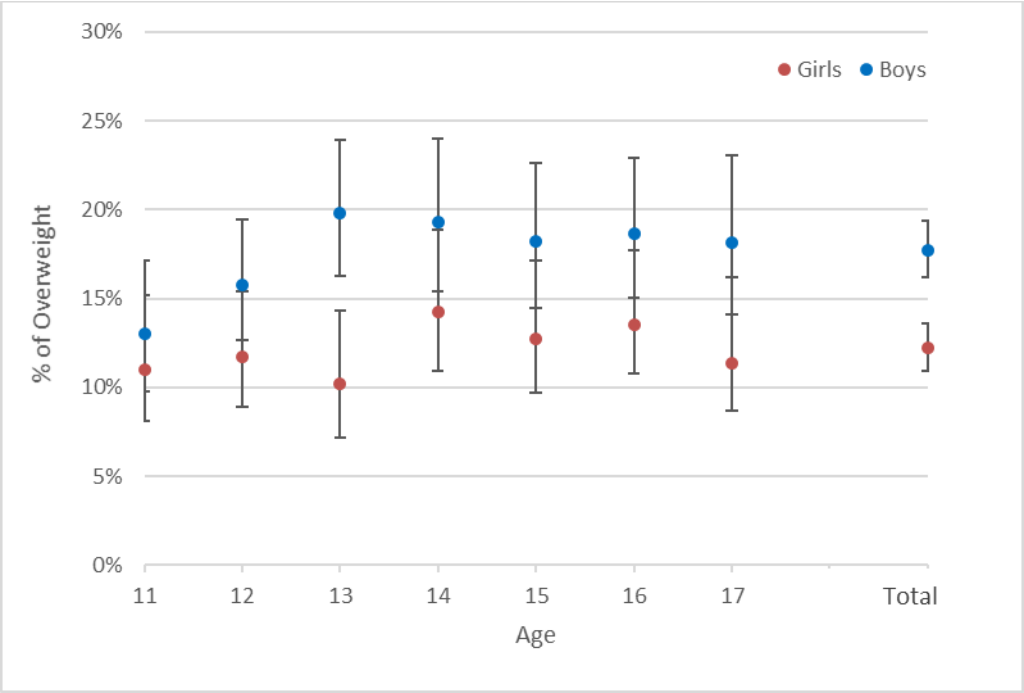
The proportions of underweight and overweight for girls and boys are shown by age in Figure 13 and Figure 14. The estimated proportion of underweight girls is higher than the estimated proportion of underweight boys in all age groups, and the difference is statistically significant for the 13-, 14-, 16- and 17-year-olds. For overweight, the estimated proportion of overweight boys is higher than the estimated proportion of overweight girls in all age groups, but the difference is only statistically significant for the 13-year-olds. As one can see from the large confidence intervals, the statistical power is decreased due to the low absolute number of adolescents in the different age categories.

Figure 13: Prevalence of Underweight of 11- to 17-Year-Olds by Age and Gender



Source: HBSC-LU 2014, n= 5,853, weighted, 95% CI

Figure 14: Prevalence of Overweight of 11- to 17-Year-Olds by Age and Gender



Source: HBSC-LU 2014, *n*= 5,853, weighted, 95% CI

7.4 Prevalence of weight-related health concerns

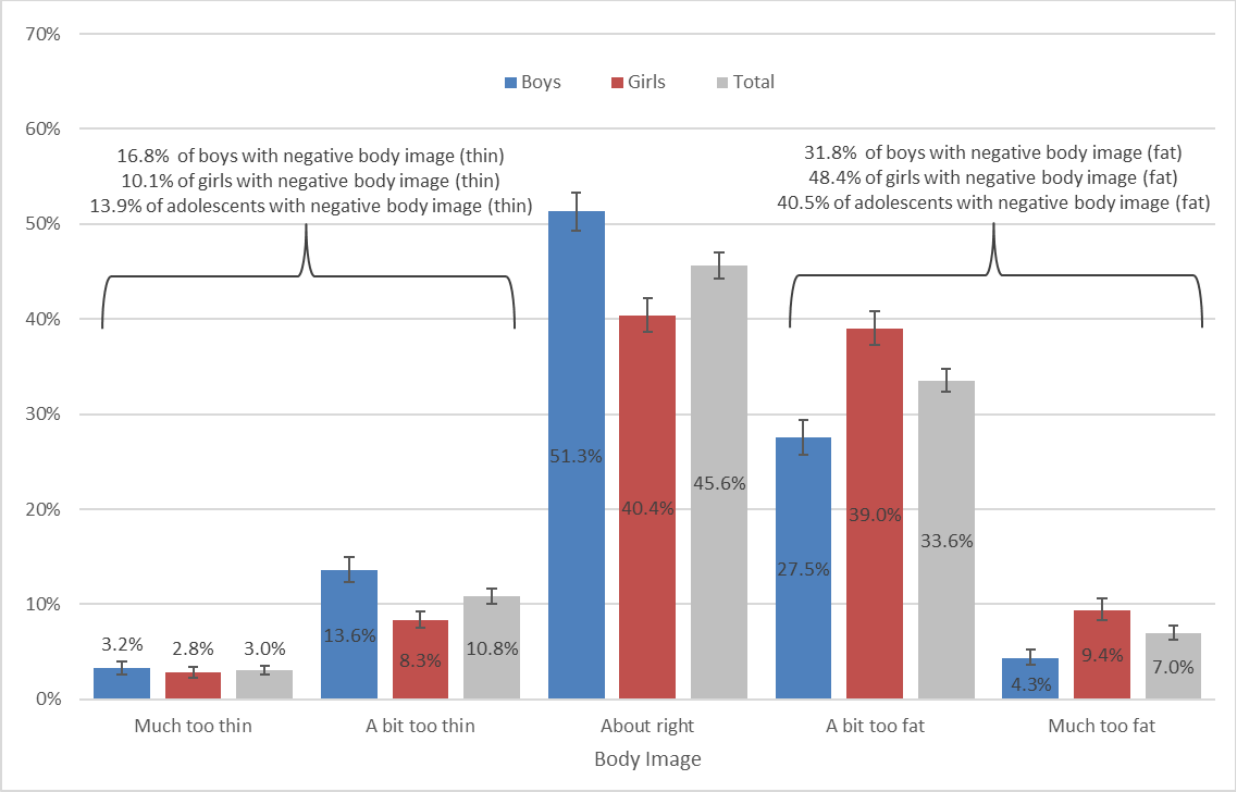
With the fifth research question, the focus of this thesis is expanded to include the weight-related health concerns body image and weight reduction behaviour. As for overweight and underweight, it is important to assess the prevalence of these weight-related health concerns to be able to evaluate whether they are crucial phenomena and to start understanding them. The available information on the prevalence of these weight-related health concerns in Luxembourg is, however, scarce (see chapter 4). The following section first describes the prevalence of negative and positive body image as observed among adolescents according to the HBSC 2014 data, before describing the prevalence of weight reduction behaviour as observed according to the same data.

The analysis of the HBSC data 2014 reveals that less than half (45.6%; CI-95: 44.3-47.0%) of all adolescents have a positive body image and think that their body is about right (see Figure 15). In consequence, more than half of all adolescents have a negative body image and think that their body is much too thin (3.0%; CI-95: 2.6-3.5%), a bit too thin (10.8%; CI-95: 10.1-

11.7%), a bit too fat (33.6%; CI-95: 32.3-34.8%) or much too fat (7.0%; CI-95: 6.3-7.7%). The differences between all categories of body image are statistically significant.

The results of the analysis of the prevalence of positive and negative body image are shown in Figure 15. There is a statistically significant (X^2 (4, *n*=6,418)=192, *p*=.000) relation between gender and body image. With 40.4% (CI-95: 38.7-42.2%), the proportion of girls who have a positive body image is statistically significantly lower than the proportion of boys who have a positive body image (51.3%; CI-95: 49.3-53.3%). In addition to the difference in the prevalence of positive and negative body image, there are differences in the proportion of girls and boys who think their body is too thin and the proportion of boys and girls who think their body is too fat. While statistically significantly more girls (48.4%; CI-95: 46.6-50.2%) than boys (31.8%; CI-95: 29.9-33.8%) think their body is too fat, statistically significantly more boys (16.8%; CI-95: 15.5-18.2%) than girls (11.1%; CI-95: 10.1-12.2%) think their body is too thin.

Figure 15: Prevalence of Body Image of 11- to 17-Year-Olds by Gender



Source: HBSC 2014 Luxembourg, *n* = 6,418, weighted, 95% CI

The body image and weight status according to the IOTF classification match for many adolescents, and the relation between them is statistically significant (X^2 (8, *n*=5,791)=1689, *p*=.000). More specifically, 84.6% (CI-95: 81.8-87.0%) of the adolescents who are categorised as being overweight have a negative fat body image, 53.1% (CI-95: 51.6-54.7%) of the

adolescents who are categorised as having normal weight think that their body is about right and 41.3% (CI-95: 37.7-45.1%) of the adolescents who are categorised as being underweight have a negative thin body image (see Table 9). At the same time, some adolescents who are categorised as underweight show a major difference between their perceived body image and their calculated actual weight status: 12.1% (CI-95: 10.0-14.6%) of the adolescents who are categorised as underweight think their body is a bit or much too fat. In contrast, only 0.9% (CI-95: 0.5-1.8%) of the adolescents who are categorised as overweight think their body is a bit or much too thin. The differences in prevalence of body image by weight status are statistically significant, with the exception of the difference of the prevalence of negative thin and positive (about right) body image among adolescents who are categorised as underweight.

Table 9: Prevalence of Body Image of 11- to 17-Year-Olds by Weight Status

Body Image	Weight Status			Total (CI-95)
	Underweight (CI-95)	Normal weight (CI-95)	Overweight (CI-95)	
Negative thin	41.3% (37.7-45.1%)	11.6% (10.6-12.6%)	0.9% (0.5-1.8%)	79.8% (78.6-80.9%)
Positive (about right)	46.6% (42.8-50.4%)	53.1% (51.6-54.7%)	14.5% (12.2-17.2%)	46.5% (45.1-47.9%)
Negative fat	12.1% (10.0-14.6%)	35.3% (33.7-36.9%)	84.6% (81.8-87.0%)	39.4% (38.0-40.9%)

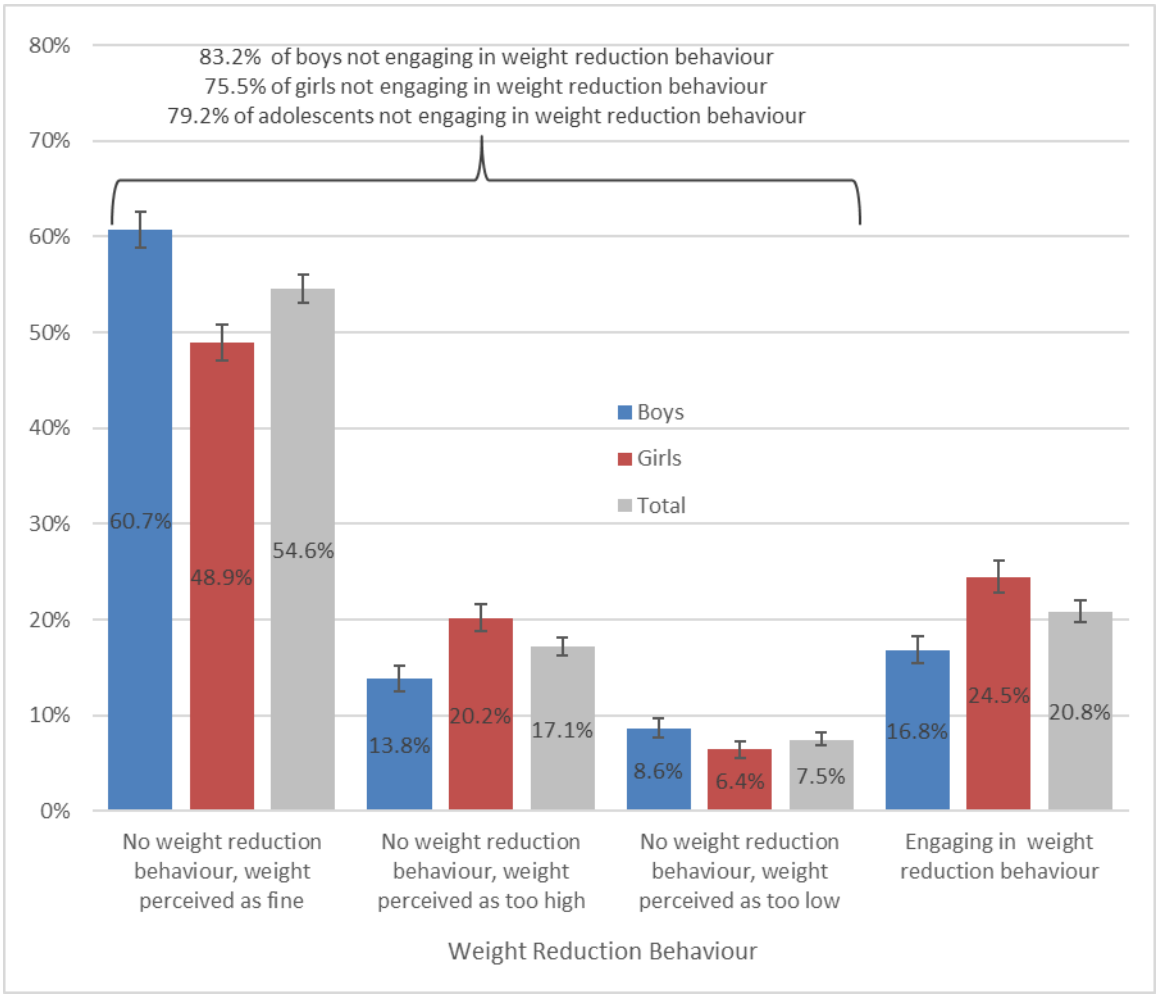
Source: HBSC 2014 Luxembourg, *n* = 5,791, weighted, 95% CI

In addition to body image, weight reduction behaviour is the second weight-related health concern taken into account. Adolescents who report that they are currently on a diet or are doing something else to lose weight are identified as engaging in weight reduction behaviour. With 20.8% (CI-95: 19.7-22.0%), one-fifth of adolescents aged 11 to 17 years engage in weight reduction behaviour, while 79.2% (CI-95: 78.0-80.3%) do not engage in weight reduction behaviour (see Figure 16). One-fifth (17.1%; CI-95: 16.2-18.1%) of adolescents report that they are currently not engaged in weight reduction behaviour, but need to lose weight. About half of all adolescents (54.6%; CI-95: 53.1-56.0%) report that they are not engaging in weight reduction behaviour because their weight is fine, and 7.5% (CI-95: 6.8-8.2%) do not engage in weight reduction behaviour because they think they need to gain weight. The differences between all categories of weight reduction behaviour are statistically significant.

A substantial and statistically significant (X^2 (3, n=6,439)=120, p=.000) difference in the proportion of boys and girls who engage in weight reduction behaviour is revealed by the analysis of the prevalence of weight reduction behaviour by gender. Figure 16 shows the statistically significant difference in the prevalence of weight reduction behaviour among boys and girls. Every fourth girl (24.5%; CI-95: 22.8-26.2%) engages in weight reduction behaviour. With 16.8% (CI-95: 15.5-18.2%), a statistically significant lower proportion of boys engage in

weight reduction behaviour. In addition, there are statistically significant differences between the reasons that girls and boys report for not engaging in weight reduction behaviour. In addition to one-fourth of the girls (24.5%; CI-95: 22.8-26.2%) engaging in weight reduction behaviour, one-fifth of the girls (20.2%; CI-95: 18.9-21.6%) report that they are currently not on a diet or doing something else to lose weight, but think that they should lose weight. The proportion of boys not engaging in weight reduction behaviour but thinking they should lose weight is, at 13.8% (CI-95: 12.6-15.2%), statistically significantly lower than that of girls. The proportion of boys not engaging in weight reduction behaviour and thinking their weight is fine (60.7%; CI-95: 58.8-62.6%) or thinking that they need to gain weight (8.6%; (CI-95: 7.7-9.7%) is statistically significantly higher than the proportion of girls not engaging in weight reduction behaviour and thinking their weight is fine (48.9%; CI-95: 47.0-50.8%) or thinking that they need to gain weight (6.4%; CI-95: 5.6-7.4%).

Figure 16: Prevalence of Weight Reduction Behaviour of 11- to 17-Year-Olds by Gender



Source: HBSC 2014 Luxembourg, *n* = 6,439, weighted, 95% CI

Similar to the relation between body image and weight status, there is a statistically significant relation between weight reduction behaviour and weight status (X^2 (2, *n*=5,788)=291, *p*=.000). As shown in Table 10, around two-fifths (40.1% (CI-95: 36.8-43.6%) of the adolescents who are categorised as being overweight report that they are currently on a diet or doing something else to lose weight. Of the adolescents who are categorised as normal weight, 18.2% (CI-95: 16.9-19.6%) engage in weight reduction behaviour as do 9.1% (CI-95: 7.3-11.3%) of the adolescents who are categorised as being underweight. The differences in prevalence of weight reduction behaviour by weight status are statistically significant.

Table 10: Prevalence of Weight Reduction Behaviour of 11- to 17-Year-Olds by Weight Status

	Weight Status			Total (CI-95)
Weight Reduction Behaviour	Underweight (CI-95)	Normal weight (CI-95)	Overweight (CI-95)	
No	90.9% (88.7-92.7%)	81.8% (80.4-83.1%)	59.9% (56.4-63.2%)	79.8% (78.6-80.9%)
Yes	9.1% (7.3-11.3%)	18.2% (16.9-19.6%)	40.1% (36.8-43.6%)	20.2 (19.1-21.4%)

Source: HBSC 2014 Luxembourg, *n*= 5,788, weighted, 95% CI

In summary, the results presented in this chapter reveal that the prevalence of overweight and underweight is similar among adolescents in Luxembourg, with one in seven adolescents categorised as overweight and one in seven adolescents categorised as underweight. Moreover, the findings indicate a decrease in the prevalence of normal weight since 2006. The prevalence of underweight decreases with age and the prevalence of normal weight increases with age, but no statistically significant difference in the prevalence of overweight by age is observed. As far as gender is concerned, similar proportions of boys and girls are categorised as having normal weight, but girls have a higher risk of being underweight than boys whereas boys have a higher risk of being overweight than girls.[25] A considerably higher proportion of girls have a negative body image and a higher proportion of girls currently engage in weight reduction behaviour (25%; CI-95: 23.4-26.4%). For weight-related health concerns, the findings reported in this chapter reveal that less than half of the adolescents think their body is about right and one-fifth of adolescents engage in weight reduction behaviour. Weight status seems to be linked to body image as well as weight reduction behaviour in adolescents in Luxembourg.

[25] Differences in the proportions of boys and girls who are under- or overweight by one or two categories are not statistically significant and therefore not reported here.

8 Effects of socio-economic status on overweight and underweight

After examining the prevalence and socio-demographic distribution of overweight and underweight, the next step of the analysis turns towards the main interest of this thesis and focuses on possible socio-economic health inequalities in the health concern under study. The second refined research question is thus whether there are socio-economic inequalities in the prevalence of overweight and underweight in adolescents in Luxembourg and how these compare with each other. In addition to comparing the results for overweight and underweight, the empirical analysis aims at exploring potential socio-economic inequalities in depth by analysing the effects of objective as well as subjective aspects of socio-economic status on weight status.

As seen in chapter 4, international empirical findings in many western countries have confirmed that the body mass index of young people with a high socio-economic status is smaller than that of young people with low socio-economic status (e.g. Dupuy et al., 2011; Elgar et al., 2015; Elgar, Xie et al., 2016). Consistent with the health gradient, this translates into a relatively lower risk of young people with higher socio-economic status of being overweight and thus into a positive effect of higher socio-economic status on adolescent health (Dupuy et al., 2011; Inchley et al., 2017; Starfield et al., 2002). Based on the international empirical findings, the hypothesis on the relationship between socio-economic status and overweight in adolescents in Luxembourg is that low socio-economic status is associated with a higher risk of being overweight, while high socio-economic status is associated with a lower risk of being overweight. The relationship between socio-economic status and underweight has received little attention, and it is unknown whether there are socio-economic differences in the risk of being underweight in adolescents. In addition, the review of the international empirical findings revealed a lack of information on the empirical relevance of the differentiation of objective and subjective aspects of socio-economic status for weight status in adolescence.

To specify the relationship between socio-economic status and potential health-compromising weight status, the distribution of overweight and underweight according to socio-economic status is calculated and the bivariate relationships are described using different statistical tests. In a second step, the relationship between socio-economic status and overweight and underweight is statistically confirmed by using hierarchical logistic regression models and adding independent variables in subsequent models. To explore the relationship in more depth,

the analysis is executed for objective as well as subjective socio-economic status. A comparison of the results for overweight and underweight will reveal whether there are similarities, mirrored effects or differences between the influences of socio-economic status on both health risks.

8.1 Prevalence of overweight and underweight by socio-economic status

The prevalence of weight status among subgroups of young people with different socio-economic backgrounds gives us a first insight into the relationship between socio-economic status (SES[26]) and overweight and underweight. For each end of the weight status spectrum, results will be reported for both objective and subjective SES. Objective SES is measured by relative family affluence, while subjective SES is measured by perceived wealth. To present results that are easier to interpret and to gain insights that are easily ascertained, objective and subjective SES are expressed in terms of high, medium and low categories. The attribution of these categories is based on different procedures for objective and subjective SES[27].

First, the overall relationships between weight status (including overweight, normal weight and underweight) and SES is tested to establish whether there is a statistically significant relation between them. Results reveal that the relation is statistically significant for objective and subjective SES. For objective SES, the chi-square value is 39.4 at 4 degrees of freedom (*df*) and 5,441 observations. The relation is, therefore, statistically significant at a p-value of 0.000. For subjective SES, the relation is just as statistically significant, with a chi-square value of 39.5 (*df*=4, *n*=5,622).

A further step focuses on the prevalence of overweight in young people by SES subgroups. For objective SES, Figure 17 illustrates the lower prevalence of overweight among young people who have higher objective SES compared to young people who have lower objective SES. With 18.7% (CI-95: 16.4-21.2%), adolescents with low relative family affluence have a higher prevalence of overweight than adolescents who rank medium and have a 14.9%

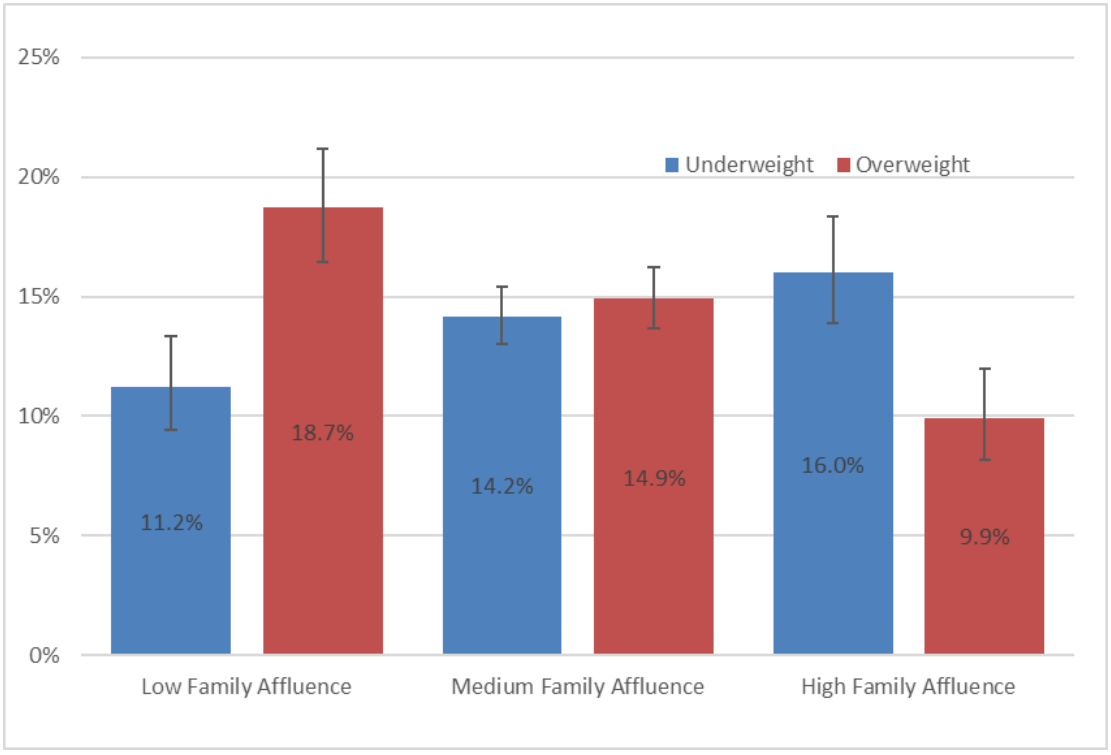
[26] For a clearer presentation of the results, the abbreviation SES isused instead of the full term socio-economic status for text passages reporting statistical results.
[27] For objective SES, the categories represent the students ranked in the top 20%, medium 60% and bottom 20%. For subjective SES, the high category represents students who perceive their family to be very or quite well off, the average category those who perceive their family to be well off and the low category those who perceive their family to be not so or not at all well off.

(CI-95: 13.7-16.2) prevalence of overweight. The adolescents with medium relative family affluence, in turn, have a higher prevalence of overweight than those who rank high (9.9%; CI-95: 8.2-12.0). All of these differences are statistically significant and indicate a negative statistical relationship between objective SES and overweight.

Similar results are found for the prevalence of overweight according to subjective SES. Figure 18 illustrates the lower prevalence of overweight among adolescents with higher subjective SES compared to adolescents with lower subjective SES. The prevalence of overweight is higher (21.3%; CI-95: 18.0-24.9%) among adolescents who do not perceive their family to be well off compared to those who perceive their family as average well off (16.0%, CI-95: 14.5-17.6%). The adolescents who perceive their family to be very well off have an even lower prevalence of overweight (12.7%; CI-95: 11.5-14.1%). All of these differences are statistically significant and point towards a negative statistical relationship between subjective SES and overweight.

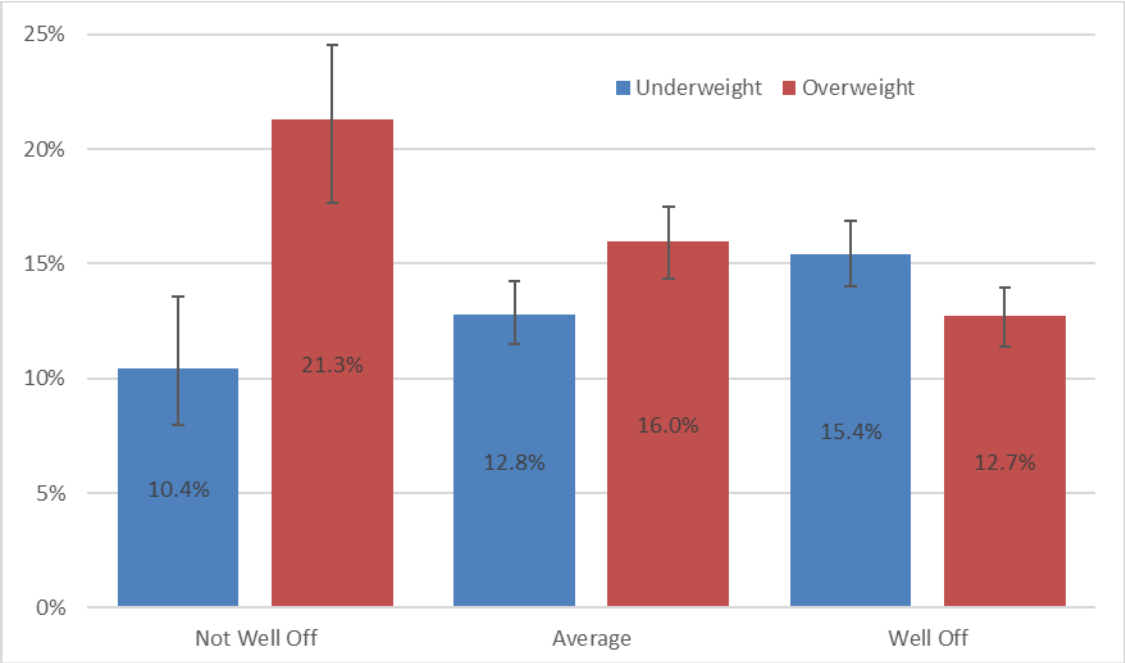
The analysis of the prevalence of overweight by both objective and subjective SES shows a lower prevalence for adolescents with higher SES compared to adolescents with lower SES. This indicates that the risk of being overweight decreases with increasing SES in adolescents in Luxembourg and is consistent with the health gradient. Logistic regression is used later in the chapter to confirm this negative statistical relation when age and gender are controlled for.

Figure 17: Prevalence of Overweight and Underweight by Objective SES



Source: HBSC-LU 2014, weighted, *n*-total=5,441, *n*-overweight=788, *n*-underweight=781

Figure 18: Prevalence of Overweight and Underweight by Subjective SES



Source: HBSC-LU 2014, weighted, *n*-total=5,622, *n*-overweight=825, *n*-underweight=802

In a further step, the prevalence of underweight by objective and subjective SES is described. As shown in Figure 17, the prevalence of underweight is higher among adolescents with higher objective SES compared to adolescents with lower objective SES. At 11.2% (CI-95: 9.4-13.3%), the prevalence of underweight is lower for adolescents who have a low objective SES compared to adolescents who have a high objective SES (16%, CI-95: 13.9-18.4%). This difference is statistically significant.

For subjective SES, the results are similar, and this is depicted in Figure 18. The prevalence of underweight is higher among adolescents with higher subjective SES than adolescents with low subjective SES. At 10.4% (CI-95: 8.0-13.6%), adolescents who perceive their family as not being well off have a statistically significantly lower prevalence of underweight than adolescents who perceive their family as being well off (15.4%; CI-95: 14-16.9%).

The prevalence of underweight by objective and subjective SES both show a higher prevalence for adolescents with high SES compared to adolescents with low SES. This indicates a positive statistical relation between SES and underweight, which contradicts the health gradient. Logistic regression is used later in the chapter to confirm this negative relation when age and gender are controlled for.

As Figure 17 and Figure 18 indicate by comparing the prevalence of overweight and underweight by objective and subjective SES, the relation between SES and overweight or underweight is inverse[28]. Adolescents with high objective or subjective SES have a lower prevalence of overweight than adolescents with low SES, but they also have a higher prevalence of underweight. Adolescents with low objective or subjective SES have a lower prevalence of underweight than adolescents with high SES, but they have a higher prevalence of overweight.

8.2 Effects of socio-economic status on overweight and underweight

A further analytical method is drawn upon to confirm the indications derived from the descriptive bivariate analysis of the prevalence of overweight and underweight by objective and subjective SES and to explore the research question on the influence of SES on overweight and underweight in more depth. Hierarchical logistic regression is used to confirm whether the statistical significance of the indicated relations persist when other socio-demographic variables are added in subsequent models. Models are built using hierarchical regression, and the explanatory power of the model excluding SES and the model including SES is calculated. The overall statistical significance of the models are assessed by the likelihood ratio (LR) chi-square test, and the model fit is assessed by the AIC and BIC.

Age and gender were identified as relevant socio-demographic characteristics by the descriptive statistics presented in the previous chapter and the usefulness of their addition to the initial statistic model is therefore evaluated. The decisions to include or exclude variables from the model balances theoretical interests, the inclusion of all relevant variables adding explanatory power to the model and the principle of parsimony (the principle of preferring simpler models to more complex models if the explanatory power is similar) (Field, 2013). The base line of explanatory power of the model fit is given by an ‘empty’ regression model, which only includes the dependent variable. Gender and age are subsequently added to the models to assess whether these variables improve the model fit.

[28] The prevalence of normal weight was also analysed according to objective and subjective SES (see Figure 42 in the appendix). No statistically significant differences were found.

Table 11: Hierarchical Building of the Basic Regression Model

Model	**Model fit assessed by AIC/BIC[29] for Overweight**	**Model fit assessed by AIC/BIC for Underweight**
'Empty' model	4402/4408	4374/4380
Model including gender	4375/4388	4309/4322
'Basic' model including gender and age	4370/4390	4260/4280

Source: HBSC-LU 2014, *n*=5312[30]

As shown in Table 11, gender increases the explanatory power of the model both for overweight and underweight, while age only adds explanatory power to the model for underweight. For the effect of age on overweight, the results are inconclusive and while the AIC indicates a slight improvement of the model fit from 4375 to 4370, the BIC indicates a slight deterioration from 4388 to 4390. The results are consistent with a small gain in explained variance that is not large enough to make up for the 'penalty adjustment' that the BIC and AIC include for each additional variable. This result is also reflected in the statistical significance of the coefficient of age in the basic models as shown in Table 12 and Table 13. While the effect of age on overweight is not statistically significant (p-value=0.054), the effect of age on underweight is statistically significant (p-value<0.000).

In the interest of parsimony, one would continue with a model including age for underweight and a model excluding age for overweight, but age is only barely statistically non-significant and the advantages of keeping the models intuitively comparable is paramount. The analysis therefore continues with age in the models for both overweight and underweight. This leads to a basic regression model, which includes the dependent variable as well as two socio-demographic variables of secondary interest (gender and age).

The analysis of the basic regression model gives indications about the relation between overweight and underweight on one hand and gender and age on the other hand. The coefficients of gender are statistically significant at p<0.000 in the model predicting overweight and the model predicting underweight. Crucially, the coefficient of gender in the model predicting overweight is negative, while the coefficient of gender in the model predicting underweight is positive. Although girls have a lower risk of being overweight than boys, they

[29] AIC and BIC are computed for unweighted data. The lower the value of the AIC and the BIC, the better the model fits the data.
[30] To improve the intuitive comparability of the models, the models were calculated on the same sample by using manual listwise deletion before running the analysis.

have a higher risk of being underweight with all other variables held constant. The odds[31] of being overweight for girls are 0.65 (CI-95: 0.55-0.76) times those of boys, while the odds of being underweight for girls are 1.95 (CI-95: 1.66-2.30) times those of boys. Being female is a protective factor in relation to overweight, but a risk factor in relation to underweight.

For age, the coefficient is statistically non-significant at p=0.054 in the model predicting overweight and statistically significant at p<0.000 in the model predicting underweight. It is thus not possible to detect an association between age and overweight, while an association between age and underweight can be confirmed in the available data. A one-year increase in age entails a 13% decrease in the odds of being underweight with all other variables held constant. The results from the bivariate analysis presented in the previous chapter are thus confirmed by the results from the logistic regression models.

The next step is to analyse whether including SES in the regression model adds to the explanatory power of the model and improves the model fit. Adding SES to the 'basic' regression model also shows whether the relationship indicated by the bivariate analysis is statistically significant when age and gender are held constant.

First, the models for overweight are analysed and compared. The results in Table 12 show that adding objective SES to the basic model decreases the AIC from 4370 to 4324 and the BIC from 4390 to 4350. Adding subjective SES to the basic model decreases the AIC from 4370 to 4352 and the BIC from 4390 to 4379. Both variables increase the fit of the model for overweight and increase the explanatory power of the model. Both objective and subjective SES have an effect on overweight that is confirmed by the high statistical significance (p-value<0.000) of their coefficients in the model predicting overweight.

The relation between overweight and SES indicated by the results of the bivariate analysis is thus confirmed when age and gender are held constant. The model fit of the model including objective SES is better compared to the model including subjective SES (both AIC and BIC values are lower). This indicates that objective SES explains more of the variance of overweight than subjective SES.

[31] The odds ratio represents the change in the odds of the dependent variable caused by a one-unit change in the independent variable under study, if all other variables are held constant. The odds ratios do not represent probabilities. They indicate the proportion not the magnitude of the change.

Table 12: Overweight, Coefficients, P-Value and Odds Ratio (95% CI) of SES, Gender and Age

	Overweight		
	Coefficient	**p-value**	**Odds ratio (95% CI)**
'Basic' Model			
Gender (Results for female)	-.4315873	0.000 ***	0.65 (0.55-0.76)
Age	.0376696	0.054 ns	1.04 (0.99-1.08)
LR chi2 (DF)[1)]	36.01 (2)	0.000 ***	
AIC[1)]/BIC [1)]	4370/4390		
Model 'Objective SES'			
Relative Family Affluence (Objective SES)	-.9779191	0.000 ***	0.38 (0.29-0.50)
Gender (Results for female)	-.4339679	0.000 ***	0.65 (0.55-0.76)
Age	.0385402	0.050 *	1.04 (1.00-1.08)
LR chi2 (DF)[1)]	84.60 (3)	0.000 ***	
AIC[1)]/BIC [1)]	4324/4350		
Model 'Subjective SES'			
Perceived family wealth (Subjective SES)	-.2182548	0.000 ***	0.80 (0.73-0.88)
Gender (Results for female)	-.4486723	0.000 ***	0.64 (0.55-0.75)
Age	.0299255	0.130 ns	1.03 (0.99-1.07)
LR chi2 (DF)[1)]	56.14 (3)	0.000 ***	
AIC[1)]/BIC [1)]	4352/4379		

Source: HBSC 2014, *n*=5,312 weighted

ns=*p*>0.05, *=*p*<0.05, **=*p*<0.01, ***=*p*<0.001

1) AIC, BIC and LR chi2 computed for unweighted data

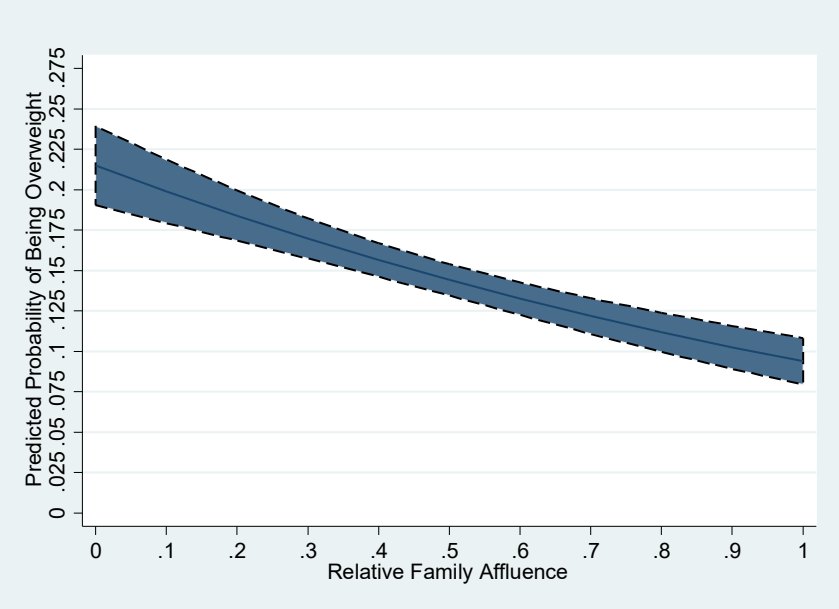
The signs of the coefficients and the odds ratios reported in Table 12 specify the relation between overweight and SES. The coefficients of relative family affluence (measuring objective SES) and perceived family wealth (measuring subjective SES) are both negative and highly statistically significant at p<0.000. With increasing SES, the risk of adolescents to be overweight decreases. The odds[32] of being overweight for adolescents with the highest objective SES are 0.38 (CI-95: 0.29-0.50) times those of adolescents with the lowest objective SES, with all other variables held constant. Similarly, a one-unit increase in perceived family

[32] For objective SES as measured by relative family affluence, the one-unit change expressed by the odds ratio represents the entire spectrum of the values (continuous from 0-1) and thus the difference between the lowest and highest possible SES. For subjective SES as measured by perceived family wealth with its value ranging from 1 - 5, a one-unit change represents less magnitude at the same odds ratio value.

wealth is associated with a 20% decrease of the odds of being overweight, with all other variables held constant. A negative statistical relation between overweight and SES is therefore confirmed by logistic regression and indicates that adolescents with low SES have a higher risk of being overweight than adolescents with high SES.

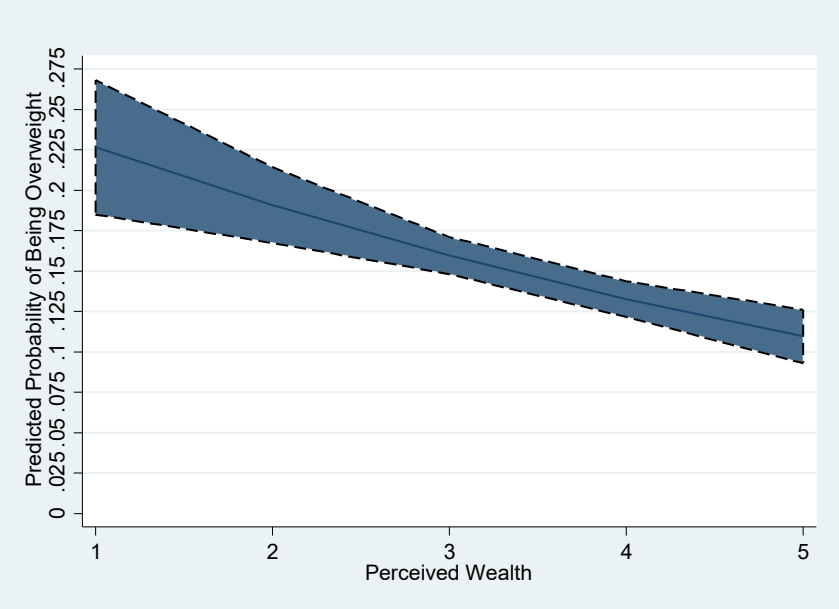
The visual representation of the predicted probabilities of being overweight by objective and subjective SES in Figure 19 and Figure 20 shows and confirms the negative statistical relation between overweight and both aspects of SES. A visual comparison of the predicted probabilities of being overweight by objective SES in Figure 19 and by subjective SES in Figure 20 shows that the relations between overweight and both aspects of SES are very similar, but subjective SES has a slightly less pronounced effect on the predicted probability of being overweight than objective SES.

Figure 19: Predicted Probability of Overweight by Objective SES with 95% CI



Source: HBSC-LU 2014, *n*=5,312, gender and age held constant

Figure 20: Predicted Probability of Overweight by Subjective SES with 95% CI



Source: HBSC-LU 2014, *n*=5,312, gender and age held constant

It is worth noting that some of the results for overweight seem to point towards a minor interaction between age and SES[33]. The models were therefore rerun with the interaction term. While the coefficient of the interaction term between objective SES and age is statistically significant at p-value=0.014, the AIC and BIC test did not show a conclusive gain in explanatory power through the inclusion of the interaction term (see Table 27 in the appendix). The coefficient of the interaction term between subjective SES and age is not statistically significant. Even though this interaction effect is in line with our theoretical understanding, it exerts only a minor effect and does not add any explained variance to the model. Because subsequent results would at the same time lose substantially in intuitive explanatory power if the interaction term was included, all further analyses will continue without inclusion of the interaction term.

In a further step, the basic model and models including SES for underweight are calculated and compared. The results in Table 13 show that both objective and subjective SES increase the fit of the basic model and the explanatory power for underweight. Adding objective SES to the model decreases the AIC from 4260 to 4242 and the BIC from 4280 to 4269. The coefficient of relative family affluence (measuring objective SES) is statistically significant at a p-value under 0.000. Adding subjective SES to the basic model decreases the AIC from 4260 to 4251

[33] In the international HBSC protocol Wild and Aleman-Diaz (2013) recommend the ranking of relative family affluence by age as procedure to take this interaction into account. This procedure was adopted in this study and reduced the scope of the interaction term.

and the BIC from 4280 to 4278. The coefficient of perceived family wealth (measuring subjective SES) is statistically significant at a p-value of 0.005. Both aspects of SES have statistically significant effects on underweight, but the model fit indicates that the model including objective SES explains more of the variance of underweight than the model including subjective SES. The positive statistical relation between underweight and SES indicated by the bivariate analysis is thus confirmed when age and gender are held constant.

Table 13: Underweight, Coefficients, P-Value and Odds Ratio (95% CI) of SES, Gender and Age

	Underweight		
	Coefficient	**p-value**	**Odds ratio (95% CI)**
Basic Model			
Gender (Results for female)	.6699402	0.000 ***	1.95 (1.66-2.30)
Age	-.1415763	0.000 ***	0.87 (0.83-0.90)
LR chi2 (DF)[1)]	117.75 (2)	0.000 ***	
AIC[1)]/BIC [1)]	4260/4280		
Model 'Objective SES'			
Relative Family Affluence (Objective SES)	.6262373	0.000 ***	1.87 (1.42-2.47)
Gender (Results for female)	.6708483	0.000 ***	1.96 (1.66-2.30)
Age	-.1420995	0.000 ***	0.87 (0.83-0.90)
LR chi2 (DF)[1)]	137.67 (3)	0.000 ***	
AIC[1)]/BIC [1)]	4242/4269		
Model 'Subjective SES'			
Perceived family wealth (Subjective SES)	.1391531	0.005 **	1.15 (1.04-1.27)
Gender (Results for female)	.6793207	0.000 ***	1.97 (1.67-2.32)
Age	-.1362298	0.000 ***	0.87 (0.84-0.91)
LR chi2 (DF)[1)]	128.64 (3)	0.000 ***	
AIC[1)]/BIC [1)]	4251/4278		

Source: HBSC 2014, *n*=5,312, weighted

ns=$p>0.05$, *=$p<0.05$, **=$p<0.01$, ***=$p<0.001$

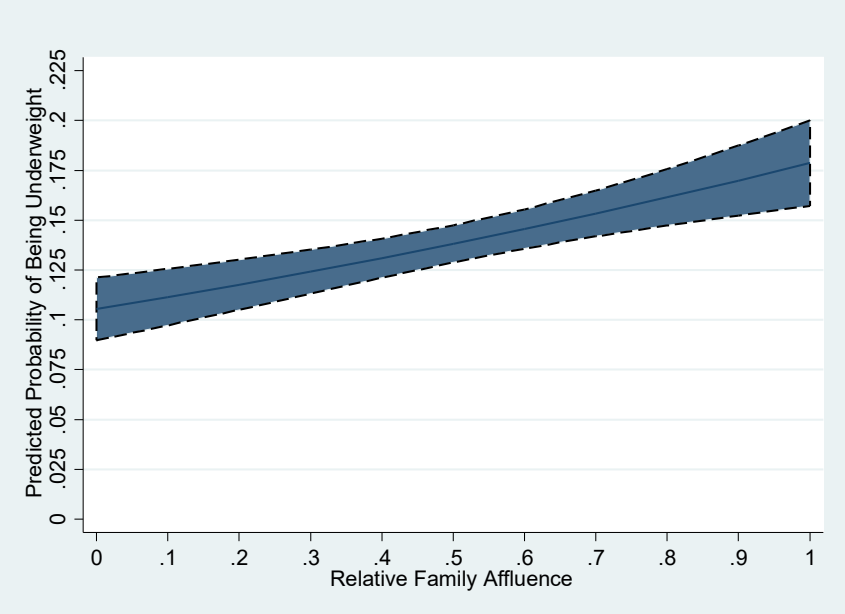
[1)] AIC, BIC and LR chi2 computed for unweighted data

As far as the direction of the relation is concerned, the signs of the coefficients of objective as well as subjective SES in relation to underweight are positive (see Table 13). The risk of being underweight increases with increasing SES, when all other variables are held constant. The odds of being underweight for adolescents with the highest possible relative family affluence (objective SES) are 1.87 (CI-95: 1.42-2.47) times the odds of adolescents with the lowest possible family affluence. For perceived family wealth (subjective SES), a one-unit increase

entails a 15% increase of the odds of being underweight, with all other variables held constant. The relation between underweight and SES is a positive statistical relationship in the sense that the risk of being underweight increases with increasing SES. This relation by which adolescents with high SES have a higher risk of being underweight than adolescents with low SES is not in line with the health gradient.

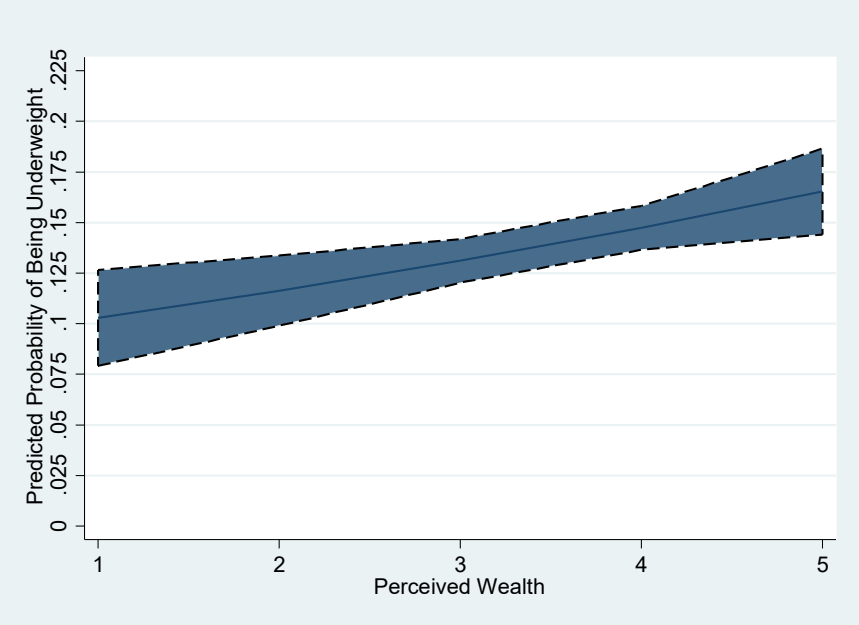
This positive statistical relation between underweight and SES is illustrated in the visual representation of the predicted probabilities of being underweight by SES in Figure 21 and Figure 22. The visual comparison of the predicted probabilities of being underweight by objective SES (relative family affluence) in Figure 21 and by subjective SES (perceived wealth) in Figure 22 shows that the relation between underweight and both aspects of SES are similar. Subjective SES has, however, less effect on the predicted probability of being underweight than objective SES.

Figure 21: Predicted Probability of Underweight by Objective SES with 95% CI



Source: HBSC-LU 2014, *n*=5,312, gender and age held constant

Figure 22: Predicted Probability of Underweight by Subjective SES with 95% CI



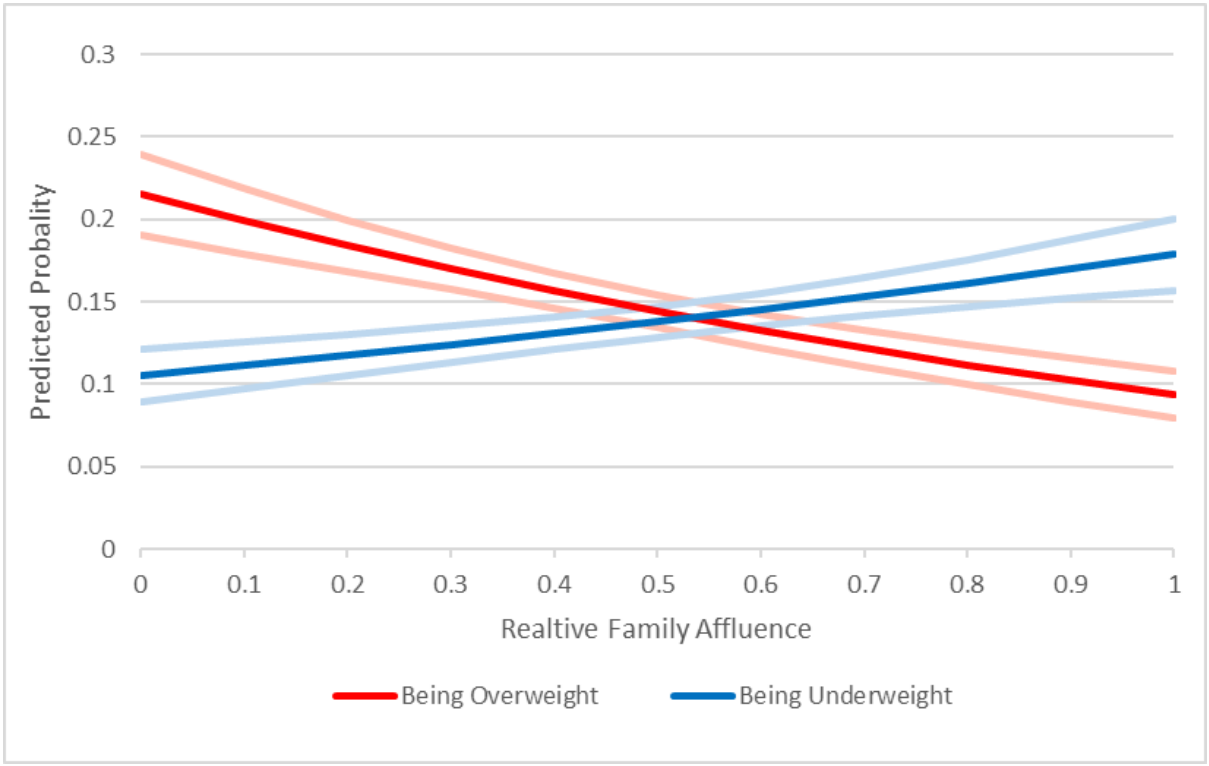
Source: HBSC-LU 2014, *n*=5,312, gender and age held constant

To complete the presentation of results in this chapter, the findings on the effects of SES on overweight and underweight are compared. As demonstrated, objective and subjective SES have statistically significant effects on overweight and underweight of adolescents in Luxembourg according to the 2014 HBSC data and when gender and age are held constant. The negative statistical relation of overweight and SES indicates that the risk of being overweight decreases with increasing SES, while the positive statistical relation between underweight and SES indicates that the risk of being underweight increases with increasing SES. SES thus influences overweight and underweight in opposite directions. While the results were established and confirmed for overweight and underweight separately, they will be compared in the following visual representations.

Figure 23 and Figure 24 show the predicted probabilities of being overweight and underweight for objective and subjective SES, when all other variables are held constant. The predicted probabilities of overweight and underweight by objective SES as shown in Figure 23 are very similar in slope and statistical significance (CI-95%). Even though the effect of objective SES on underweight seems slightly less pronounced than the effect of objective SES on overweight, the effects on overweight and underweight are nearly perfect identical opposites and can, therefore, not only be described as opposing in direction, but as inverse. The predicted probabilities of overweight and underweight by subjective SES as shown in Figure 24 are less similar. The effect of subjective SES on underweight seems less pronounced than the effect

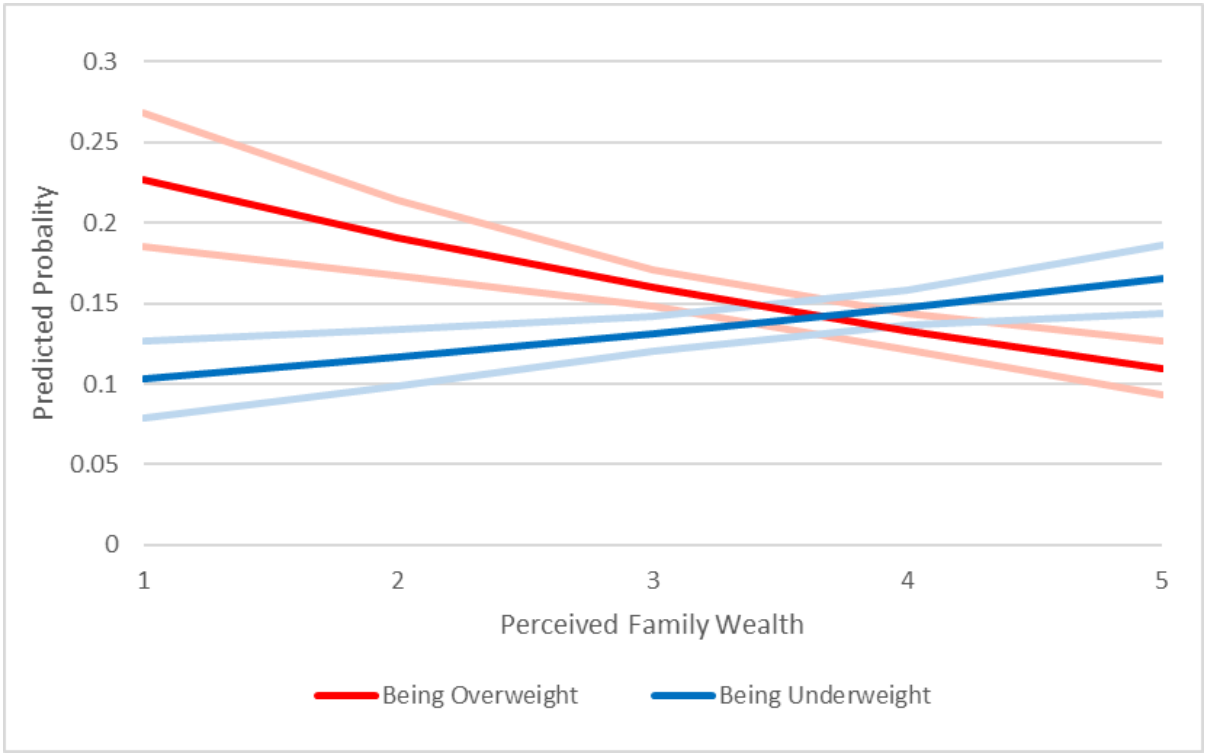
of subjective SES on overweight. This is depicted in an intercept that is off centre and a slope that is less steep with closer lowest and highest point (an indicator of less attributed variance) for the effect of subjective SES on underweight in comparison to the effect of subjective SES on overweight. In addition, the effects of subjective SES have slightly lower statistical precision and larger 95% confidence bands, that the effects of objective SES. Though less similar than the effects of objective SES, the effects of subjective SES on overweight and underweight can also be described as very similar opposites or inverse.

Figure 23: Predicted Probabilities of Overweight and Underweight by Objective Socio-Economic Status with 95% CI



Source: HBSC-LU 2014, *n*=5,312, gender and age held constant

Figure 24: Predicted Probabilities of Overweight and Underweight by Subjective Socio-Economic Status with 95% CI



Source: HBSC-LU 2014, *n*=5,312, gender and age held constant

In summary, the results of the logistic regression confirm the results obtained from the bivariate descriptive analysis: In the 2014 HBSC data of 11- to 17-year-olds in Luxembourg, there is a strong indication that the risk of being overweight decreases with increasing socio-economic status, while the risk of being underweight increases with increasing socio-economic status if all other variables are held constant. The effects of socio-economic status at both ends of the weight spectrum are thus inverse. These results are robust both for objective as well as subjective socio-economic status and very similar. One additional result can be noted: Subjective socio-economic status as measured by perceived family wealth seems to have a slightly less pronounced effect on underweight than objective socio-economic status as measured by relative family affluence. Socio-economic status thus seems to have a complex relationship with weight status, with high socio-economic status having a protective effect when it comes to overweight, but also having a detrimental effect when it comes to underweight.

9 Distinct effects of objective and subjective socio-economic status on overweight and underweight

The previous chapter confirms the existence of socio-economic health inequalities in adolescents' overweight and underweight for both objective and subjective aspects of socio-economic status. The question that prevails is whether the observed effects represent distinct effects of objective and subjective aspects of socio-economic status or whether they both capture the same single overall effect of socio-economic status. The next step in the analysis is to focus on the third research question and to determine whether the effects of objective and subjective socio-economic status on overweight and underweight are distinct and unique.

In chapter 2, the theoretical importance of the differentiation between objectively available resources and the subjective perception of available resources has been established. Some studies observe relations between objective and/or subjective socio-economic status and certain aspects of health and illness (Chen & Paterson, 2006; Elgar et al., 2017; Goodman et al., 2001; Goodman et al., 2007; Karvonen & Rahkonen, 2011; Marmot, 2005; Moor et al., 2015; Quon & McGrath, 2015; Solar & Irwin, 2005, 2005). Though there are few studies that specifically focus on the relevance of the differentiation of objective and subjective socio-economic status for adolescent health, the majority of the empirical studies that observe effects of socio-economic status on adolescent health and that include a second aspect of socio-economic status as control variable found independent effects of objective and subjective aspects of socio-economic status (Chen & Paterson, 2006; Elgar, McKinnon et al., 2016; Goodman et al., 2007; Karvonen & Rahkonen, 2011; Quon & McGrath, 2014, 2015). The hypothesis is thus that the effects of objective and subjective socio-economic status on adolescent overweight and underweight in Luxembourg are distinct but similar.

To confirm this hypothesis, this chapter reports results for logistic regression models predicting overweight and underweight that include both objective and subjective aspects of socio-economic status. The variable relative family affluence measuring objective socio-economic status and the variable perceived family wealth measuring subjective socio-economic status are thus included in the same model. The effect of one variable measuring socio-economic status can thereby be analysed while the effect of the other variable measuring socio-economic status is held constant. The statistical significance of the coefficients, the odds ratios and the

changes in the explanatory power of the models are used to test for unique distinct effects of both aspects of socio-economic status.

Before proceeding with the analysis, the level of multicollinearity between the independent variables is determined through the correlation of the variables and through the variance inflation factor (VIF)[34]. The variables measuring objective and subjective socio-economic status (SES[35]) correlate at 0.3141 according to the Pearson's correlation coefficient. With 1 indicating perfect correlation, a correlation of 0.3141 does not indicate a problematic level of correlation with regards to multicollinearity. As Table 14 shows, the VIF for all the dependent variables in the models range from 1.12 to 1.00, with a mean of 1.06. In line with the correlation coefficient, this does not indicate high or problematic multicollinearity (Neter et al., 1989; O'brien, 2007). Even though the standard error will be enlarged due to multicollinearity, the level of multicollinearity is low enough to proceed with the analysis.

Table 14: Multicollinearity for Objective and Subjective SES

Variable	**Variance Inflation Factor (VIF)**
Relative Family Affluence	1.11
Perceived family wealth	1.12
Gender	1.00
Age	1.01
Mean VIF	1.06

Source: HBSC 2014, *n*=5,312, weighted

First, the model predicting overweight is analysed. The separate models including only one aspect of SES presented in the previous chapter indicate that overweight decreases with increasing objective as well as subjective SES. The results for the multiple logistic regression model for overweight including both objective and subjective SES are shown in Table 15. Even though both aspects of SES are included in the model, the negative statistical relations with overweight are both confirmed:

For the effect of objective SES on overweight, the model including both aspects of SES confirms the statistical significance of the negative coefficient of relative family affluence from the model including only objective SES at a p-value of 0.000. At 0.42 (CI-95: 0.32-0.57), the odds ratio is slightly less pronounced in the model including both aspects of SES than in the model including only objective SES (0.38; CI-95: 0.29-0.50). The comparison of the AIC and

[34] The variance inflation factor (VIF) is calculated for a linear regression model including all the variables in the logistic regression model.

[35] For a clearer presentation of the results, the abbreviation SES will be used instead of the full term socio-economic status for text passages reporting statistical results.

BIC is inconclusive, as the AIC is 4 points lower in the model including both aspects of SES in comparison to the model including only objective SES and the BIC is 3 points higher. The inclusion of subjective SES did not increase the explanatory power enough to compensate for the disadvantage of including a further variable.

Table 15: Overweight by Objective and Subjective SES - Coefficients, P-Value and Odds Ratio (95% Confidence Interval)

	Overweight		
	Coefficient	***p*-value**	**Odds ratio (95% CI)**
Model 'Objective SES'			
Relative Family Affluence (Objective SES)	-.9779191	0.000 ***	0.38 (0.29-0.50)
Gender (Results for female)	-.4339679	0.000 ***	0.65 (0.55-0.76)
Age	.0385402	0.050 *	1.04 (1.00-1.08)
LR chi2 (DF)[1)]	84.60 (3)	0.000 ***	
AIC[1)]/BIC [1)]	4324/4350		
Model 'Subjective SES'			
Perceived family wealth (Subjective SES)	-.2182548	0.000 ***	0.80 (0.73-0.88)
Gender (Results for female)	-.4486723	0.000 ***	0.64 (0.55-0.75)
Age	.0299255	0.130 ns	1.03 (0.99-1.07)
LR chi2 (DF)[1)]	56.14 (3)	0.000 ***	
AIC[1)]/BIC [1)]	4352/4379		
Model 'Objective & Subjective SES'			
Relative Family Affluence (Objective SES)	-.8577159	0.000 ***	0.42 (0.32-0.57)
Perceived family wealth (Subjective SES)	-.1282326	0.012 *	0.88 (0.80-0.97)
Gender (Results for female)	-.4446372	0.000 ***	0.64 (0.55-0.75)
Age	.0336389	0.90 ns	0.13 (0.99-1.08)
LR chi2 (DF)1)	90.49 (4)	0.000 ***	
AIC[1)] / BIC [1)]	4320 / 4353		

ns= $p>0.05$, *=$p<0.05$, **=$p<0.01$, ***=$p<0.001$

Source: HBSC 2014, n=5,312 weighted

1) AIC, BIC and LR chi2 computed for unweighted data

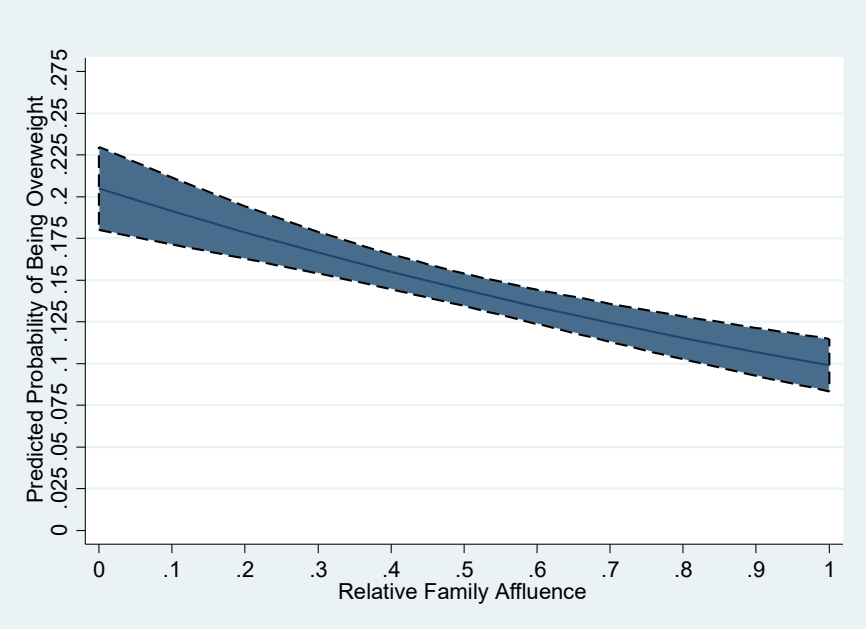
The results for subjective SES from the model including both aspects of SES confirm the negative relation with overweight that was found in the model including only subjective SES at a p-value of 0.012. The coefficient of perceived family wealth (objective SES) is, however, only significant at the highest cut-off level for statistical significance. As for objective SES, the odds ratio is slightly less pronounced in the model including both aspects of SES (0.88; CI-95: 0.80-0.97)) than in the model including only subjective SES (0.80; CI-95: 0.73-0.88). Both the AIC and BIC are lower for the model including both aspects of SES than the model including only

subjective SES. The AIC drops from 4352 to 4320 and the BIC drops from 4379 to 4353. The inclusion of objective SES increased the fit of the model predicting overweight in comparison to the model including only subjective SES.

The effects of both aspects of SES on overweight are statistically significant even if the other aspect is held constant and thereby controlled for by the model. Objective and subjective SES thus have a distinct effect on overweight.

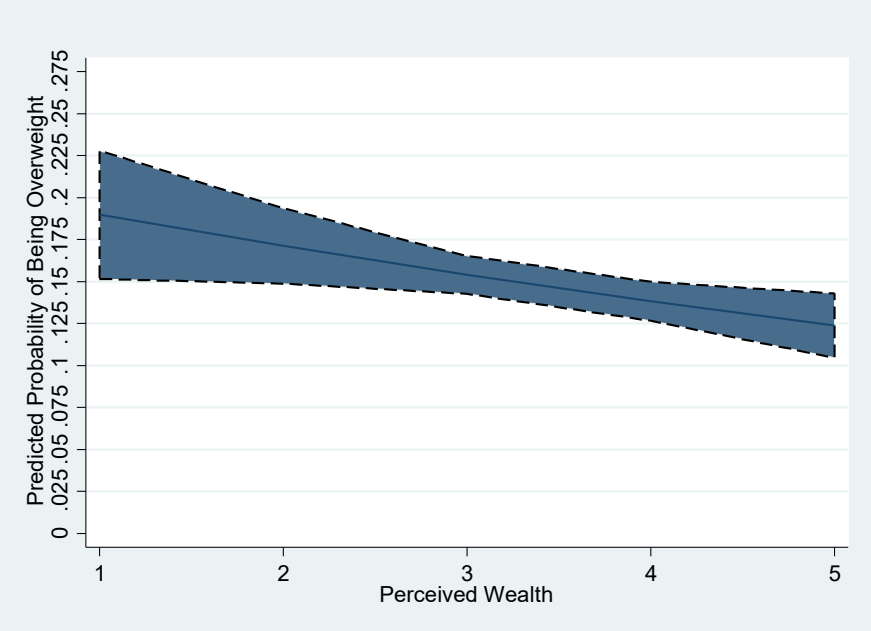
The comparison of the model fit and explanatory power of the models predicting overweight indicate that objective SES has more explanatory power in relation to overweight than subjective SES. This also apparent in the graphical representations of the probability of being overweight by objective SES (Figure 25) and by subjective SES (Figure 26) as predicted in a model including both aspects of SES and holding gender and age constant. While both figures depict significant effects, the slope representing the predicted probability of being overweight by the objective SES is steeper than the slope representing the predicted probability of being overweight by subjective SES. At the lowest possible relative family affluence (objective SES), the model calculates a 20.5% (CI-95: 18-23%) prevalence of overweight. At the highest possible relative family affluence, it calculates a prevalence of 9.9% (CI-95: 8.3-11.5%). The difference between the predicted prevalence of overweight at the lowest possible perceived family wealth (subjective SES) at 19% (CI-95: 15.2-22.8%) and the highest possible perceived family wealth at 12.4% (CI-95: 10.5-14.3%) is smaller and the calculated effect is less pronounced.

Figure 25: Predicted Probability of Overweight by Objective SES with 95% CI (Subjective SES held constant)



Source: HBSC-LU 2014, *n*=5,312, weighted; perceived wealth, gender and age held constant

Figure 26: Predicted Probability of Overweight by Subjective SES with 95% CI (Objective SES held constant)



Source: HBSC-LU 2014, *n*=5,312, weighted; relative family affluence, gender and age held constant

For underweight, the models including only one aspect of SES presented in the previous chapter indicate that the prevalence of underweight in adolescents decreases with increasing objective and subjective SES. The results for the model predicting underweight and including both objective and subjective SES confirm this positive statistical relationship for objective SES, but not for subjective SES (see Table 16):

Comparing the results for the effect of objective SES on underweight from the model including only objective SES and the model including both aspects of SES confirms the statistical significance of the positive coefficient of relative family affluence at a p-value of 0.000. The increase in the predicted probability of being underweight associated with an increase in objective SES is depicted in Figure 27. As for overweight, the odds ratio for objective SES is slightly less pronounced in the model including both aspects of SES (1.7; CI-95: 1.29-2.32) than in the model including only objective SES (1.87; CI-95: 1.42-2.47). The comparison of the AIC and BIC of both models is inconclusive as the AIC is 2 points lower for the model including both aspects of SES than for the model including only objective SES and the BIC is 4 points higher. The inclusion of the additional measure of SES did thus not increase the explanatory power enough to compensate for the loss in terms of parsimony caused by the inclusion of an additional variable.

Table 16: Underweight by Objective and Subjective SES - Coefficients, P-Value and Odds Ratio 95% Confidence Interval)

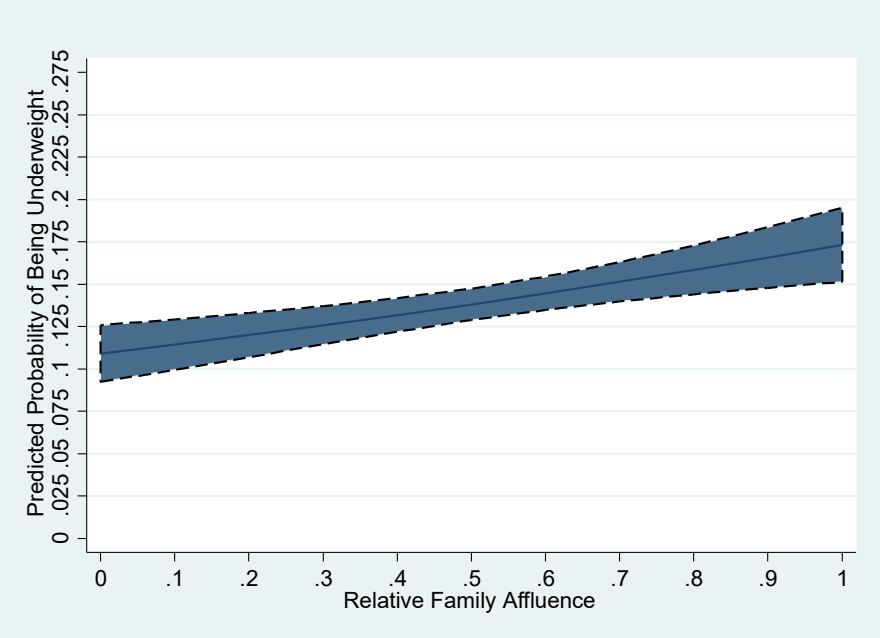
	Underweight		
	Coefficient	**p-value**	**Odds ratio (95% CI)**
Model 'Objective SES'			
Relative Family Affluence (Objective SES)	.6262373	0.000 ***	1.87 (1.42-2.47)
Gender (Results for female)	.6708483	0.000 ***	1.96 (1.66-2.30)
Age	-.1420995	0.000 ***	0.87 (0.83-0.90)
LR chi2 (DF)[1)]	137.67 (3)	0.000 ***	
AIC[1)]/BIC [1)]	4242/4269		
Model 'Subjective SES'			
Perceived family wealth (Subjective SES)	.1391531	0.005 **	1.15 (1.04-1.27)
Gender (Results for female)	.6793207	0.000 ***	1.97 (1.67-2.32)
Age	-.1362298	0.000 ***	0.87 (0.84-0.91)
LR chi2 (DF)[1)]	128.64 (3)	0.000 ***	
AIC[1)]/BIC [1)]	4251/4278		
Model 'Objective & Subjective SES'			
Relative Family Affluence (Objective SES)	.5498253	0.000 ***	1.73 (1.29-2.32)
Perceived family wealth (Subjective SES)	.0818933	0.114 ns	1.09 (0.98-1.20)
Gender (Results for female)	.6759589	0.000 ***	1.97 (1.67-2.32)
Age	-.1390047	0.000 ***	0.87 (0.83-0.91)
LR chi2 (DF)[1)]	141.72 (4)	0.000 ***	
AIC[1)] / BIC [1)]	4240 / 4273		

ns= $p>0.05$, *=$p<0.05$, **=$p<0.01$, ***=$p<0.001$

Source: HBSC 2014, n=5,312 weighted

1) AIC, BIC and LR chi2 computed for unweighted data

Figure 27: Predicted Probability of Underweight by Objective SES with 95% CI (subjective SES held constant)



Source: HBSC-LU 2014, *n*=5,312, weighted, perceived wealth, gender and age held constant

On the other hand, the positive statistical relation between subjective SES and underweight revealed by the separate models presented in the previous chapter is not confirmed in the model including both aspects of SES. With a p-value of 0.114, the coefficient of perceived family wealth is not statistically significant in the model including both aspects of SES. While a distinct relation between subjective SES and underweight was not confirmed in the 2014 HBSC data, these results do not exclude the existence or confirm the absence of a unique relationship between subjective SES and underweight in the population. The odds ratio for objective SES are less pronounced when subjective SES is included in the model and the confidence interval of subjective SES only includes zero by a small margin. This suggest that there might be a unique but small effect of subjective SES on underweight in the population, which is not statistically significant in the model including both aspects of SES due to the increase of the standard error caused by the mild multicollinearity.

The results for underweight from the model including both aspects of SES thus confirm a positive and distinct statistical relationship between objective SES and underweight. The existence of a unique effect of subjective SES on underweight is neither confirmed nor disconfirmed in the HBSC data.

In summary, distinct effects of objective and subjective socio-economic status on overweight are confirmed by statistically significant coefficients un models including both aspects of socio-economic status. Both aspects of socio-economic status influence overweight in the same direction. A distinct effect on underweight is only confirmed as statistically significant for objective socio-economic status, while a distinct effect of subjective socio-economic status on underweight is neither confirmed nor excluded by the results. The comparisons of the explanatory power of the different models and the graphical representations of the predicted probabilities of being overweight or underweight by socio-economic status indicate a smaller effect size for subjective socio-economic status than for objective socio-economic status for both overweight and underweight.

10 Opposite effects of objective and subjective socio-economic status on weight-related health concerns

After confirming a distinct effect of objective and subjective socio-economic status on overweight and a distinct effect of objective socio-economic status on underweight, the focus of the next step in the analysis moves from overweight and underweight to weight-related health concerns, namely negative body image and weight reduction behaviour. Since the importance, strength and direction of the influence of socio-economic status on adolescent health varies according to the observed health phenomena (see chapter 3), it is important to consider additional aspects of health to explore the effects of socio-economic status on adolescents' health. In addition to weight status as weight-related physical health outcome, body image and weight reduction behaviour are taken into account as examples of psychological health outcomes and health behaviours. The description of the prevalence of negative body image and weight reduction behaviour in chapter 7 confirmed a substantial prevalence of both weight-related health concerns and confirmed their relevance as health phenomena. The relations analysed in this chapter are thus the effects of socio-economic status on weight-related health concerns and the potential interrelations between these effects and the effects of socio-economic status on overweight and underweight. In reference to the fourth research question, this chapter therefore seeks to establish whether objective and subjective socio-economic status are linked to weight-related health concerns and whether it is possible to find indications for effects of socio-economic status on these weight-related health risks that are mediated by weight status.

In this chapter the effect of objective and subjective socio-economic status on body image and weight reduction behaviour will be explored. The association of body image and weight reduction behaviour with overweight and underweight is also analysed. The effects of socio-economic status on body image and weight reduction behaviour, if the effects of overweight and underweight are accounted for in the model, are also calculated These results give indications of indirect effects of objective and subjective socio-economic status on weight-related health risks that are mediated through underweight or overweight. Differences and similarities between the effects of objective and subjective socio-economic status are of specific interest as they provide an indication of the relevance of the differentiation of these aspects of socio-economic status for the understanding of inequalities in adolescent health in

affluent contexts beyond overweight and underweight. The analyses are explorative as the available previous empirical results are not sufficient to reach conclusions on the expected results or to formulate a specific hypothesis.

To explore the differences in statistical significance, the direction and explanatory power in the logistic regression models are calculated for the relations of objective and subjective socio-economic status with body image and weight reduction behaviour. As in all previous analyses, objective SES is measured by relative family affluence and subjective SES is measured by perceived wealth. The p-values and odds ratio of the effects of objective and subjective socio-economic status on negative body image and weight reduction behaviour are reported. In a second step, overweight and underweight are included in the models to control for the effect of socio-economic status on overweight and underweight. To compare and evaluate the fits of the models measured by the AIC and BIC, the same procedure as applied for the hierarchical logistic regression for overweight and underweight is used. For each dependent variable, the explanatory power is calculated for the 'basic' model, which includes gender and age, but does not including any measures of SES. This serves as comparative baseline for the model fits of the models including the different aspects and combinations of socio-economic status. For each dependent variable, the models including objective and subjective socio-economic status are checked for multicollinearity before proceeding with the analysis.

10.1 Effects of socio-economic status on negative body image

To begin, the effects of objective and subjective socio-economic status (SES)[36]on body image are analysed in models including one as well as both aspects of SES. For the exploration of health inequalities, the distribution of negative body image is of particular interest and is specifically focused on in this thesis. Negative body image is analysed separately, depending on whether the adolescents they think their body is too thin (negative thin body image) or whether they think their body is too fat (negative fat body image). The effects of objective and subjective SES on negative body image are also explored in models including underweight for negative thin body image and overweight for negative fat body image.

[36] For a clearer presentation of the results, the abbreviation SES will be used instead of the full term socio-economic status for the text passages reporting statistical results.

All models including negative body image were checked for multicollinearity using the variance inflation factor (VIF) and have very similar scores. With VIFs for objective and subjective SES between 1.11 and 1.12 and mean VIFs for the overall models between 1.05 and 1.06 (see Table 34 in the appendix), multicollinearity is mild and does not contraindicate the analysis. The standard errors are, however, enlarged in the models including both aspects of SES.

The results of the models calculating the risk of adolescents thinking that their body is too thin (negative thin body image) and the effects of objective and subjective SES on it are presented in Table 17.

The analysis reveals a statistically significant relation between negative thin body image and being underweight. The odds of adolescents who are underweight to think that their body is too thin are 8.18 (CI-95: 6.75-9.91) times as high as those of adolescents who are not underweight. The basic models with gender and age but without SES reveal an interesting relation between negative thin body image and gender and age. Whether they are underweight or not, girls have a lower risk of thinking that their body is too thin than boys. If the effect of being underweight and age are held constant in the model, the odds of girls having a negative thin body image is 0.46 (CI-95: 0.38-0.55) times that of boys. No relation emerges between the risk of having a negative thin body image and age in the model excluding underweight. If underweight is included in the model and its effect held constant, a positive statistical relation is revealed between the risk of having a negative thin body image and age (p-value = 0.038). It thus seems that body perception becomes more negative with increasing age and that older adolescents are more likely to think that their body is too thin even if they are not underweight.

As far as the influence of objective and subjective SES on the risk of thinking that one's body is too thin is concerned, the models excluding underweight show no statistically significant effect of objective or subjective SES on negative thin body image. With the AIC increasing 2 to 3 points and the BIC increasing 8 to 16 points, the comparisons of the model fits also indicate that objective and subjective SES do not add explanatory power to the models excluding underweight (see Table 17).

Table 17: Negative Thin Body Image by Objective and Subjective SES

	Negative thin body image			**Negative thin body image // Underweight**		
	Coefficient	**p-value**	**Odds ratio (95% CI)**	**Coefficient**	**p-value**	**Odds ratio (95% CI)**
Basic Model 'Without SES'						
Being Underweight				2.101504	0.000 ***	8.18 (6.75-9.91)
Gender (Results for female)	-.4622909	0.000 ***	0.63 (0.54-0.74)	-.7798661	0.000 ***	0.46 (0.38-0.55)
Age	-.008007	0.696 ns	0.99 (0.95-1.03)	.0457117	0.038 *	1.05 (1.00-1.09)
LR chi2 (DF)[1)]	29.04 (2)	0.000 ***		498.25 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4221/4241			3741/3767		
Model 'Objective SES'						
Relative Family Affluence (Objective SES)	-.0934116	0.506 ns	0.91 (0.69-1.20)	-.3415977	0.024*	0.71 (0.53-0.95)
Being Underweight				2.12141	0.000 ***	8.34 (6.87-10.13)
Gender (Results for female)	-.4620401	0.000 ***	0.63 (0.54-0.74)	-.7809305	0.000 ***	0.46 (0.38-0.55)
Age	-.007978	0.697 ns	0.99 (0.95-1.03)	.0453413	0.040 *	1.05 (1.00-1.09)
LR chi2 (DF)[1)]	29.53(3)	0.000 ***		503.84 (4)	0.000 ***	
AIC[1)] / BIC [1)]	4223/4249			3738/3770		
Model 'Subjective SES'						
Perceived Wealth (Subjective SES)	-.0411816	0.391 ns	0.96 (0.87-1.05)	-.0956765	0.060 ns	0.91 (0.82-1.00)
Being Underweight				2.111284	0.000 ***	8.26 (6.81-10.02)
Gender (Results for female)	-.4649333	0.000 ***	0.63 (0.53-0.74)	-.7848552	0.000 ***	0.46 (0.38-0.54)
Age	-.0094947	0.645 ns	0.99 (0.95-1.03)	.0417705	0.060 ns	1.04 (1.00-1.09)
LR chi2 (DF)[1)]	29.82 (3)	0.000 ***		502.38 (4)		
AIC[1)] / BIC [1)]	4223/4249			3739/3772		
Model 'Objective & Subjective SES'						
Relative Family Affluence (Objective SES)	-.061167	0.684 ns	0.94 (0.70-1.26)	-.2798183	0.081 ns	0.76 (0.55-1.04)
Perceived Wealth (Subjective SES)	-.0347536	0.498 ns	0.97 (0.87-1.07)	-.0667505	0.216 ns	0.94 (0.84-1.04)
Being Underweight				2.124695	0.000 ***	8.37 (6.89-10.16)
Gender (Results for female)	-.4643731	0.000 ***	0.63 (0.54-0.74)	-.7843681	0.000 ***	0.46 (0.38-0.54)
Age	-.0092484	0.654 ns	0.99 (0.95-1.03)	.0426252	0.056 ns	1.04 (1.00-1.09)
LR chi2 (DF)[1)]	30.02 (4)	0.000 ***		505.72 (5)		
AIC[1)] / BIC [1)]	4224/4257			3738/3777		

ns= p>0.05, *=p<0.05, **=p<0.01, ***=p<0.001

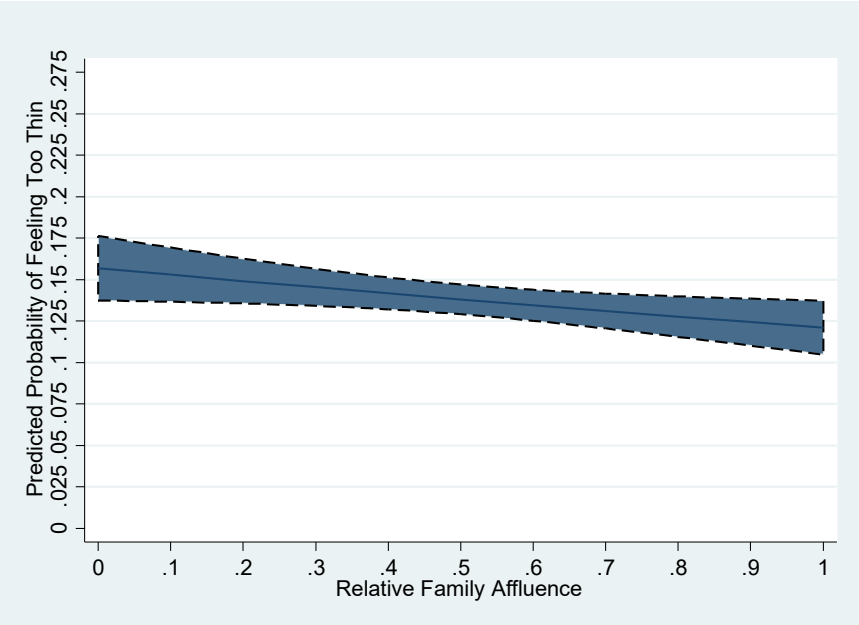
Source: HBSC 2014, *n*= 5,273 weighted / *n*=5,266 weighted, //=held constant

1) AIC, BIC and LR chi2 computed for unweighted data

There is, however, a statistically significant (p-value=0.024) negative effect of objective SES on negative thin body image in the model including underweight, objective SES, gender and age. Irrespective of whether the adolescents are underweight or not, their risk of thinking that their body is too thin thus seems to decrease with increasing objective SES. In this model, the odds of thinking that their body is too thin for adolescents with the highest relative family affluence is 0.91 (CI-95: 0.82-1.00) times that of adolescents with the lowest relative family affluence. This can be seen as an indication that the decrease in the risk of adolescents to think that their body is too thin which is associated with an increase in objective SES, is masked in the model excluding underweight because the increase in the risk of being underweight that is associated with increasing objective SES is not controlled for. The comparison of fit of the models is however is inconclusive. The inclusion of objective SES does not increase the explanatory power enough to compensate for the penalty in terms of parsimony. The relation between objective SES and negative thin body image is no longer statistically significant when subjective SES is added to the model. The inconclusive comparison of the model fit indicates that the effect of objective SES on negative thin body image is of small effect size and is no longer statistically significant in the model including subjective SES due to multicollinearity.

Figure 28 shows the predicted probabilities of having a negative thin body image by objective SES when underweight, gender and age are held constant. For youth with the lowest relative family affluence, the predicted probability of thinking that their body is too thin is 15.7% (CI-95: 13.7–17.6%). At the other end of the slope, the predicted probability of thinking that their body is too thin is 12.1% (CI-95: 10.4-13.7%) for adolescents with the highest perceived wealth.

Figure 28: Predicted Probability of Negative Thin Body Image by Objective SES with 95% CI (underweight held constant)



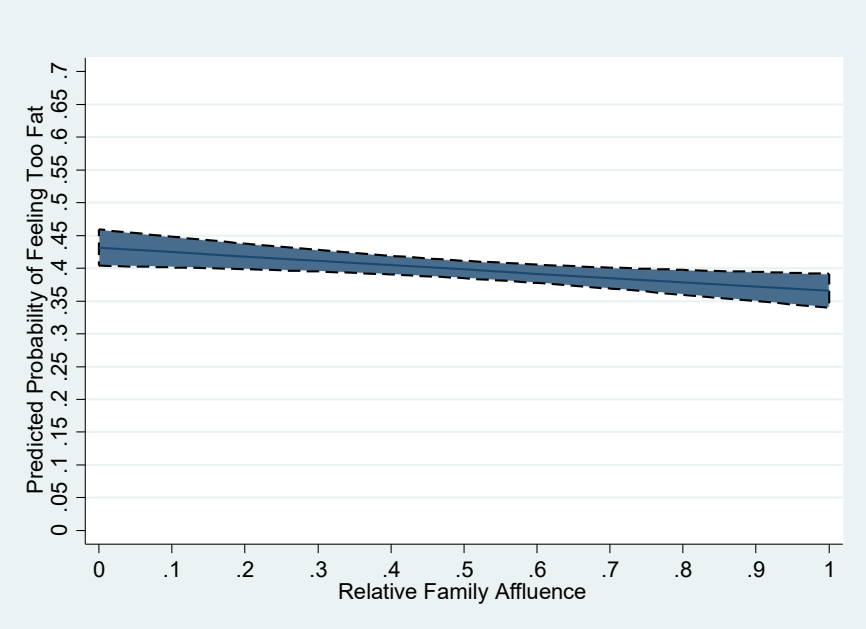
Source: HBSC-LU 2014, *n*=5,266, weighted, underweight, gender and age held constant

The relation between subjective SES and negative thin body image is not statistically significant in any model. Similar to previous results, this non-significance does not exclude the existence or confirm the absence of a relationship in the population.

In summary, a statistically significant negative relation between objective SES and negative thin body image is observed when the effect of being underweight is held constant in the model. This can be seen as an indication that the risk of adolescents thinking that their body is too thin decreases with increasing objective SES, while the risk of being underweight that increases with objective SES mediates an indirect increasing effect of objective SES on negative thin body image

Having a negative body image is, however, not limited to thinking that one's body is too thin; some adolescents are unsatisfied and think that their body is too fat. The results for the calculation of the different models including negative fat body image are presented in Table 18. The basic models not including SES reveal that overweight, gender and age are statistically significantly related to negative fat body image (with p-values of 0.002 or lower). Being female, older and overweight increase the risks of adolescents to think that their body is too fat. Being overweight has a strong effect on the risk of having a negative fat body image. For overweight adolescents, the odds of thinking that their body is too fat are 15.14 times the odds of adolescents who are not overweight.

Figure 29: Predicted Probability of Negative Fat Body Image by Objective SES with 95% CI



Source: HBSC-LU 2014, *n*=5,273, weighted, gender and age held constant

Investigating the relation between objective SES and negative fat body image, the model including only objective SES shows a statistically significant negative relation (see Table 18

and Figure 29). This relation is, however, not confirmed when subjective SES is included in the model. As the statistical significance and the odds ratio of the coefficient of subjective SES do not change when objective SES is included into the model and held constant, the non-significance of the objective SES in the model including both aspects of SES does not seem to be linked to multicollinearity. When overweight is included in the models and held constant, the coefficients of objective SES are also not statistically significant, and the standard errors are very large. The changes in the model fit that can be attributed to the inclusion of objective SES into the models only shows an increase in the explanatory power for the inclusion of objective SES to the 'basic' model. For the comparison of the model fits for the other three models including objective SES to the models not including objective SES, the AIC and BIC increase which indicates a decrease of explanatory power of the models through the inclusion of objective SES. Overall, the changes in the model fit indicate that objective SES does not add explanatory power to the model predicting negative fat body image.

Together with the negative statistical relation between overweight and objective SES and the positive statistical relation between overweight and negative body image that have been confirmed earlier in this thesis, the results in Table 18 indicate that the statistically significant effect of objective SES on negative fat body image in the model including only objective SES is not a direct effect, but only an effect mediated through overweight. Since the risk of being overweight decreases with increasing objective SES and the risk of having a negative fat body image is lower for adolescents that are not overweight, it is probable that the decrease in the risk of having a negative fat body image with increasing objective SES, indicated in the model including only objective SES, is due to the relation between objective SES and overweight.

For the relation between subjective SES and negative fat body image, the results are very clear. The negative coefficient of subjective SES is statistically significant (p-value = 0.000) in all models, regardless of whether objective SES, overweight, gender or age are held constant. The decrease in the risk of having a negative fat body image associated with an increase in subjective SES is independent of the effect of objective SES, overweight, gender and age. The odds ratio for subjective SES are very similar in all models and range from 0.84 (CI-95: 0.78-0.89) to 0.86 (CI-95: 0.80-0.93). The odds of having a negative fat body image of adolescents with a 1-unit higher perceived wealth are 0.84 to 0.86 times those of adolescents with a 1-unit lower perceived wealth.

The comparison of the model fit based on the AIC and BIC shows an increase of the model fit for all the models when subjective SES is added to them. When subjective SES is added to the models, the AIC drops between 17 and 31 points and the BIC drops between 11 and 24 points. Subjective SES thus adds explanatory power to all the models predicting negative fat body image.

Table 18: Negative Fat Body Image by Objective and Subjective SES

	Negative Body Image (fat)			Negative Body Image (fat) // Overweight		
	Coefficient	**p-value**	**Odds ratio (95% CI)**	**Coefficient**	**p-value**	**Odds ratio (95% CI)**
Basic Model 'Without SES'						
Being Overweight				2.717459	0.000 ***	15.14 (12.22-18.77)
Gender (Results for female)	.6628346	.000 ***	1.94 (1.73-2.18)	.9536915	0.000 ***	2.60 (2.28-2.95)
Age	.0545774	.000 ***	1.06 (1.03-1.09)	.0510098	0.002 **	1.05 (1.02-1.09)
LR chi2 (DF)[1)]	148.14 (2)	.000 ***		1010.91 (3)	0.000 ***	
AIC[1)] / BIC [1)]	6929/6948			6059/6085		
Model 'Objective SES'						
Relative Family Affluence (Objective SES)	-.2828234	0.006 **	.75 (0.62-0.92)	.006749	0.952 ns	1.01 (0.81-1.25)
Being Overweight				2.717989	0.000 ***	15.15 (12.22-18.79)
Gender (Results for female)	.6647171	0.000 ***	.94 (1.73-2.18)	.9536914	0.000 ***	2.60 (2.28-295)
Age	.0547552	0.000 ***	.06 (1.03-1.09)	.0510068	0.002 **	1.05 (1.02-1.09)
LR chi2 (DF)[1)]	155.12 (3)	0.000 ***		1010.95 (4)	0.000 ***	
AIC[1)] / BIC [1)]	6924/6950			6061/6094		
Model 'Subjective SES'						
Perceived Wealth (Subjective SES)	-.1852838	0.000 ***	.83 (0.78-0.89)	-.14764	0.000 ***	0.86 (0.80-0.93)
Being Overweight				2.705812	0.000 ***	14.97 (12.07-18.56)
Gender (Results for female)	.6549499	0.000 ***	.92 (1.72-2.16)	.9475264	0.000 ***	2.58 (2.27-2.94)
Age	.0480015	0.001 **	.05 (1.02-1.08)	.0455717	0.005 ***	1.05 (1.01-1.08)
LR chi2 (DF)[1)]	180.59 (3)			1029.77 (4)	0.000 ***	
AIC[1)] / BIC [1)]	6898/6924			6042/6074		
Model 'Objective & Subjective SES'						
Relative Family Affluence (Objective SES)	-.12065	0.265 ns	.89 (0.72-1.10)	.1644564	0.167 ns	1.18 (0.93-1.49)
Perceived Wealth (Subjective SES)	-.1724132	0.000 ***	.84 (0.78-0.90)	-.1654869	0.000 ***	0.85 (0.78-0.92)
Being Overweight				2.717655	0.000 ***	15.14 (12.21-18.79)
Gender (Results for female)	.6562689	0.000 ***	.93 (1.72-2.16)	.9468567	0.000 ***	2.58 (2.26-2.93)
Age	.0485277	0.001 **	.05 (1.02-1.08)	.0448734	0.006 **	1.05 (1.01-1.08)
LR chi2 (DF)[1)]	181.38 (4)			1032.52 (5)	0.000 ***	
AIC[1)] / BIC [1)]	6899/6932			6041/6081		

ns= p>0.05, *=p<0.05, **=p<0.01, ***=p<0.001

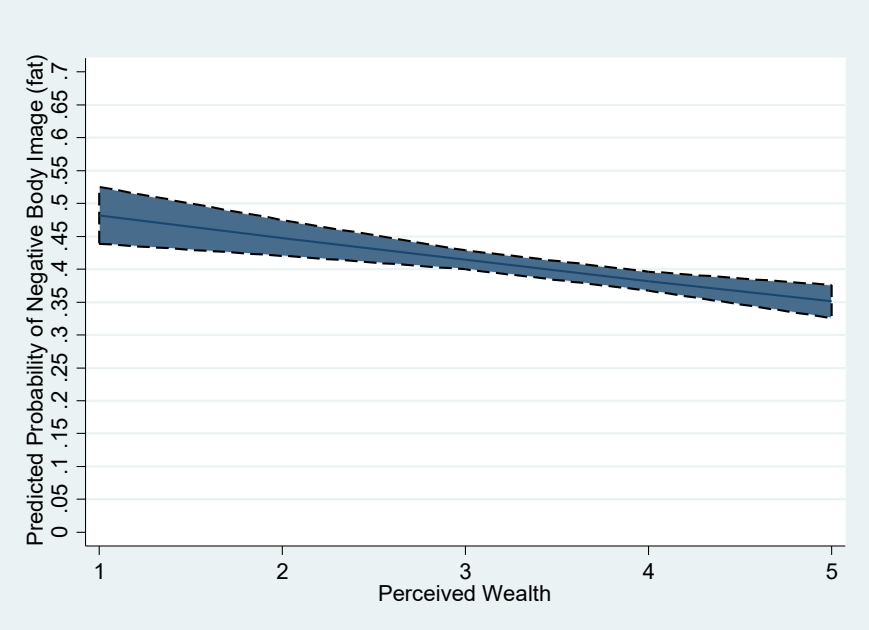
Source: HBSC 2014, *n*=5,273 weighted / *n*=5,266 weighted, //=held constant

1) AIC, BIC and LR chi2 computed for unweighted data

Figure 30 shows the predicted probabilities of negative fat body image by subjective SES when objective SES, overweight, gender and age are held constant. For youth with the lowest perceived wealth and with all other variables held constant, the predicted probability of thinking that their body is too fat is 48.2% (CI-95: 43.90-52.5%). In contrast, the predicted probability of thinking that their body is too fat is 35.1% (CI-95 32.6-37.6) for adolescents with the highest perceived wealth.

In summary, the risk of having a negative fat body image decreases with increasing subjective SES. This negative statistical relation is observed in all the models and is independent of objective SES, overweight, age and gender. For objective SES, there does not seem to be a direct relation with negative body image (fat). The relation that was observed in one model seems to be due to an effect of objective SES mediated through overweight.

Figure 30: Predicted Probability of Negative Fat Body Image by Subjective SES with 95% CI (Objective SES and Overweight held constant)



Source: HBSC-LU 2014, *n*=5,266, weighted, objective SES, overweight, gender and age held constant

10.2 Effects of socio-economic status on weight reduction behaviour

Weight reduction behaviour is a behavioural aspect of weight-related health. Adolescents who report that they are presently on a diet or doing something else to lose weight are considered to be engaging in weight reduction behaviour. The relation between objective and subjective SES and the risk of engaging in weight reduction behaviour is analysed in this section both

with and without holding the effects of overweight and negative body image constant in the models.

Before proceeding with the analysis, the models predicting weight reduction behaviour were checked for multicollinearity. With VIFs for objective and subjective SES between 1.11 and 1.13 and mean VIFs for the overall models at 1.06, multicollinearity is mild for these models and does not contraindicate the analysis (see Table 35 in the appendix). As is the case for the dependent variables analysed previously, even mild collinearity increases the standard errors in the models that include both aspects of SES.

The basic models without SES show the relation of age and gender with weight reduction behaviour (see Table 19 and Table 20). In all basic models, age is positively related to weight reduction behaviour, with p-values between 0.000 and 0.002. The likelihood of engaging in weight reduction behaviour increases with increasing age. For gender, on the other hand, the statistically significantly higher risk of girls engaging in weight reduction behaviour, which is observed in the basic model and the model including overweight, is not confirmed in the models including negative fat body image. The effect of gender on weight reduction behaviour seems to be partially mediated through negative fat body image, since the risk of having a negative fat body image is higher for girls and having a negative fat body image increases the likelihood of engaging in weight reduction behaviour. When this process is accounted for, the independent effect of gender on weight reduction behaviour might be too small to be statistically confirmed in the HBSC data.

Both being overweight and having a negative fat body image are identified as important predictors of weight reduction behaviour (see Table 20). When they are added to the basic models without SES, their positive coefficients are statistically significant at a p-value of 0.000 and the model fit improves. For adolescents who are overweight, the odds of engaging in weight reduction behaviour are 3.51 (CI-95: 2.96-4.17) times those of adolescents who are not overweight. For adolescents who think that their body is too fat, the odds of engaging in weight reduction behaviour are 7.64 (CI-95: 6.48-9.01) times those of adolescents who do not think that their body is too fat. The relation between weight reduction behaviour and objective and subjective SES is calculated in models holding overweight and negative fat body image constant. The lower AIC and BIC found for the model including negative body image compared to the model including overweight indicates that negative body image adds more explanatory power to the model and that it is a stronger predictor of weight reduction behaviour in adolescents than overweight.

The relations between objective and subjective SES and weight reduction behaviour as presented in Table 19 are not statistically significant in the models including gender and age.

The AIC and BIC increase, and the model fit thus does not increase enough to compensate for the additional variables. As noted before, the non-significance of the coefficients does not confirm the absence of a relation. The results from the additional models provide some indications of possible reasons for the statistically non-significant results of the first models.

Table 19: Weight Reduction Behaviour by Objective and Subjective SES

	Weight reduction behaviour		
	Coefficient	**p-value**	**Odds ratio (95% CI)**
Basic Model 'Without SES'			
Gender (Results for female)	.4477957	0.000 ***	1.56 (1.36-1.80)
Age	.0792351	0.000 ***	1.08 (1.04-1.12)
LR chi2 (DF)[1)]	59.01 (2)	0.000 ***	
AIC[1)] / BIC [1)]	5195/5214		
Model 'Objective SES'			
Relative Family Affluence (Objective SES)	.1212789	0.337 ns	1.13 (0.88-1.45)
Gender (Results for female)	.447617	0.000 ***	1.56 (1.36-1.80)
Age	.0792106	0.000 ***	1.08 (1.04-1.12)
LR chi2 (DF)[1)]	59.91 (3)	0.000 ***	
AIC[1)] / BIC [1)]	5195/5222		
Model 'Subjective SES'			
Perceived Wealth (Subjective SES)	.0013725	0.974 ns	1.00 (0.92-1.09)
Gender (Results for female)	.447888	0.000 ***	1.57 (1.36-1.80)
Age	.0792864	0.000 ***	1.08 (1.04-1.22)
LR chi2 (DF)[1)]	59.02 (3)	0.000 ***	
AIC[1)] / BIC [1)]	5196/5223		
Model 'Objective & Subjective SES'			
Relative Family Affluence (Objective SES)	.1337711	0.315 ns	1.14 (0.88-1.48)
Perceived Wealth (Subjective SES)	-.0130458	0.770 ns	0.99 (0.90-1.08)
Gender (Results for female)	.4467318	0.000 ***	1.56 (1.36-1.80)
Age	.0787236	0.000 ***	1.08 (1.04-1.12)
LR chi2 (DF)[1)]	60.06 (4)	0.000 ***	
AIC[1)] / BIC [1)]	5197/5230		

ns= p>0.05, *=p<0.05, **=p<0.01, ***=p<0.001

Source: HBSC 2014, *n*=5,272 weighted

1) AIC, BIC and LR chi2 computed for unweighted data

Table 20: Weight Reduction Behaviour by Objective and Subjective SES (Overweight and Negative Fat Body Image held constant)

	Weight reduction behaviour // Overweight			**Weight reduction behaviour // Negative fat body image**		
	Coefficient	**p-value**	**Odds ratio (95% CI)**	**Coefficient**	**p-value**	**Odds ratio (95% CI)**
Basic Model 'Without SES'						
Being Overweight	1.256848	0.000 ***	3.51 (2.96-4.17)			
Negative body image (fat)				2.033205	0.000 ***	7.64 (6.48-9.01)
Gender (Results for female)	.5563284	0.000 ***	1.74 (1.51-2.02)	.1447719	0.065 ns	1.16 (0.99-1.35)
Age	.0761495	0.000 ***	1.08 (1.04-1.12)	.0639937	0.001 **	1.07 (1.02-1.11)
LR chi2 (DF)[1)]	265.62 (3)	0.000 ***		793.29(3)		
AIC[1)] / BIC [1)]	4978/5004			4425/4452		
Model 'Objective SES'						
Relative Family Affluence (Objective SES)	.3314933	0.011 *	1.39 (1.08-1.80)	.2726087	0.043 *	1.31 (1.01-1.71)
Being Overweight	1.284947	0.000 ***	3.61 (3.04-4.30)			
Negative Body Image (fat)				2.041457	0.000 ***	7.70 (6.53-9.08)
Gender (Results for female)	.5585765	0.000 ***	1.75 (1.51-2.02)	.1416575	0.07 ns	1.15 (0.99-1.34)
Age	.0755989	0.000 ***	1.08 (1.04-1.12)	.0632196	0.002 **	1.07 (1.02-1.11)
LR chi2 (DF)[1)]	272.30 (4)	0.000 ***		797.05 (4)	0.000 ***	
AIC[1)] / BIC [1)]	4973/5006			4424/4456		
Model 'Subjective SES'						
Perceived Wealth (Subjective SES)	.0500517	0.241 ns	1.05 (0.97-1.14)	.0969351	0.030 *	1.10 (1.01-1.20)
Being Overweight	1.265399	0.000 ***	3.54 (2.98-4.21)			
Negative Body image (fat)				2.04818	0.000 ***	7.75 (6.57-9.15)
Gender (Results for female)	.5608943	0.000 ***	1.75 (1.51-2.03)	.148005	0.060 ns	1.16 (0.99-1.35)
Age	.0779084	0.000 ***	1.08 (1.04-1.12)	.0670087	0.001 **	1.07 (1.03-1.11)
LR chi2 (DF)[1)]	266.72 (4)	0.000 ***		798.25 (4)	0.000 ***	
AIC[1)] / BIC [1)]	4979/5012			4422/4455		
Model 'Objective & Subjective SES'						
Relative Family Affluence	.3152186	0.021 *	1.37 (1.05-1.79)	.2004721	0.157 ns	1.22 (0.93-1.61)
Perceived Wealth	.0172772	0.702 ns	1.02 (0.93-1.11)	.0760074	0.107 ns	1.08 (0.98-1.18)
Being Overweight	1.286529	0.000 ***	3.62 (3.04-4.30)			
Negative Body Image (fat)				2.051016	0.000 ***	7.78 (6.59-9.18)
Gender (Results for female)	.5600099	0.000 ***	1.75 (1.51-2.03)	.1449467	0.065 ns	1.16 (0.99-1.35)
Age	.0762189	0.000 ***	1.08 (1.04-1.12)	.0657628	0.001 **	1.07 (1.03-1.11)
LR chi2 (DF)[1)]	272.37 (5)	0.000 ***		799.95 (5)	0.000 ***	
AIC[1)] / BIC [1)]	4975/5015			4423/4462		

ns= p>0.05, *=p<0.05, **=p<0.01, ***=p<0.001

Source: HBSC 2014, *n*=5,265 weighted / *n*=5,277 weighted, //=held constant

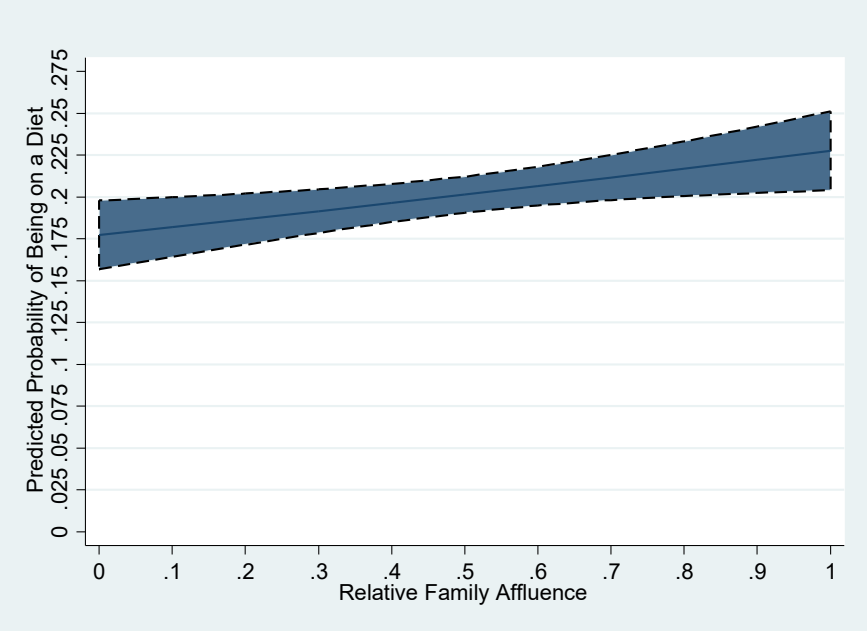
1) AIC, BIC and LR chi2 computed for unweighted data

The results for the models including overweight do not show a statistically significant relation between weight reduction behaviour and subjective SES (see Table 20). The coefficients of subjective SES are not statistically significant neither in the model with nor without objective SES. Adding subjective SES to the basic model results in an increase in AIC and BIC, thereby indicating a worse model fit because the gain in explanatory power is not high enough to warrant the addition of the variable.

For objective SES on the contrary, the coefficient is statistically significant at a p-value of 0.011 in the model without subjective SES (see Table 20). The likelihood of engaging in weight reduction behaviour increases with increasing objective SES when the effect of overweight is held constant. The odds of engaging in weight reduction behaviour for adolescents with the highest relative family affluence are 1.39 (CI-95: 1.08-1.80) times those for adolescents with the lowest relative family affluence. The comparison of the model fit is not conclusive, with the AIC dropping from 4978 to 4973, but the BIC increasing from 5004 to 5006. Figure 31 shows the increase in predicted probabilities of weight reduction behaviour that is attributed to objective SES when overweight, gender and age are held constant in the model. The calculated probability of engaging in weight reduction behaviour in this model is 17.7% (CI-95: 15.7-19.8%) for adolescents with the lowest relative family affluence and 22.8% (CI-95: 20.4-25.1%) for adolescents with the highest relative family affluence.

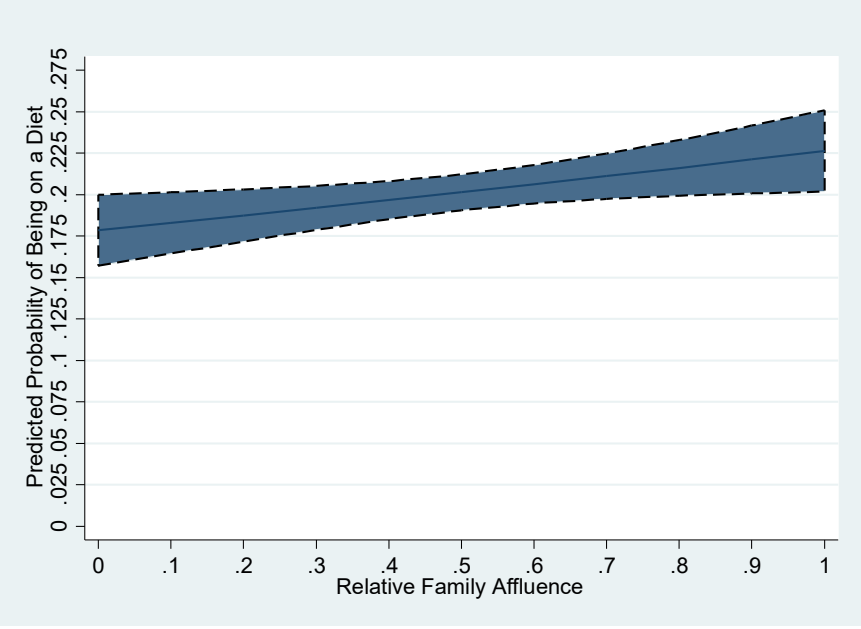
When overweight is held constant, the effect of objective SES on weight reduction behaviour does not change when subjective SES is added to the model. With a statistically significant p-value of 0.021 and an odds ratio of 1.37 (CI-95: 1.05-1.79), the results for relative family affluence are very similar to those from the model that does not include subjective SES. The increase in predicted probabilities for weight reduction behaviour attributed to increasing objective SES in this model (as shown in Figure 32) is nearly identical to the one in the model without subjective SES (see Figure 31).

Figure 31: Predicted Probability of Weight Reduction Behaviour by Objective SES with 95% CI (Overweight held constant)



Source: HBSC-LU 2014, *n*=5,265, weighted, overweight, gender and age held constant

Figure 32: Predicted Probability of Weight Reduction Behaviour by Objective SES with 95% CI (Overweight and Subjective SES held constant)



Source: HBSC-LU 2014, *n*=5,265, weighted, subjective SES, overweight, gender and age held constant

These results for the models including overweight are an indication that there might be an indirect negative statistical effect of objective SES on weight reduction behaviour that is mediated by overweight and that masks the positive direct statistical relation between weight

reduction behaviour and objective SES in the model excluding overweight. The direct relation between objective SES and weight reduction behaviour associates an increase in objective SES with an increase in risk of engaging in weight reduction behaviour. At the same time, an indirect mediated relation of objective SES on weight reduction behaviour through overweight associates an increase of objective SES with a decrease in overweight and a subsequent decrease in weight reduction behaviour. Holding overweight constant in the model controls for the negative, indirect effect of objective SES onto weight reduction behaviour and enables the model to detect the positive, direct relation between objective SES and weight reduction behaviour.

In a next step, the effect of having a negative fat body image is controlled for in the model predicting weight reduction behaviour. The results presented in Table 20 reveal further indications for conflicting direct and mediated relations between weight reduction behaviour and SES. When negative fat body image is held constant in the model, both objective and subjective SES have statistically significant, positive statistical associations with weight reduction behaviour.

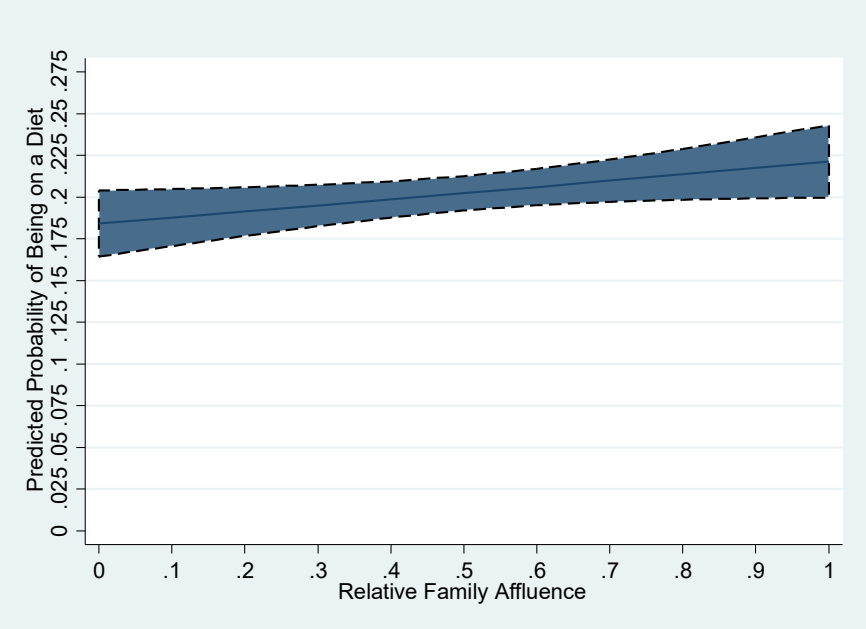
For objective SES, a positive and statistically significant coefficient (p-value = 0.043) is revealed in the model excluding subjective SES and holding negative fat body image constant. The risk of engaging in weight reduction behaviour increases with increasing objective SES, when negative fat body image is held constant. The odds of engaging in weight reduction behaviour of adolescents with the highest relative family affluence are 1.31 times (CI-95: 1.01-1.71) those of adolescents with the lowest relative family affluence. With a dropping AIC (by 1 point) but an increasing BIC (by 4 points), the comparison of the model fit is inconclusive. Figure 33 shows the predicted probabilities of weight reduction behaviour by objective SES when negative fat body image, gender and age are held constant. For the adolescents with the lowest relative family affluence, the predicted probability of engaging in weight reduction behaviour is 18.4% (CI-95: 16.4-20.4%) while it is 22.1% (CI-95: 20.0-24.3%) for adolescents with the highest relative family affluence.

A similar relation is observed between subjective SES and weight reduction behaviour in the model excluding objective SES, but including negative fat body image, age and gender. The positive coefficient of perceived wealth is statistically significant, with a p-value of 0.030. The likelihood of engaging in weight reduction behaviour increases with increasing subjective SES when the effect of having a negative fat body image is held constant. The odds to engage in weight reduction behaviour of adolescents perceiving their wealth to be 1 category higher are 1.10 times higher than the odds of adolescent perceiving their wealth to be 1 category lower. Again, the comparison of AIC and BIC is inconclusive, with a drop in the AIC and an increase in the BIC. Figure 34 represents the increase in the probabilities of engaging in weight

reduction behaviour that the model attributes to subjective SES when the effect of negative fat body image is held constant. The probability of engaging in weight reduction behaviour of adolescents who perceive their family to be not at all well off are 17.1% (CI-95: 14.3-19.9%) compared to 22.3% (CI-95: 20.1-24.5%) for adolescents who perceive their family to be very well off (with negative fat body image, age and gender held constant).

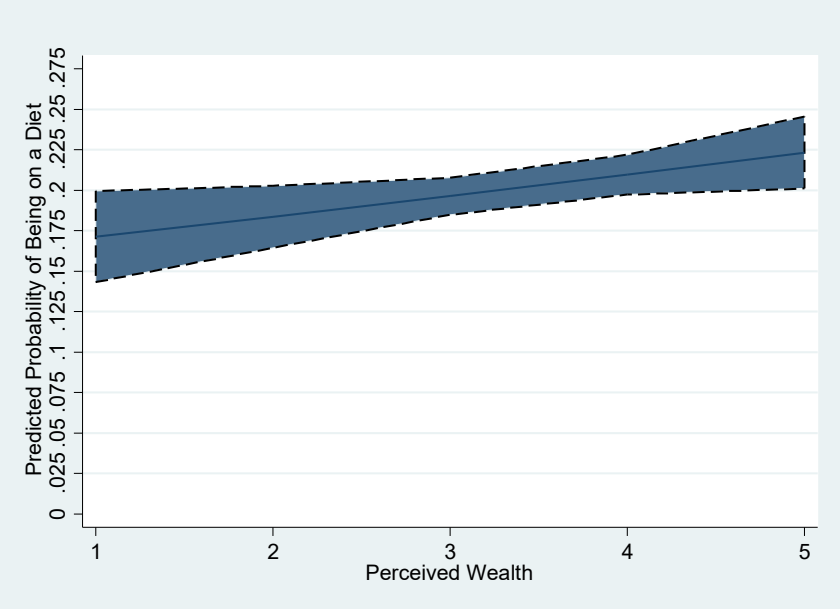
When, in addition to negative fat body image, both aspects of SES are included in the model, neither the coefficient of objective SES, nor the coefficient of subjective SES can be identified as statistically significant in relation to weight reduction behaviour. This does however not, confirm the absence of a relation and might be due the enlargement of the standard errors caused by multicollinearity.

Figure 33: Predicted Probability of Weight Reduction Behaviour by Objective SES with 95% CI (Negative Fat Body Image held constant)



Source: HBSC-LU 2014, *n*=5,227, weighted, negative body image (fat), gender and age held constant

Figure 34: Predicted Probability of Weight Reduction Behaviour by Subjective SES with 95% CI (Negative Fat Body Image held constant)



Source: HBSC-LU 2014, *n*=5,227, weighted, negative body image (fat), gender and age held constant

Similar to the models including overweight, the results for the models predicting weight reduction behaviour and including negative fat body image indicate that there might be an indirect negative statistical effect of objective and subjective SES on weight reduction behaviour that is mediated by negative fat body image and that masks the positive direct statistical relation between weight reduction behaviour and both aspects of SES in the model excluding negative fat body image. The direct relation between objective and subjective SES and weight reduction behaviour associates an increase in SES with an increase in the risk of engaging in weight reduction behaviour. At the same time, an indirect mediated relation of objective and subjective SES on weight reduction behaviour through negative fat body image associates an increase of objective and subjective SES with a decrease in negative fat body image and a subsequent decrease in weight reduction behaviour. Holding negative fat body image constant in the model controls for the negative indirect effect of objective and subjective SES onto weight reduction behaviour and enables the model to detect the positive, direct relation between both aspects of SES and weight reduction behaviour.

To allow for a better overview of the associations between objective and subjective SES and weight-related health concerns, Table 21 summarises the results presented in this chapter. Subjective SES can be described as a protective factor in relation to negative fat body image and objective SES can be described as a protective factor in relation to negative thin body

image. For weight reduction behaviour, objective and subjective SES can, however, be described as a risk factor.

Table 21: Overview of the Effects of Objective and Subjective SES on Weight-Related Health Concerns

Models		Direction and significance of the coefficients of the independent SES variables included in the model			
		Objective SES	Subjective SES	Objective & Subjective SES	
Dependent variables predicted by the model	Negative Fat Body Image	** ⬇	*** ⬇	NS	*** ⬇
	Negative Fat Body Image // Overweight	NS	*** ⬇	NS	*** ⬇
	Negative Thin Body Image	NS	NS	NS	NS
	Negative Thin Body Image // Underweight	* ⬇	NS	NS	NS
	Weight Reduction Behaviour	NS	NS	NS	NS
	Weight Reduction Behaviour // Overweight	* ⬆	NS	* ⬆	NS
	Weight Reduction Behaviour // Negative Fat Body Image	* ⬆	* ⬆	NS	NS

Source: HBSC 2014, weighted, *n* for each analysis between 5,265 and 5,277, //=held constant

11 Association of health relevant factors with overweight, underweight and socio-economic status

The last step in the analysis is the exploration of possible associations of health relevant factors with overweight and underweight. This ties in with the fifth research question and gives indications on the health relevant factors contributing to overweight and underweight in adolescents and aids the understanding of the processes leading to overweight and underweight. In addition, the relation between health relevant factors and socio-economic status is explored to identify health relevant factors that might be interesting for future research on the indirect influences of socio-economic status on adolescent health through health relevant factors that are included in the theoretical model of this thesis.

While three significant groups of health relevant factors through which socio-economic status influences adolescent health were identified in the literature (material, psycho-social and cultural-behavioural factors), this thesis focuses on psycho-social and cultural behavioural health relevant factors (Due et al., 2011; Marmot & Wilkinson, 2001; e.g. Moor et al., 2017; Weyers et al., 2010). The review of the empirical findings on overweight and underweight identified several health relevant factors that are associated with overweight or underweight in other countries (Dupuy et al., 2011; Haug et al., 2009; Janssen et al., 2005; Lobstein et al., 2004). These include behavioural factors that relate to the energy balance (energy intake – energy expenditure) such as dietary intake, physical activity or sedentary behaviour but also psycho-social factors that influence behaviour and psychological well-being such as having negative feelings or being teased (Geliebter & Aversa, 2003; Lobstein et al., 2004; Lundgren et al., 2004). The literature does not, however, allow for an informed exclusion of health relevant factors with regards to overweight and underweight among adolescents in Luxembourg. The analysis of the association between health relevant factors and overweight, underweight and socio-economic status therefore uses all the health relevant factors, for which data is available and that are deemed relevant and valid for Luxembourg by the Luxembourg HBSC country team (see Table 22 for a list and description of these health relevant factors) (Heinz et al., 2018).

Table 22: Description of Health Relevant Factors

Health relevant factor	**Description**
Daily breakfast	Having breakfast on every school day
Daily fruit intake	Eating fruit at least once a day
Daily vegetable intake	Eating vegetables at least once a day
Daily sweets consumption	Eating sweets (candy, chocolate) at least once a day
Daily soft drink consumption	Drinking sugared soft drinks at least once a day
Sedentary behaviour – TV watching	Watching TV, videos (including YouTube or similar offers), DVDs or other screen entertainment for at least 2 hours per day
Sedentary behaviour – PC/gaming	Playing on a computer, game console, tablet, smartphone or other electronic devices (excluding motion or fitness games) for at least for at least 2 hours per day
Physical activity	Being physically so active that they get out of breath or sweat for at least 2 hours a week in their free time (outside school hours)
School pressure	Feeling some or very stressed by schoolwork
Attitude towards school	Liking school a lot or somewhat
Class climate	Agreeing with the statement 'Most of the students in my class are kind and helpful'
Family communication	Rating the quality of the family communication with at least 4.5 (possible scores from 1 to 5) on average

For more detail, see chapter 6.

The first step in the exploration is the analysis of the relation of the different health relevant factors with overweight and underweight. For each health relevant factor, two separate logistic regression models estimating overweight or underweight and including the health relevant factor as well as age and gender are calculated. The statistical significance of the coefficients, the odds ratios and the changes in the explanatory power of the models are used to test for an association between the health relevant factor and overweight or underweight. In a second step, the relationship between the health relevant factors and socio-economic status is analysed. For each health relevant factor, three separate logistic regression models estimating the health relevant factors and including age and gender are calculated: The variable relative

family affluence measuring objective socio-economic status and the variable perceived family wealth measuring subjective socio-economic status are successively included into the models. The first model includes objective socio-economic status, the second model includes subjective socio-economic status and the third model includes both aspects of socio-economic status. The statistical significance of the coefficients, the odds ratios and the changes in the explanatory power of the models are used to test for effects of both aspects of socio-economic status on the health relevant factors and to confirm the effects of both aspects of socio-economic status as distinct.

Table 23: Multicollinearity for Health Relevant Factors

Variable	**Variance Inflation Factor (VIF)**
Daily fruit intake	1.31
Daily vegetable intake	1.30
Daily sweets consumption	1.11
Daily soft drink consumption	1.16
School pressure	1.16
Attitude towards school	1.16
Family communication	1.10
Daily breakfast	1.09
Sedentary behaviour – PC/gaming	1.17
Sedentary behaviour – TV watching	1.18
Physical activity	1.09
Class climate	1.04
Relative family affluence	1.17
Perceived wealth	1.16
Gender	1.11
Age	1.14
Mean VIF	1.15

Source: HBSC 2014, *n*=4,791, weighted

Before proceeding with the analysis and as in the previous chapter, the level of multicollinearity between the independent variables needs to be determined through the correlation of the variables and through the variance inflation factor (VIF)[37]. The highest correlation between the potential associated factors of overweight and underweight as measured by the Pearson's correlation coefficient was observed between the variables measuring the daily consumption

[37] The variance inflation factor (VIF) is calculated for a linear regression model including all the variables in the logistic regression model.

of fruits and vegetables at 0.4591. Three more correlations between 0.3500 and 0.2500 were observed, but all other correlations were below 0.200. (see Table 28 in the appendix).

As Table 23 shows, the VIF for the all the independent variables in the models range from 1.31 to 1.04, with a mean of 1.15. The highest VIF is observed for variables measuring the daily consumption of fruits (1.31) and vegetables (1.30). All other VIF values are below 1.2. Apart from the variables measuring the daily consumption of fruits and vegetables, the correlation and VIF does not indicate high or problematic multicollinearity. Nevertheless, the standard error would be enlarged due to multicollinearity. To be able to test all associated factors including daily fruit and vegetable consumption and to avoid Type II errors due to the inflated standard errors, the relation between overweight or underweight and the potential associated factors will be detected in separate models.[38]

The first analysis focuses on the relation of the different health relevant factors with overweight and underweight and specifically tests which of these health relevant factors are associated with the occurrence of overweight and underweight. The results for the separate logistic regression models estimating overweight or underweight and including the health relevant factor as well as age and gender are reported in this thesis. While the results observing statistically significant relations between health relevant factors and overweight or underweight are reported in this chapter in Table 24, the results for the health relevant factors that are not statistically significantly related to overweight or underweight are reported in Table 29 in the appendix.

For overweight, an association with six of the analysed health relevant factors (daily consumption of breakfast and sweets, sedentary behaviour – TV watching and PC/gaming, physical activity and class climate) was confirmed by the analysis.

The risk of being overweight is higher for adolescents who report a high level of sedentary behaviour than for adolescents who report a low level of sedentary behaviour, whether it is TV watching or PC/gaming activities. These positive statistical relations between overweight and sedentary behaviour – PC/gaming and sedentary behaviour – TV watching are confirmed at p-values under 0.05. The odds of being overweight for students who report a high level of sedentary behaviour through PC/gaming are 1.21 (CI-95: 1.03-1.43) times those students of who report a low level of PC/gaming. Similarly, the odds of being overweight for students who

[38] To avoid some of the risks of Type I errors (the false statistical significance of effects in the data that do not exist in the population), the association of all of the potential factors with overweight and underweight was also analysed in a model including all the factors.

report a high level of sedentary behaviour through TV watching are 1.18 (CI-95: 1.00-1.40) times those of students who report a low level of TV watching.

A lower risk of being overweight was observed for adolescents who report daily consumption of breakfast, high levels of physical activity, good class climate or daily consumption of sweets than for adolescents who report less than daily consumption of breakfast, low levels of physical activity, neutral to bad class climate or less than daily consumption of sweets. The negative statistical relation between overweight and these factors are confirmed at p-values at or under 0.009. The odds of being overweight for students who report daily consumption of breakfast, high levels of physical activity, good class climate or daily consumption of sweets are between 0.66 and 0.79 (CI-95; shown in Table 24) times those of students of who report less than daily consumption of breakfast, low levels of physical activity, neutral to bad class climate or less than daily consumption of sweets.

For underweight, an association with four of the analysed health relevant factors (sedentary behaviour – TV watching and daily consumption of breakfast, sweets and soft drinks) was confirmed.

The risk of being underweight is higher for adolescents who report a daily consumption of breakfast, sweets or soft drinks than for adolescents who report to consume breakfast, sweets or soft drinks less than on a daily basis. The positive statistical relations between these factors and underweight are confirmed at p-values at or under 0.019. The odds of being overweight for students who report a daily consumption of breakfast, sweets or soft drinks are between 1.23 and 1.73 (CI-95; shown in Table 24) times those of students of who report less than daily consumption of breakfast, sweets or soft drinks.

A lower risk of being underweight was observed for adolescents who report high levels of sedentary behaviour through TV watching. This negative statistical relation between overweight and watching TV is confirmed at a p-value of 0.031. The odds of being overweight for students who report watching TV for at least 2 hours on weekdays are 0.84 (CI-95: 0.71-0.98) times those of students who report watching less than 2 hours of TV on weekdays.

The pattern of the associations that is confirmed for health relevant factors and weight status by the HBSC 2014 data for Luxembourg differ considerably between overweight and underweight. Sedentary behaviour - TV watching and the daily consumption of breakfast and sweets are associated with opposing effects on overweight and underweight. For three more heath relevant factors (sedentary behaviour - PC/gaming, physical activity and class climate), an association can only be confirmed with overweight. For the daily consumption of soft drinks, an association can only be confirmed with underweight.

Table 24: Overweight and Underweight by Health Relevant Factors - Coefficients, P-Value and Odds Ratio (95% Confidence Interval)

	Overweight			**Underweight**		
	Coefficient	**p-value**	**Odds ratio (95% CI)**	**Coefficient**	**p-value**	**Odds ratio (95% CI)**
Empty Model						
Gender (Results for female)	-.4315873	0.000 ***	0.65 (0.56-0.76)	.6699402	0.000 ***	1.95 (1.66-2.30)
Age	-.4315873	0.054 ns	1.04 (1.00-1.08)	-.1415763	0.000 ***	0.87 (0.83-0.90)
LR chi2 (DF)[1)]	36.01 (2)	0.000 ***		117.75 (2)	0.000 ***	
AIC[1)] / BIC [1)]	4370/4390			4260/4280		
n=5,312				*n*=5312		
Model 'Daily Breakfast'						
Having Breakfast Daily	-.4208437	0.000 ***	0.66 (0.56-0.77)	.3793953	0.000 ***	1.46 (1.24-1.72)
LR chi2 (DF)[1)]	59.90 (3)	0.000 ***		138.67 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4230/4256			4134/4160		
n=5,172				*n*=5172		
Model 'Daily Sweets Consumption'						
Eating Sweets Daily	-.419	0.000 ***	0.66 (0.54-0.81)	.0605088	0.000 ***	1.73 (1.46-2.06)
LR chi2 (DF)[1)]	53.20 (3)	0.000 ***		156.70 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4284/4310			4173/4199		
n=5,243				*n*=5243		
Model 'Daily Soft Drink Consumption'						
Drinking Soft Drinks Daily	-.075184	0.397 ns	0.93 (0.78-1.10)	.208717	0.019 *	1.23 (1.03-1.47)
LR chi2 (DF)[1)]	36.95 (3)	0.000 ***		123.83 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4304/4330			4206/4233		
n=5,244				*n*=5244		
Model 'Sedentary Behaviour – PC/Gaming'						
PC-Gaming	.1927714	0.019 *	1.21 (1.03-1.43)	-.0290083	0.737 ns	0.97 (0.82-1.15)
LR chi2 (DF)[1)]	42.02 (3)	0.000 ***		115.75 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4221/4247			4130/4156		
n=5,166				*n*=5166		
Model ' Sedentary Behaviour – TV'						
Watching TV	.1689215	0.045 *	1.18 (1.00-1.40)	-.1778992	0.031 *	0.84 (0.71-0.98)
LR chi2 (DF)[1)]	41.09 (3)	0.000 ***		118.36 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4242/4268			4129/4155		
n=5173	*n*=5173					

ns=$p>0.05$, *=$p<0.05$, **=$p<0.01$, ***=$p<0.001$

Source: HBSC 2014, gender and age are included in all the models, but are not reported in this table

1) AIC, BIC and LR chi2 computed for unweighted data

Table 24 continued

	Overweight			Underweight		
	Coefficient	**p-value**	**Odds ratio (95% CI)**	**Coefficient**	**p-value**	**Odds ratio (95% CI)**
Model 'Physical Activity'						
Vigorous Physical Activity	-.3046671	0.000 ***	0.74 (0.62-0.87)	.0441654	0.618 ns	1.04 (0.88-1.24)
LR chi2 (DF)[1)]	46.51 (3)	0.000 ***		118.78 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4297/4323			4164/4190		
n=5,230				*n*=5230		
Model 'Class Climate'						
Supportive Classmates	-.2294601	0.009 **	0.79 (0.67-0.94)	.1135697	0.229 ns	1.12 (0.93-1.35)
LR chi2 (DF)[1)]	42.68 (3)	0.000 ***		117.82 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4306/4333			4206/4233		
n=5,259						

ns=$p>0.05$, *=$p<0.05$, **=$p<0.01$, ***=$p<0.001$

Source: HBSC 2014, gender and age are included in all the models, but are not reported in this table

1) AIC, BIC and LR chi2 computed for unweighted data

As seen in chapter 6 and the previous chapter, the non-significant coefficients of the other health relevant factors (daily fruit intake, daily vegetable intake, school pressure, attitude towards school and family communication) in relation to overweight and underweight do not exclude the possibility of the existence of an association in the population. In fact, the comparison of the model fits of the different models through the AIC and BIC reveals that every analysed health relevant factor increases the explanatory power of the models predicting overweight and underweight. This is an indication that effects of small effect size on overweight and underweight exist for all the health relevant factors that were analysed.[39]

The next step in the analysis is the exploration of the relation between socio-economic status and the health relevant factors that are statistically significantly associated with overweight or underweight. Similar to the analysis of the relation between socio-economic status and

[39] To avoid some of the risks of Type I errors (the false statistical significance of effects in the data that do not exist in the population), the association of all of the potential factors with overweight and underweight was also analysed in a model including all the factors. Two differences showed between the results of the separate models and the results of combined models were. First, the coefficient of Watching TV was not significant in the model predicting overweight. Second, the consumption of fruits was significant at 0.036 in the model predicting underweight. This indicates that the effect of the consumption of fruits is masked in the separate models by an unaccounted effect between the independent variables.

overweight and underweight in chapters 8 and 9, three separate logistic regression models estimating the health relevant factors and including age and gender are calculated for each health relevant factor. The first model includes objective socio-economic status, the second model includes subjective socio-economic status and the third model includes both aspects of socio-economic status. The detailed results for the analysis of the relation between with socio-economic status and the health relevant factors that are statistically significantly associated with overweight or underweight are reported in Table 30, Table 31, Table 32 and Table 33 in the appendix. Table 25 summarises the findings on the relation between socio-economic status and the health relevant factors.

Objective socio-economic status is statistically significantly related to all seven health relevant factors (daily consumption of breakfast, sweets and soft drinks, sedentary behaviour – TV watching and PC/gaming, physical activity and class climate) that are associated with overweight or underweight. A positive statistical relation was observed between objective socio-economic status and daily consumption of breakfast and sweets, physical activity and class climate. An increase in objective socio-economic status is thus associated with an increase in the probability of adolescents reporting these health relevant factors. A negative statistical relation was, on the other hand, observed between objective socio-economic status and daily consumption of soft drinks, sedentary behaviour – TV watching and PC/gaming. An increase in objective socio-economic status is thus associated with a decrease in the probability of adolescents reporting these health relevant factors. For the models predicting daily sweets consumption and sedentary behaviour – PC/gaming, the inclusion of objective socio-economic status did not increase the model fit and the explanatory power of the model. With the exception of the effect of objective socio-economic status on sedentary behaviour – TV watching, all the effects of objective socio-economic status on the analysed health relevant factors were confirmed as independent and distinct from the effects of subjective socio-economic status in the models including both aspects of socio-economic status.

The effects of subjective socio-economic status on the analysed health relevant factors are statistically significant, except for the effects on daily sweets consumption and daily soft drink consumption. The coefficients of subjective socio-economic status are of the same sign as the coefficient of objective socio-economic status. Increases in subjective socio-economic status are thus associated with the same increases and decreases in the probability of adolescents reporting health relevant factors as objective socio-economic status. For the models predicting sedentary behaviour – PC/gaming, the inclusion of subjective socio-economic status did not increase the model fit and the explanatory power of the model. Except for the effects of subjective socio-economic status on sedentary behaviour – TV watching and physical activity, the statistically significant effects of subjective socio-economic status on the analysed health

relevant factors were confirmed as independent and distinct from the effects of objective socio-economic status in the models including both aspects of socio-economic status.

Table 25: Overview of Health Relevant Factors by Objective and Subjective Socio-economic Status

Models (Dependent Variable)	Sign and significance (p-value) of coefficients of SES + Increase in the models' explanatory power (EP)°								
	Objective SES			Subjective SES			Objective & Subjective SES		
	Sign	p-value	EP	Sign	p-value	EP	Sign	p-value	EP
Daily Breakfast	+	0.000 ***	Y	+	0.000 ***	Y	+	0.000 ***	Y
							+	0.001 **	
Daily Sweets Consumption	+	0.034 *	N	+	0.565 ns	N	+	0.041 *	N
							-	0.920 ns	
Physical Activity	+	0.000 ***	Y	+	0.000 ***	Y	+	0.000 ***	Y
							+	0.595 ns	
Class Climate	+	0.000 ***	Y	+	0.002 **	Y	+	0.003 **	Y
							+	0.045 *	
Daily Soft Drinks Consumption	-	0.000 ***	Y	-	0.065 ns	N	-	0.000 ***	Y
							+	0.788 ns	
Sedentary Behaviour – TV Watching	-	0.004 **	Y	-	0.003 **	Y	-	0.007 **	N
							-	0.045 *	
Sedentary Behaviour – PC/Gaming	-	0.031 *	N	-	0.034 *	N	-	0.118 ns	N
							-	0.130 ns	

ns=$p>0.05$, *=$p<0.05$, **=$p<0.01$, ***=$p<0.001$

Source: HBSC 2014, weighted (see Table 30, Table 31, Table 32 and Table 33 in appendix for the results of the separately calculated models)

°Increase in the models explanatory power (EP) determined by comparison of the AIC and BIC between the 'basic' models excluding SES and models including SES for each independent variable (Y = Yes, increase in explanatory power, N = No increase in explanatory power or contradictory results between AIC and BIC)

In summary, the results reported in this chapter reveal a statistically significant relation with overweight or underweight for seven of the twelve analysed health relevant factors. According to the statistical results, a decrease in the risk of being overweight is associated with daily consumption of breakfast and sweets, physical activity and a good class climate while an increase in the risk of being overweight is associated with sedentary behaviour - TV watching and PC/gaming. A decrease in the risk of being underweight is associated with sedentary behaviour - TV watching, while an increase in the risk of being underweight is associated with

daily consumption of breakfast, sweets and soft drinks. These results describe statistical relations that will be interpreted and assessed for their theoretical relevance in the following chapter. Socio-economic status has a statistically significant influence on all the health relevant factors that are associated with overweight or underweight. An increase in socio-economic status is associated with an increase in the probability of adolescents reporting daily consumption of breakfast and sweets, physical activity and good class climate on one hand and a decrease in the probability of adolescents reporting daily consumption of soft drinks and the sedentary behaviours of PC/gaming and TV watching on the other hand.

12 Interpretation of results and discussion

This chapter discusses the results presented in chapters 7, 8, 9, 10 and 11 in relation to the five refined research questions developed in chapter 5. The goal is to consider whether each research question has been adequately answered and to discuss the answers deduced from the analyses. The results are discussed in relation to the theoretical model (see chapter 2) and the pre-existing empirical knowledge reviewed in chapter 3 and 4. In addition, the limitations of the study are considered. Last, it is determined whether the results of this study allow for conclusions on the relevance of specific elements of the theoretical model or of the overall theoretical model for the context and population under study as well as beyond the context and population studied here.

12.1 Interpretation of results

12.1.1 Overweight and underweight: Crucial health concerns

The interest in applying the theoretical model of this thesis to overweight and underweight is linked to the importance of the health concerns these conditions pose. To establish whether overweight and underweight are crucial health concerns, their scope and current development is evaluated. The first refined research question queries the prevalence of overweight and underweight among adolescents in Luxembourg and whether an ongoing evolution of the prevalence exists? A sub-question focuses on the socio-demographic risk groups that are particularly likely to be overweight or underweight.

The empirical results presented in chapter 7 provide the answer to this first research question. In 2014 and as observed in the HBSC data, the BMI of 14.9% (CI-95: 13.9-15.9%) of adolescents aged 11 to 17 years in Luxembourg is categorised as overweight. This prevalence is slightly lower than the prevalence of overweight among adolescents that was observed by Lorentz and Tchicaya (2010), Bös and colleagues (2006) or the international HBSC study (Inchley et al., 2016). At the same time, this prevalence is slightly higher than the 11.9% observed by the ministry of health (Ministère de la Santé, 2018). On one hand, these small

deviations could be due to the differences in the age groups that were included in the samples of these studies (for studies confirming differences in the prevalence of overweight by age see Haug et al., 2009). On the other hand, these deviations could be an indication that measures based on self-reported height and weight from adolescents observe slightly lower overweight rates in comparison to reports by parents (as used by Lorentz & Tchicaya, 2010) or measurements taken by professionals (as used by Bös et al., 2006 and Chau, N. et al., 2013).

In addition, the use of different cut-off points for the categorisation of the BMI (WHO versus IOTF categorisation) could play a role in these deviations. The empirical results from the Luxembourg HBSC study seem to find a legitimate middle ground between different measurements and categorisations. The prevalence of overweight among adolescents in Luxembourg is quite similar to the prevalence in neighbouring countries and other western European countries (Currie et al., 2012; Currie et al., 2008; Inchley et al., 2016; Janssen et al., 2005). With regard to overweight in adolescents, Luxembourg is thus confronted with a similarly challenging health situation as its neighbours.

The prevalence of underweight among adolescents in Luxembourg is 13.7% (CI-95:12.7-14.6) according to the 2014 HBSC data. This prevalence deviates substantially from the 0.5 to 0.9% of adolescents with insufficient weight that the ministry of health observed in the years 2015-2017 (Ministère de la Santé, 2016, Ministère de la Santé, 2017, Ministère de la Santé, 2017). The deviation is most probably due to differences in the applied cut-off points (e.g. IOTF categorisation vs worldwide WHO cut-off for extreme underweight (Onis et al., 2004)). The prevalence of underweight in adolescents in Luxembourg as observed in the HBSC data is similar to the prevalence observed in neighbouring countries and in line with observed geographical patterns (Lazzeri et al., 2014; Richter & Kolip, 2015). Underweight in Luxembourg is thus also an ‘important overlooked phenomenon’, that is seldom considered as health concern though it concerns critical proportions of adolescents (Lazzeri et al., 2014, p. 2213).

It is important to note that the proportion of adolescents that can be categorised as overweight is roughly the same as the proportion of adolescents that can be categorised as underweight. The international findings reviewed in chapter 4 identify both overweight and underweight as potential concerns for the current and future health of the adolescents. With one in seven adolescents affected, the scope of both overweight and underweight is significant enough to be considered an important heath concern. Thus, for its adolescents, Luxembourg is faced with health concerns at both ends of the weight spectrum. One could say that the candle is burning at both ends.

To evaluate the urgency of the health concern, the information on whether its prevalence is increasing, decreasing or stable is an important factor. The first research question includes the

assessment to determine whether there is an ongoing evolution of the prevalence of overweight or underweight. The data available for Luxembourg in the HBSC data enables a cross-sectional comparison of the prevalence of overweight or underweight in 2006, 2010 and 2014. In absence of longitudinal studies, the cross-sectional comparison of prevalence provides indications of the evolution of prevalence over time. Though not statistically significant, the results reported in chapter 7 indicate an increase of the prevalence of overweight between 2006 and 2014. In socio-demographic terms, 12 years is a rather short period of time and it is unexpected and worrying to see a change of body proportions of adolescents in such a short time span (half a generation).

These results contradict the hypothesis that no evolution of the prevalence of overweight can be observed in Luxembourg because of a similar plateauing of the increase in overweight as described in the international literature (O'Dea et al., 2011; Olds et al., 2011; Rokholm et al., 2010). For the prevalence of underweight among adolescents in Luxembourg, no trends are observable in the HBSC data. Thus, there is no indication that the increase in prevalence of underweight that Lazzeri and colleagues (2014) observed in some countries is also occurring in Luxembourg. While there is no indication for a worsening of the situation, there is also no indication of an improvement of the situation through a decrease in the prevalence of underweight among adolescents in Luxembourg. Overall, the HBSC data show that the health concern posed by overweight and underweight to adolescents in Luxembourg is not decreasing and remains an urgent issue for the country. With the results from the HBSC data confirming both overweight and underweight as critical in scope and urgency, they can be considered crucial health concerns. These results do not however confirm the 'shift to the right of the entire distribution of BMI' that Lazzeri and colleagues (2014, p. 2211) discuss.

With overweight and underweight being identified as crucial health concern for adolescents, it is important to know whether there are specific groups of adolescents that are at risk of being overweight or underweight. A sub-question to the first research question thus concerns the socio-demographic distribution of the risk of being overweight and underweight.

The results from the HBSC data presented in chapter 7 and chapter 8 show no difference in the prevalence of overweight by age for adolescents. In Luxembourg, the increase of overweight with age that is observed for adults is not observed for adolescents (Direction de la Santé & Luxembourg Institute of Health, 2017b; Lorentz & Tchicaya, 2006). For underweight, an association with age was observed for 11- to 17-year-old adolescents. The prevalence of underweight decreases with age, and younger adolescents are at greater risk of being underweight than older adolescents. With regard to gender differences, the increased prevalence of overweight in adult men in comparison to adult women observed in Luxembourg is confirmed for adolescents (Lorentz & Tchicaya, 2006). In addition, clearly distinct risk profiles

for girls and boys in relation to underweight have been observed in the HBSC data. While the proportion of boys who are overweight is higher than the proportion of boys who are underweight, the proportion of girls who are underweight is higher than the proportion of boys who are overweight. Boys have an increased risk of being overweight, and girls have an increased risk of being underweight. This confirms both the hypothesis and the international empirical findings presented in chapter 4.

In summary and in response to the first research question, it can be concluded that the prevalence and trends of overweight and underweight in Luxembourg indicate that both are crucial health issues that have not declined between 2006 and 2014. While boys are at a greater risk of being overweight, girls and younger adolescents have a higher risk of being underweight. Potentially health compromising weight status, whether overweight or underweight, are thus crucial health concerns for a significant proportion of Luxembourg adolescents.

12.1.2 Inverse effects of socio-economic status on overweight and underweight

Having established the importance of the health concern to which the theoretical model of this thesis is applied, the next step is to assess whether there are socio-economic health inequalities in the health concern under study that could be explained by the theoretical model. The second refined research question is, therefore, whether and which relation there is between socio-economic status and the risk being overweight and underweight among adolescents in Luxembourg.

Both the international and national literature report a higher risk of being overweight among adolescents with lower socio-economic status than among adolescents with higher socio-economic status (Currie et al., 2012; Currie et al., 2008; Inchley et al., 2016; Lorentz & Tchicaya, 2010; Tchicaya & Lorentz, 2014). The hypothesis examined here focused on whether this relation also occurs for the risk of being overweight among adolescents in Luxembourg.

The results from the bivariate descriptive analysis of the 2014 HBSC data (see chapter 7) concerning the prevalence of overweight by socio-economic status show a higher prevalence of overweight for adolescents with low objective socio-economic status compared to adolescents with high objective socio-economic status as well as a higher prevalence of overweight for adolescents with low subjective socio-economic status compared to

adolescents with high subjective socio-economic status. When age and gender are held constant in the multivariate analysis, both objective and subjective socio-economic status continue to have a significant negative statistical relation with overweight (see chapter 8). The results from the multivariate analysis thus associate an increase in socio-economic status with a decrease of the risk of being overweight. The decrease of the risk of being overweight associated with subjective socio-economic status is less pronounced than the decrease of the risk of being overweight associated with objective socio-economic status. The highly significant negative association of overweight with both objective and subjective family affluence suggests that the strong negative effect of different dimensions of SES on adolescent overweight found in international studies for affluent countries is also present in Luxembourg (see: Barriuso et al., 2015; Brug et al., 2012; Due et al., 2009; Dupuy et al., 2011; Elgar et al., 2015; Inchley et al., 2017; O'Dea, Hoang & Dibley, 2012; Shrewsbury & Wardle, 2008). The hypothesis and the previous international and national results are thus confirmed by the descriptive bivariate analysis as well as the multivariate analysis of the 2014 HBSC data.

For the risk of being underweight, no hypothesis of a probable existence or direction of a relation with socio-economic status was deducible from the international and national literature. The results from the 2014 HBSC data show that the relation between socio-economic status and underweight is different than the relationship between socio-economic status and overweight (see chapter 7). The prevalence of underweight is higher among adolescents with higher objective socio-economic status compared to adolescents with lower objective socio-economic status. Similarly, for subjective socio-economic status, the prevalence of underweight is higher among adolescents with higher subjective socio-economic status than among adolescents with lower subjective socio-economic status. While the difference in prevalence by socio-economic status is not as large for underweight as it is for overweight, it is statistically significant.

In the multivariate analysis, a significant, positive statistical relation between underweight and objective or subjective socio-economic status continues to be observed when age and gender are held constant (see chapter 8). The effect on the risk of being underweight that is associated with subjective socio-economic status is less pronounced than the effect associated with objective socio-economic status. An increase in socio-economic status is thus associated with an increase in the risk of being underweight in the multivariate model predicting underweight. The effect on the risk of being underweight that is associated with subjective socio-economic status is less pronounced than the effect associated with objective socio-economic status. In contrast to the results for overweight and the health gradient, adolescents with higher socio-economic status have a higher risk of being underweight than adolescents with lower socio-

economic status. Higher socio-economic status thus has a negative impact on adolescents' health as far as underweight is concerned.

The comparison of the results for overweight and underweight indicate that the effects of socio-economic status on overweight and underweight are opposing in direction, but quite similar in slope. The effects of socio-economic status on overweight and underweight are thus inverse. For adolescents in Luxembourg, high socio-economic status is a protective factor against potentially health-compromising overweight but also a risk factor for potentially health-compromising underweight. Low socio-economic status, on the other hand, is associated with a higher risk of being overweight and a lower risk of being underweight.

In response to the second research question, it can thus be concluded that socio-economic health inequalities exist in adolescents' risk of being overweight or underweight in Luxembourg. The effect of socio-economic status on overweight and underweight is, however, inverse. The results gathered in response to the second research question are interesting and relevant for the overall scientific knowledge of health inequalities in adolescence because they show the existence of health inequalities in underweight and the existence of contradictory effects of socio-economic status on health in adolescence. While the results for overweight are in line with the general consensus in the literature (high socio-economic status as protective factor or non-relevant factor for adolescent health) (Starfield et al., 2002), the results for underweight are in contradiction with this consensus and the idea of the health gradient as a sole description of the relationship between socio-economic status and health. The results for underweight are in line with results from Germany (Richter & Kolip, 2015). The results for underweight show the existence of contradictory relations between socio-economic status and health in adolescence in some contexts and stress the importance of testing for such unexpected relations. A wider analysis of the relation between socio-economic status and underweight in so-called developed countries should be considered to assess whether the observed relation only occurs in Luxembourg and Germany or whether it is a phenomenon in further countries as well. Similar relations might exist or might be emerging with the continuous development of societies for other aspects of adolescent health. They could go unnoticed because studies focus on expected positive effects of expected protectors and expected negative effects of risk factors, without testing for less expected effects.

Due to the current lack of in-depth information on the relation between socio-economic status and different aspects of adolescent health in Luxembourg, it is impossible to evaluate whether the contradictory results for overweight and underweight represent one of few exceptions to an overall protective or absent effect of socio-economic status on adolescent health in Luxembourg (Heinz et al., 2018) or whether they represent an indication of an overall contradictory effect of high socio-economic status on adolescent health in Luxembourg. The

results gathered in response to the second research question confirm that socio-economic health inequalities exist among adolescents in Luxembourg for certain health domains, but do not indicate the overall direction of health inequalities among adolescents in Luxembourg.

12.1.3 Distinct effects of objective and subjective socio-economic status

With the confirmation of the existence of socio-economic health inequalities in adolescent overweight and underweight, a further examination of socio-economic status as a key element in the theoretical model of this thesis is the next step. In line with the key aspects of socio-economic status identified in the international literature (see chapter 3), the third research question asks whether the influences of objective and subjective socio-economic status on overweight and underweight are unique and distinct. The hypothesis is that objective and subjective socio-economic status have distinct but similar effects on overweight and underweight in Luxembourg.

The results of the logistic regression models including both objective and subjective aspects of socio-economic status (presented in chapter 9) indicate whether both aspects of socio-economic status have unique effects on overweight and underweight. Distinct effects of objective and subjective socio-economic status on overweight are confirmed by statistically significant coefficients. Both aspects of socio-economic status influence overweight in the same direction. A distinct effect on underweight is only confirmed as statistically significant for objective socio-economic status, while a distinct effect of subjective socio-economic status on underweight is neither confirmed nor excluded by the results. The comparisons of the explanatory power of the different models and the graphical representation of the predicted probabilities of being overweight or underweight by socio-economic status indicate a smaller effect size for subjective socio-economic status than for objective socio-economic status for overweight and underweight.

The hypothesis that objective and subjective socio-economic status have unique effects on overweight and underweight was confirmed for overweight. The effects of both aspects of socio-economic status influence overweight in the same direction but differ in effect size. They are thus less similar than expected. For underweight, the hypothesis was neither confirmed nor refuted. On one hand, the results for overweight confirm the findings from international studies of a unique effect of subjective and objective socio-economic status on some aspects of adolescent health (e.g. (Chen & Paterson, 2006; Elgar, McKinnon et al., 2016; Goodman et al., 2007; Karvonen & Rahkonen, 2011; Quon & McGrath, 2014, 2015). At the same time, the

results for underweight reiterate the varied, complex and fragmented effects of socio-economic status on different health outcomes and behaviours in adolescence (for an overview see Hanson & Chen, 2007; Richter, 2005; Richter & Hurrelmann, 2009afor an overview see ; Richter & Hurrelmann, 2009a).

In addition to the results confirming a unique effect of objective and subjective socio-economic status on overweight reported in chapter 9, the results presented in chapter 10 confirm unique effects of objective and subjective socio-economic status on daily breakfast consumption, class climate and sedentary behaviour – TV watching. The results reported in chapter 10 reveal that the relation between socio-economic status and some weight-related health concerns can only be detected by objective socio-economic status (i.e. negative thin body image) while other can only be detected by subjective socio-economic status (negative fat body image). The results reported in chapter 9 and 10 thus confirm the relevance of the differentiation between objective and subjective socio-economic status for the analysis and understanding of socio-economic health inequalities beyond weight status.

12.1.4 Opposite effects of socio-economic status on weight-related health concerns

As the literature review (see chapter 3 and 4) concludes that the importance, strength and direction of the influence of socio-economic status on adolescent health varies according to the observed health phenomena, the research focus is expanded to include weight-related health concerns (De Clercq et al., 2017; Elgar et al., 2017; Holstein et al., 2009; Inchley et al., 2016; Moor et al., 2014; Moor et al., 2015; Nielsen, F. et al., 2015; Pförtner et al., 2016; Richter et al., 2012; Richter & Lampert, 2008; Starfield et al., 2002; Torsheim et al., 2004; Vereecken et al., 2005). The weight-related health concerns analysed in this thesis are negative body image (as an example of a psychological health outcome) and weight reduction behaviour (as an example of a health behaviour). The aim of the fourth research question is to explore the relation between socio-economic status and these two weight-related health concerns. The focus of the exploration is the differentiation between objective and subjective socio-economic status as well as the influence of overweight and underweight on the relation between socio-economic status and weight-related health concerns.

The empirical results presented in chapter 7 revealed that substantial proportions of adolescents in Luxembourg have a negative body image and engage in weight reduction behaviour. Less than half (45.6%; CI-95: 44.3-47.0%) of all adolescents have a positive body image. With 40.5%, the proportion of the adolescents thinking that their body is too fat is larger

than the proportion of adolescents thinking that their body is too thin (13.9%). Girls have a higher risk of having a negative body image than boys and they are more likely than boys to think that their body is too fat. Boys on the other hand, have a lower risk of having a negative body image than girls and are more likely than girls to think that their body is too thin. It is confirmed, by the bivariate analysis presented in chapter 7 and the multivariate analysis presented in chapter 10, that the risk of having a negative thin body image is increased for adolescents who are categorised as underweight on one hand and that the risk of having negative fat body image is increased for adolescents who are categorised as overweight on the other hand.

Around one-fifth (20.8%; CI-95: 19.7-22.0%) of all adolescents report that they are currently on a diet or are doing something else to lose weight. Girls have a higher risk (24.5%; CI-95: 22.8-26.2%) of engaging in weight reduction behaviour than boys (16.8%; CI-95: 15.5-18.2). The bivariate analysis presented in chapter 7 and the multivariate analysis presented in chapter 10 confirm that the risk of engaging in weight reduction behaviour is increased for adolescents who are categorised as overweight.

Both negative body image and weight reduction behaviour are thus more widespread health concerns than overweight and underweight among adolescents in Luxembourg and are confirmed as relevant weight-related health concerns. Socio-economic inequalities in these weight-related health concerns thus affect a substantial proportion of adolescents in Luxembourg. The findings of the multivariate analysis on the effects of objective and subjective socio-economic status on negative body image (feeling too thin and feeling too fat) and weight reduction behaviour are reported in chapter 10. The observed effects of socio-economic status on negative body image differ between negative thin body image and negative fat body image as well as between objective and subjective socio-economic status. The results for the relation of negative body image (thin and fat) with subjective socio-economic status will be interpreted and discussed first, before the focus is shifted to objective socio-economic status:

Concerning the relation between subjective socio-economic status and negative body image, no relation between negative thin body image and subjective socio-economic status can be confirmed in the calculated models, regardless of whether the models include underweight or not. In contrast, for negative fat body image, the coefficient of subjective socio-economic status is negative and statistically significant in all models, regardless of whether they include overweight or not. Subjective socio-economic status conclusively adds to the explanatory power of all models and increases their model fit. A higher subjective socio-economic status is thus associated with a lower risk of having a negative fat body image, and this relation is independent of the effects that being overweight has on the risk of having a negative fat body image. While the results for negative fat body image thus tie in with the specific relation

between subjective social status and psychological variables that Shaked and colleagues (2016) observed, the results for thin body image do not confirm such a relation.

In the relation between objective socio-economic status and negative body image there are differences for negative thin body image and negative fat body image. For negative thin body image, no statistically significant relation with objective socio-economic status is observed in models excluding underweight. In models holding the effect of underweight constant, a negative statistical relation with objective socio-economic status is observed as long as subjective socio-economic status is not included in the model, but the inclusion of objective socio-economic status in the model does not conclusively increase the explanatory power of the model. This might be due to an indirect, positive statistical effect of objective socio-economic status on negative thin body image that is mediated by underweight and that masks this effect in the model excluding underweight. The results thus indicate that higher objective socio-economic status is associated with a decrease in negative thin body image independent of underweight but has a small effect size.

For negative fat body image, the negative statistical relation with objective socio-economic status that is observed as statistically significant in the model excluding overweight is no longer statistically significant when overweight is added to the model. Since objective socio-economic status does not conclusively add to the explanatory power of the models, these results indicate that a decreasing effect of higher objective socio-economic status on negative fat body image is mediated through overweight, but the results do not confirm the existence of an independent association between objective socio-economic status and negative fat body image.

If analysed and discussed independently from overweight and underweight, high socio-economic status can be described as a protective factor reducing the risk of having a negative body image. An increase in subjective socio-economic status is associated with a decrease in the risk of adolescents to think that their body is too fat, while an increase in objective socio-economic status is associated with a small decrease in the risk of adolescents to think that their body is too thin. These results thus provide indications that differ from the results of some studies, that found, that overweight children from a low socio-economic background are rather acceptant of their bodies (Wills et al., 2006) and that the physical esteem of children with low socio-economic status stabilises in adolescence, while that of children with medium and high socio-economic status decreases (O'Dea & Caputi, 2001). At the same time, these results are in line with studies on female adolescents, who do not find higher levels of body dissatisfaction in female adolescents with high socio-economic status, despite their stronger thin ideal norms and harsh ideal sizes. Wardle and colleagues (2004) stipulate, that adolescents with a high socio-economic status might have a higher self-esteem, that buffers the negative effect that the distance between their own body weight and their ideal could have on their body

satisfaction. These results are also in line with the concept of the socio-economic gradient in health, which identifies high socio-economic status as protective factor for adolescent health (Starfield et al., 2002).

As a second weight-related health concern, weight reduction behaviour was investigated in this thesis. Due to the unhealthy weight reduction methods used by adolescents and the unhealthy reasons that motivate adolescents to engage in weight reduction behaviour, weight reduction behaviour is considered as health risk in this thesis (Bhurtun & Jeewon, 2013; Crow et al., 2006; Ojala et al., 2007; Ojala et al., 2012). The results concerning the risk of engaging in weight reduction behaviour for adolescents in Luxembourg differ from the results observed for negative body image in terms of the direction of their association with socio-economic status: While no statistically significant associations between socio-economic status and weight reduction behaviour are observed in the models excluding negative fat body image and overweight, some of the models including negative fat body image and overweight show positive and statistically significant associations. All the statistical associations between weight reduction behaviour and socio-economic status that can be observed in the models holding negative fat body image and overweight constant are positive. This could indicate an indirect, negative statistical effect of socio-economic status on weight reduction behaviour that is mediated through overweight and negative fat body image and that masks the positive statistical effect in the model excluding overweight and negative fat body image. The inclusion of socio-economic status in the models does not, however, conclusively increase the explanatory power of the models. Only the effect of objective socio-economic status on weight reduction behaviour is confirmed in the model including both aspects of socio-economic status, and these results indicate a small effect size. The results thus indicate that higher objective and subjective socio-economic status are associated with an increase in the risk of engaging in weight reduction behaviour, but the effect sizes are small.

If analysed and discussed independently from overweight and negative fat body image, high socio-economic status can be described as a risk factor increasing the risk of adolescents in Luxembourg to engage in weight reduction behaviour. An increase in objective and subjective socio-economic status is associated with an increase in the risk of adolescents to engage in weight reduction behaviour. In contrast to the results for negative body image and overweight, these results align with the results for underweight in indicating a negative influence of increasing socio-economic status on adolescent health thus contradicting the socio-economic health gradient (Starfield et al., 2002). In addition they confirm the findings from studies observing (Wardle et al., 2004) that girls with high socio-economic status report higher levels of dietary restraint.

Possible explanations for these effects include material factors such as the ability to afford weight reduction consultations or weight reduction products, psycho-social factors such as stress caused by the attempt to maintain superiority as well as cultural-behavioural factors such as class specific health beliefs and expectations (Bartley, 2004; Bauer et al., 2008b; Graham, 2007; Richter & Hurrelmann, 2009a; Weyers et al., 2010). Specific health beliefs and attitudes about weight reduction behaviour and weight reduction behaviour itself could well be institutionalised in the habitus of the higher strata of society and could shape the perception of reality and, consequently, the behaviour of adolescents with higher socio-economic status (Bourdieu, 1989; Conner & Norman, 2005; Miebach, 2010; Richter & Hurrelmann, 2009a).

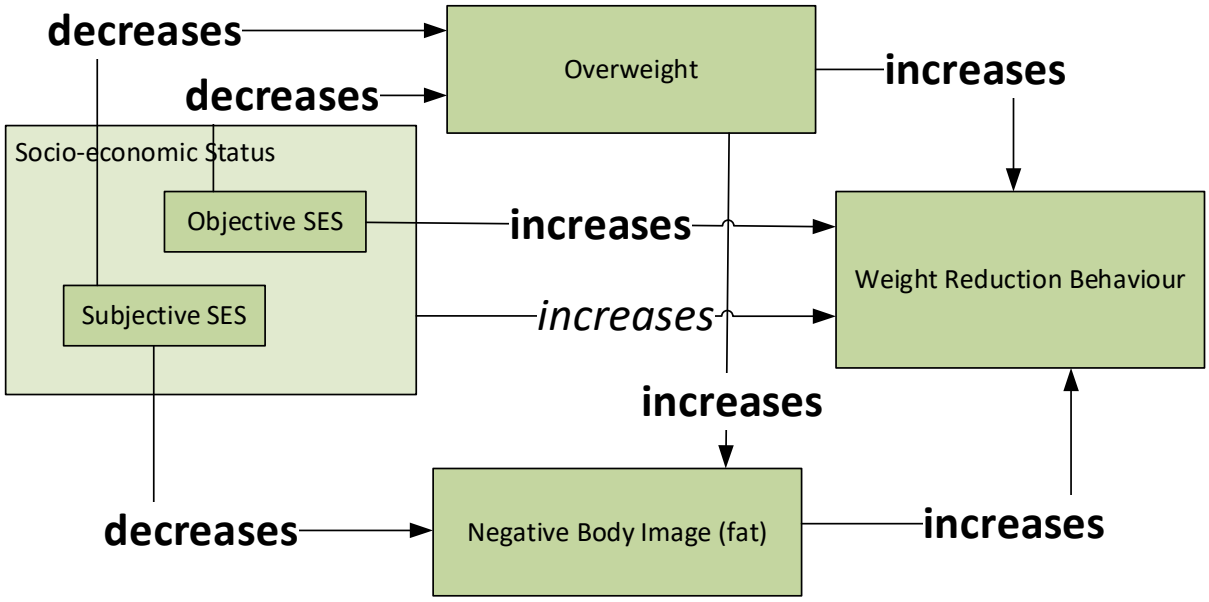
In summary and similar to the results for overweight and underweight, the results on the effects of socio-economic status on weight-related health concerns reveal effects that are opposite in direction. While an increase in socio-economic status is associated with a decrease in the risk of having negative body image, it is associated with an increase in weight reduction behaviour. The differentiation between objective and subjective socio-economic status is important for the analysis of weight-related health concerns because the relation between socio-economic status and some weight-related health concerns can only be detected by objective socio-economic status (i.e. negative thin body image) while others can only be detected by subjective socio-economic status (i.e. negative fat body image).

As in the previous section, the last step of the interpretation of the results on the relation between socio-economic status and weight-related health concerns combines the statistically significant relations observed in separate models between socio-economic status and weight reduction behaviour as well as negative fat body image with theoretical assumptions about the direction of these associations and the interactions between them. Based on a consensus in the literature, the theoretical model of this thesis concludes that the primary and key direction between socio-economic status and adolescent health is the effects of socio-economic status on health and not the effect of health on socio-economic status (Lampert & Richter, 2009; Mielck, 2005; Pförtner, Günther, Levin, Torsheim, & Richter, 2015). The resulting theoretical model depicted in Figure 35 indicates possible indirect effects of objective and subjective socio-economic status on weight reduction behaviour that could be mediated through overweight or negative fat body image.

The results from the separately calculated models confirm a positive statistical relation between weight reduction behaviour and both aspects of socio-economic status when the effects of overweight and fat body image are held constant. This effect associates an increase in socio-economic status with an increase in weight reduction behaviour. At the same time, the results suggest, that there is a negative indirect statistical effect of subjective socio-economic status via overweight and negative fat body image: Socio-economic status decreases the risk

of being overweight or having a negative fat body image. This decreases the risk of engaging in weight reduction behaviour, because not being overweight or not having a negative body image are associated with a lower risk of weight reduction behaviour. These possible contradictory effects of socio-economic status on weight reduction behaviour represent potential starting points for further empirical studies and research.

Figure 35: Theoretical Interpretation of the Observed Relations between Socio-economic Status and Weight Reduction Behaviour



Source: HBSC 2014, see previously reported results for details

1) Figure based on statistically significant results from the estimation of the described relations in separate models (i.e. only including the dependent variable, the independent variable, age and gender). The relations were not confirmed controlling for effects between mediating variables, and the model was not tested in its entirety.

2) **increases**=positive statistical relation by which an increase in the dependent variable is associated with an increase in the independent variable (for SES it represents a distinct effect of the aspects of SES that is statistically significant if the second aspect of SES is held constant).

increases=positive statistical relation by which an increase in SES is associated with an increase in the independent variable, the effect of SES is not confirmed as statistically significant and distinct in models holding the second aspect of SES constant

decreases=negative statistical relation by which an increase in the dependent variable is associated with a decrease in the independent variable (for SES it represents a distinct effect of the aspects of SES that is statistically significant if the second aspect of SES is held constant).

12.1.5 Confirmed associations of health relevant factors with overweight

With the confirmation of the relevance of the differentiation between objective and subjective socio-economic status for the empirical analysis of socio-economic health inequalities among

adolescents in Luxembourg, the focus now turns towards the next element of the theoretical model of this thesis. The fifth research question explores possible associations of health relevant factors with overweight, underweight and socio-economic status.

The results from separate logistic regression models estimating overweight or underweight and including one health relevant factor as well as age and gender are reported in chapter 10. These findings reveal a statistically significant relation with overweight or underweight for 7 of the 12 analysed health relevant factors. Of the psycho-social health relevant factors, only 1 out of 4 was associated with overweight or underweight, while this was the case for 6 out of 8 cultural-behavioural health relevant factors. Of the two groups of factors identified in the literature, the cultural behavioural factors seem to have closer relation with overweight and underweight (Due et al., 2011; Marmot & Wilkinson, 2001; Moor et al., 2017; Weyers et al., 2010).

For overweight, the statistical results associate a decrease in the risk of being overweight with daily consumption of breakfast, physical activity, good class climate and the daily consumption of sweets. A protective effect against overweight is plausible for regular eating patterns as measured by daily breakfast, physical activity and positive social relations such as a good class climate. For the daily consumption of sweets, however, a protective effect against overweight is highly implausible. Most likely, adolescents who are overweight are reluctant to admit to the daily consumption of sweets, which they perceive as socially undesirable or even stigmatised behaviour for overweight adolescents. The statistical results also associate an increase in the risk of being overweight with sedentary behaviour, whether it is watching TV or PC-gaming. Sedentary behaviour such as watching TV and PC-gaming use therefore need to be seen as risk factors in relation to overweight.

A decrease in the risk of being underweight is statistically associated with sedentary behaviour - TV watching and sedentary behaviour could therefore be seen as a protective factor against underweight. However, the negative impacts of sedentary behaviour on other health aspects do not allow an interpretation of sedentary behaviour as a protective factor for overall health. The statistical results also associate an increase in the risk of being underweight with the daily consumption of breakfast, sweets and soft drinks. Yet none of these health relevant factors are plausible risk factors for underweight. The relation between daily breakfast consumption and underweight might be confounded with effects of other variables (such as common health beliefs among socio-economic strata). The statistical relation between underweight and the daily consumption of sweets might be related to the absence of a reluctance to admit to the daily consumption of sweets among underweight adolescents, because this is not perceived as socially undesirable behaviour for underweight adolescents. The statistical relation between underweight and the daily consumption of soft drinks is most probably related to the fact that

this question specifically targets sugared soft drinks. While the consumption of sugared soft drinks might be widespread among underweight adolescents, normal weight and overweight adolescents might be choosing to drink sugar free soft drinks instead (Katzmarzyk et a., 2016).

Thus, the empirical results for the relations between health relevant factors and overweight and underweight differ considerably between overweight and underweight. While the results aid the understanding of the processes leading to overweight, the observed relations between health relevant factors and underweight need to be critically considered and necessitate further empirical and theoretical consideration.

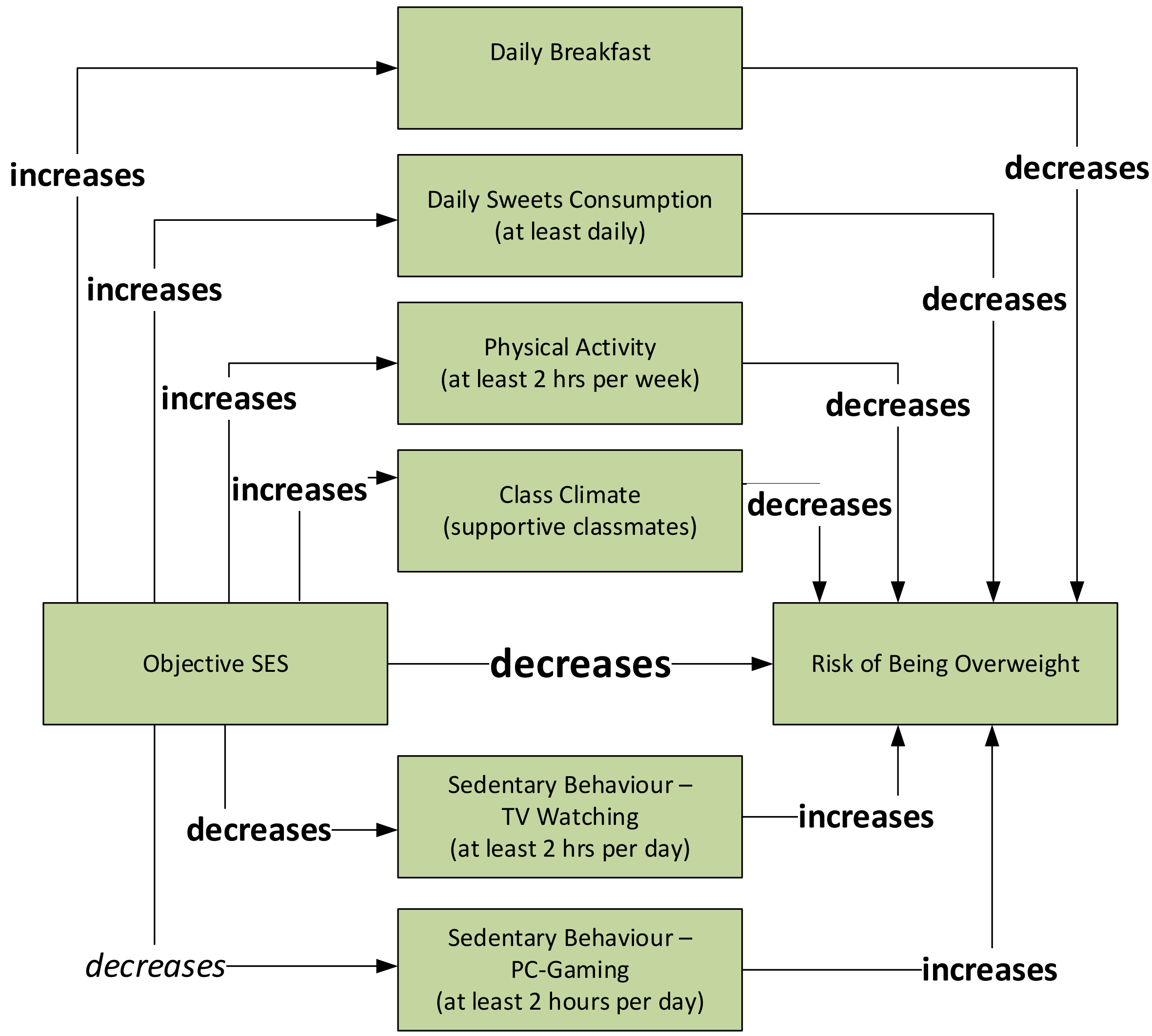
The results of the separate logistic regression models estimating the relation between health relevant factors and objective and subjective aspects of socio-economic status reveal that socio-economic status has a statistically significant influence on all the health relevant factors that are associated with overweight or underweight. An increase in socio-economic status is associated with an increase in the probability of adolescents reporting daily consumption of breakfast and sweets, physical activity and a good class climate on one hand and a decrease in the probability of adolescents reporting daily consumption of soft drinks, sedentary behaviour, PC/gaming and watching TV. Theoretically all the health relevant health factors associated with overweight and underweight could therefore mediate the indirect influences of socio-economic status on adolescent health that are described in the theoretical model underlying this thesis (Bartley, 2004; Bauer et al., 2008b; Graham, 2007; Richter & Hurrelmann, 2009a; Weyers et al., 2010).

In a last step of the interpretation of the results on the relation between health relevant factors and overweight[40] and socio-economic status, the statistically significant relations observed in separate models are combined with theoretical assumptions about the direction of these associations. Based on a consensus in the literature, the theoretical model of this thesis concludes that the primary and key direction between socio-economic status and adolescent health is the effects of socio-economic status on health and not the effect of health on socio-economic status (Lampert & Richter, 2009; Mielck, 2005; Pförtner et al., 2015). The resulting theoretical models depict possible effects of objective and subjective socio-economic status on overweight that could be mediated through health relevant factors. Figure 36 depicts the theoretical interpretation of the effects of objective socio-economic status on overweight, and Figure 37 depicts the theoretical interpretation of the effects of subjective socio-economic status on overweight. The models can serve as interesting starting points for further studies

[40] Due to the further empirical and theoretical consideration that is needed to conclusively interpret the relation between health relevant factors and underweight, no models are presented for underweight.

and research, but they have not been tested in their entirety and are not confirmed in models controlling for effects between mediating variables.

Figure 36: Theoretical Interpretation of the Observed Effects of Objective Socio-economic Status on Overweight



Source: HBSC 2014, see previously reported results for details

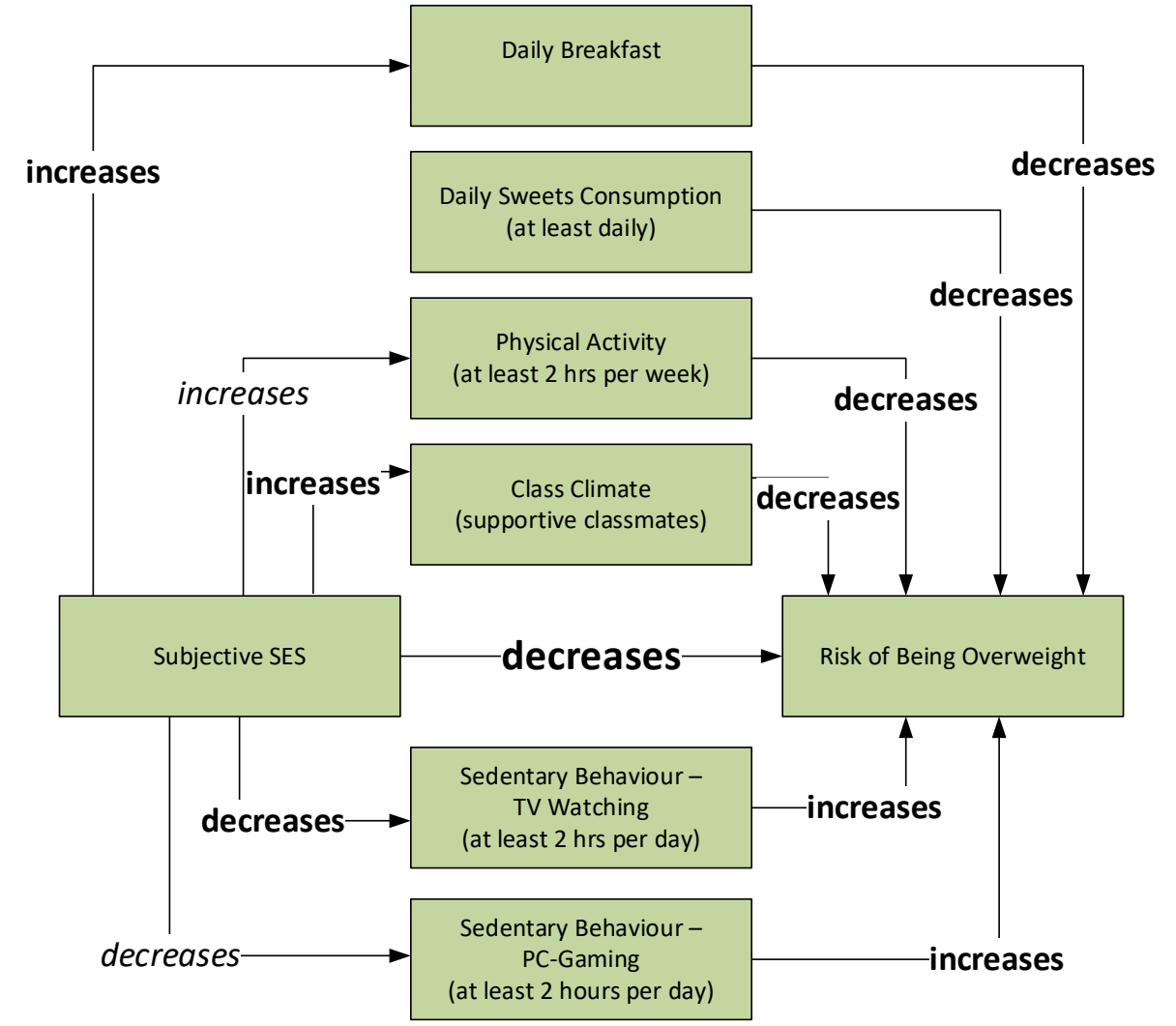
1) Figure based on statistically significant results from the estimation of the described relations in separate models (i.e. only including the dependent variable, the independent variable, age and gender). The relations were not confirmed controlling for effects between mediating variables, and the model was not tested in its entirety.

2) **increases**=positive statistical relation by which an increase in the dependent variable is associated with an increase in the independent variable (for SES it represents a distinct effect of the aspects of SES that is statistically significant if the second aspect of SES is held constant).

decreases=negative statistical relation by which an increase in the dependent variable is associated with a decrease in the independent variable (for SES it represents a distinct effect of the aspects of SES that is statistically significant if the second aspect of SES is held constant).

decreases=negative statistical relation by which an increase in SES is associated with a decrease in the independent variable, the effect of SES is not confirmed as statistically significant and distinct in models holding the second aspect of SES constant.

Figure 37: Theoretical Interpretation of the Observed Effects of Subjective Socio-economic Status on Overweight



Source: HBSC 2014, see previously reported results for details

1) Figure based on statistically significant results from the estimation of the described relations in separate models (i.e. only including the dependent variable, the independent variable, age and gender). The relations were not confirmed controlling for effects between mediating variables, and the model was not tested in its entirety.

2) **increases**=positive statistical relation by which an increase in the dependent variable is associated with an increase in the independent variable (for SES it represents a distinct effect of the aspects of SES that is statistically significant if the second aspect of SES is held constant).

increases=positive statistical relation by which an increase in SES is associated with an increase in the independent variable, the effect of SES is not confirmed as statistically significant and distinct in models holding the second aspect of SES constant.

decreases=negative statistical relation by which an increase in the dependent variable is associated with a decrease in the independent variable (for SES it represents a distinct effect of the aspects of SES that is statistically significant if the second aspect of SES is held constant).

decreases=negative statistical relation by which an increase in SES is associated with a decrease in the independent variable, the effect of SES is not confirmed as statistically significant and distinct in models holding the second aspect of SES constant

The results from the separately calculated models confirm a negative statistical relation between both aspects of socio-economic status and overweight. This effect associates an increase in socio-economic status with a decrease in the risk of being overweight. The results suggest that possible mediated influences of socio-economic status through health relevant factors on overweight contribute to the negative statistical relation between socio-economic status and overweight in two ways. The upper part of the theoretical models in Figure 36 and Figure 37 show health relevant factors that potentially decrease the risk of being overweight and that are potentially increased by socio-economic status. The lower part of the theoretical models in Figure 36 and Figure 37 show health relevant factors that potentially increase the risk of being overweight and that are potentially decreased by socio-economic status. Further studies and research are needed to explore and confirm the relevance of these models for health inequalities in Luxembourg.

12.2 Discussion of the theoretical model

The theoretical understanding of socio-economic health inequalities in adolescence that underlies this thesis was summarised in a theoretical model of the influence of socio-economic status on adolescent health in chapter 2. In this section, this model is revisited and discussed in the light of the results that are presented and interpreted throughout this thesis. In line with the theoretical arguments described in chapter 2, the direction of the relations in the model are assumed to be from socio-economic status to adolescent health (Lampert & Richter, 2009; Lampert & Schenk, 2004). Each of the five research questions from chapter 5 pertains to a different element of the theoretical model and aims to explore or confirm that element. Revisiting the theoretical model therefore includes a revisit of answers to the research questions as discussed in the previous sections of this chapter, before the theoretical model's overall relevance can be discussed.

The first element of the theoretical model that was explored is the health phenomena under study. The results underline the importance and urgency of overweight and underweight as health phenomena and thus validate the importance of the example that was chosen to apply the theoretical model to. The next step in the analysis intended to confirm the existence of an element of the theoretical model, namely the relation between socio-economic status and overweight and underweight. The results are able to assert the existence of both relations but reveal that these relations are inverse. The sociological perspective of a social stratification of society through socio-economic status (see chapter 2) as well as the relevance of the socio-economic situation of the families for adolescents, health and adolescent health can be seen in these results. The theoretical model and its assumptions are thus so far corroborated, as long as they to allow for increasing as well as decreasing effects of socio-economic status on adolescent health outcomes.

The third element of the theoretical model to be investigated was socio-economic status, more precisely, the relevance of the differentiation between objective and subjective aspects of socio-economic status as indicated by the social-psychological theory of social cognition (Conner & Norman, 2005) and social comparison processes (Schnittker & Mc Leod, 2005). The analysis aimed at a confirmation of relevance of the differentiation between objective and subjective socio-economic via the observation of differentiated and distinct effects of both aspects of socio-economic status on overweight and underweight. The results for overweight revealed similar but differentiable and distinct effects of both aspects of socio-economic status on overweight and three health relevant factors. The relevance of the differentiation between objective and subjective aspects of socio-economic status and social-psychological processes

for socio-economic health inequalities in adolescents is thus confirmed and a further element of the theoretical model is corroborated. The results provide indications, that the effect of subjective socio-economic status on adolescent health is somewhat less pronounced and independent than the effect of objective socio-economic status.

The fourth step in the investigation involves the reiteration of the three elements of the theoretical model that have so far been confirmed, for the weight-related health concerns negative body image and weight reduction behaviour. The first two element of theoretical model (the importance of these additional examples and the existence of (inverse) relations between socio-economic status and adolescent health) are reaffirmed by the results for these additional examples. The third element of the theoretical model (the differentiation between objective and subjective aspects of socio-economic status) are not reaffirmed by the results for weight-related health concerns. In addition to these reaffirmations of previously analysed elements of the theoretical model, this step of the investigation gathered indications on a further element of the theoretical model: the role of interrelations between physical, behavioural and psychological health outcomes for the relation between socio-economic status and adolescent health. The results of this thesis are based on methods that cannot provide definite confirmations for this element of the theoretical model. The results do however provide indications that these interrelations exist between weight status and weight-related health concerns and that possible mediated contradicting indirect of effects of socio-economic status on these health aspects are an interesting topic for future investigations.

The fifth step in the investigation of the theoretical model explored one sub-element of the element of the theoretical model pertaining to the different pathways of the influences socio-economic status on adolescent health: the relation between health relevant factors and overweight and underweight. For overweight, the result for the relation with the health relevant factors were theoretically plausible, interpretable and identified useful starting points for future investigations of this element of the theoretical model. This element of the theoretical model is thus corroborated for overweight. For underweight, the results for the relations with the health relevant factors were theoretically implausible and difficult to interpret. This is an indication, that the element of the different pathways in the theoretical model as adopted in chapter 2 needs to be adapted before it can aid the understanding of the effects of socio-economic status on underweight.

With regard to the overall relevance of the theoretical model, the results presented, interpreted and discussed in this thesis lead to the conclusion, that the theoretical model aids the understanding of health inequalities among adolescents in Luxembourg when it take possible inverse effects of socio-economic status on adolescent health into account. While the model seems suitable for a further exploration and explication of the influences of socio-economic

status on overweight, it does not seem suitable for a further exploration of the influences of socio-economic status on underweight.

Based on the discussed results, this thesis concludes that the theoretical model aids the understanding of health inequalities among adolescents in Luxembourg but applies differently well to different health concerns and needs to take possible inverse effects of socio-economic status into account. More research is needed on specific health beliefs, health relevant elements of class cultures and habitus and the ways through which they influence adolescent health and behaviour to refine the theoretical model.

12.3 Limitations of the study

The reliability and robustness of the results and answers to the research questions as presented in this thesis could be limited due to factors pertaining to the sample, the data collection and a lack of reference points for the interpretation of the results.

First, there are factors in relation to the sample: The population from which the sample is drawn excludes a substantial proportion of the adolescent population, namely adolescents with migration background and adolescents who do not follow the national curriculum. This limits the generalisability of the results for the entire population of adolescents in Luxembourg. In addition, the size of the sample limits the power of the statistical analysis and it is possible, that some relevant relations that exist in the population were not detected in the analysis due to a lack of statistical power. This is all the more probable, because youth is a life phase characterised by rather low levels of negative health aspects, possible latent or delayed effects of socio-economic effects as well as a possible buffering or masking of effects of socio-economic status through contexts (e.g. peers, school) (Richter, 2005; West, 1997; Willems, 2010).

Next there are factors in relation to the data collection and the nature of the data that can be described as limitations of the study: Since the data is cross-sectional rather than longitudinal, causation had to be inferred from correlations and the theoretical background, but could not be tested empirically. The data from the HBSC study is based on self-reports of adolescents. While this increases the validity of some of the measures (e.g. measures of psychological well-being or social support), biases due to social desirability, impression management, self-deception or lack of the necessary information might reduce the validity of some measures (e.g. information about parents, body weight) (Currie, C. et al., 2008). While widely used, the categorisation of weight status according to BMI has been criticised for a potential underestimation of obesity (Reilly, El-Hamdouchi, Diouf, Monyeki, & Somda, 2018). Last but

not least, the choice of the indicators for socio-economic status was to a certain extend data driven. The results of the study would have gained in robustness and reliability if additional valid indicators of socio-economic status had been available (Diemer et al 2013). In addition, the validity and reliability of none of the measures has been thoroughly tested for Luxembourg. While it is justified and common practice to infer validity or reliability of measures from other countries, this could be a source of bias. A further source of bias could be the failure to take intersectionality into consideration. An intersectionality approach simultaneously considers multiple social categories and takes interlocking identities into account (McCall, 2005; Shields, 2008).

A final aspect limiting the informative value of the study is the explorative character of many of the analysis. The mirroring of the analysis for overweight and underweight and the wide scope of the literature review improved the interpretability of the data, but especially for underweight, a large proportion of the results cannot be interpreted in comparison to previous results due to a lack of reference points and previous studies. The lack of theoretical, medical and sociological understanding of adolescent underweight in affluent countries is a challenge for the interpretation of the results.

13 Conclusion

In conclusion, the achievements and implications of this thesis are discussed with regards to its contribution to the extant scientific knowledge, its impulses for future research and its recommendations for policy and prevention.

This thesis develops the existing scientific knowledge by contributing elements that aid in narrowing the gaps in the overall scientific and empirical knowledge on socio-economic health inequalities in youth that were identified in the literature review: The most important contribution to scientific knowledge is the newly gained empirical knowledge on underweight. The results on adolescent underweight for Luxembourg contribute to the identification of underweight as a potential health concern among adolescents in wealthy countries, the provision of reference points for the interpretation of future empirical results on underweight and the confirmation of a relation between socio-economic status and underweight in a wealthy context. The parallel analysis of overweight and underweight allows for the observation of similarities and differences between them. Especially the inverse relation observed between socio-economic status and adolescent underweight on one hand and adolescent overweight on the other hand shows the importance of considering these potential health compromising weight statuses separately. The observation of both positive and negative effects of socio-economic status on adolescent health is an important finding in itself. While exceptions to the social gradients have been observed previously, the repeated observations of such exceptions to the consensus guards the scientific community against complacency and serves as a reminder to continuously revaluate factors as societies change (Heinz et al., 2018; Inchley et al., 2016; Luthar, 2003; Lyman & Luthar, 2014).

A further contribution to the scientific knowledge is the confirmation of the relevance of the differentiation between objective and subjective socio-economic status for the analysis of adolescent health in wealthy contexts. Distinct effects of objective and subjective socio-economic status on adolescents' overweight and three health relevant factors (breakfast consumption, class climate and sedentary behaviour) were confirmed. As one of the few empirical studies that report and interpret the results for both aspects of socio-economic status, this thesis adds to the body of knowledge that is built by the scientific community to allow meta-analysis of the differences between objective and subjective socio-economic status in the future (Adler et al., 2000b; Goodman et al., 2003; Hoebel et al., 2017; Ritterman et al., 2009; Singh-Manoux et al., 2005).

Last but not least, this thesis expands the scientific knowledge on the Luxemburgish society and social processes in Luxembourg. First, the extant knowledge is expanded by the confirmation of international findings on adolescent overweight for adolescents in Luxembourg. Second, the extant knowledge is expanded by novel findings on adolescent underweight, body image and weight reduction behaviour as well as their relation with socio-economic status. Especially, the multivariate analysis of socio-economic inequalities in adolescent health are novel for Luxembourg.

Abundant impulses for future studies and research are developed by this thesis, in addition to its contributions to scientific knowledge: One of the impulses for future research is the gap in the existing scientific knowledge identified around the prevalence of underweight in wealthy societies and its relation to socio-economic status. The results for Luxembourg justify an international comparative analysis of the prevalence of underweight in adolescents and the association of underweight with socio-economic status (Lazzeri et al., 2014). While such a study could be based on data from the international HBSC study, some countries would need to be excluded due to high levels of missing values for body weight (Currie et al., 2015; Inchley et al., 2016).

A further interesting starting point for future research is the confirmation of the empirical relevance of the theoretical model. This thesis was able to confirm and precise several elements of the theoretical model for adolescents in Luxembourg through empirical analysis: the existence of socio-economic inequalities in adolescent health; the inverse nature of these inequalities for overweight and underweight; and the differentiation between objective and subjective socio-economic status. The combination of these confirmed elements with the explorative results on factors both associated with weight status and socio-economic status represent a refined theoretical model (see Figure 35, Figure 36 and Figure 37). This refined theoretical model is a valuable starting point to be tested in further research on the underlying processes and pathways involved in socio-economic inequalities in adolescent overweight. The refined theoretical model is also an interesting starting point to be reworked and complemented for future research on the underlying processes and pathways involved in socio-economic inequalities in adolescent underweight.

A research question for future studies arising from this thesis is whether the influence of subjective and objective socio-economic status on adolescent health shows different patterns in different domains of health. The scope of this thesis focussed on adolescent weight-related health and only allowed the analysis of single weight-related examples of physical health outcomes, psychological health outcomes and health behaviours. The question whether the differences in the relations of these examples with socio-economic status are indicative of overall patterns in the relation between socio-economic status and health aspects in these

domains arises. A systematic review of the literature or a systematic empirical comparison of the influence of subjective and objective socio-economic status in these different domains of adolescent health would be a worthwhile scientific endeavour and could reveal interesting patterns.

Finally, a need for methodological research on the validity and reliability of commonly used international measures for adolescents in Luxembourg is identified. This need is pressing for measures and indicators of socio-economic status as well as measures and indicators of health outcomes and behaviours. In the wake of future HBSC studies, it would be useful to include small scale studies testing the validity and reliability of a variety of measures and indicators used in different international large scale surveys (i.e. HBSC, PISA or the Global school-based Student Health Survey (GSHS)) for Luxembourg as well as to foresee physiological measuring of health indicators for a subsample of adolescents to analyse the reliability of the self-reported data.

From a health prevention and policy perspective, the present study is a confirmation that overweight in the Luxembourg's adolescent population is at a worrying level and that the decision of the Luxembourg government to continue their strategy "Gesond iessen – Méi beweegen" with a new national program for 2018-2025 was important (Le Quotidien, 2018). The observation that overweight affects adolescents with lower socio-economic status disproportionately reinforces the need to adapt the prevention of overweight to adolescents with comparatively lower socio-economic background and to act upon the underlying social inequalities (Godeau, Navarro, & Arnaud, 2012; O'Dea & Caputi, 2001). It is however questionable, whether the choice of a relatively upmarket supermarket as official partner enables the program "Gesond iessen – Méi beweegen" to reach these adolescents (Cactus, 2018).

Overweight prevention and the promotion of collective lifestyles that protect from overweight can have unintended negative consequences such as the stigmatisation of overweight or negative body image and unhealthy weight reduction behaviour among adolescent of all weights (O'Dea, 2005). Lazzeri and colleagues (2014, p. 2211) stipulate, that 'national policies targeted at controlling obesity and chronic diseases may have […] undesirable effects on the thinnest individuals'. Such undesirable effects are all the more dangerous given the substantial prevalence of underweight among adolescents in Luxembourg discovered by this thesis. Health prevention in Luxembourg therefore needs to take the risk of underweight into account and needs to continue to shift the focus from the prevention of overweight to the encouragement of overall healthy lifestyles (O'Dea, 2005). In accordance with the HBSC study in Germany, this thesis thus recommends that underweight should have a stronger importance in health prevention (Richter & Kolip, 2015).

The different socio-economic patterns of adolescents' risks of being overweight and underweight further underline the importance of adapting health prevention to demographic subgroups and targeting health prevention to identified risk groups. Policies and health interventions aiming to reduce adolescents overweight might for example increase the risk of being underweight of adolescents who have a high socio-economic status by reinforcing the stigmatisation of overweight that is already part of their habitus and collective lifestyle (Lazzeri et al., 2014). Targeted and adapted prevention messages on the other hand raise the awareness of demographic subgroups for their specific health risks, without necessarily entailing a redirection of public resources from existing prevention programmes. In the case of affluent adolescents, raising their and their parents' awareness of their risk of underweight could enable a redirection of their available resources towards the prevention of underweight (Luthar et al., 2013; Lyman & Luthar, 2014). In summary, the recommendations of this thesis for policy and health prevention are to expand present prevention programs and to improve them by taking underweight as health risk in adolescents into account and by targeting them to demographic subgroups and the risk groups identified by this thesis and other scientific research.

Table of figures

Table of tables

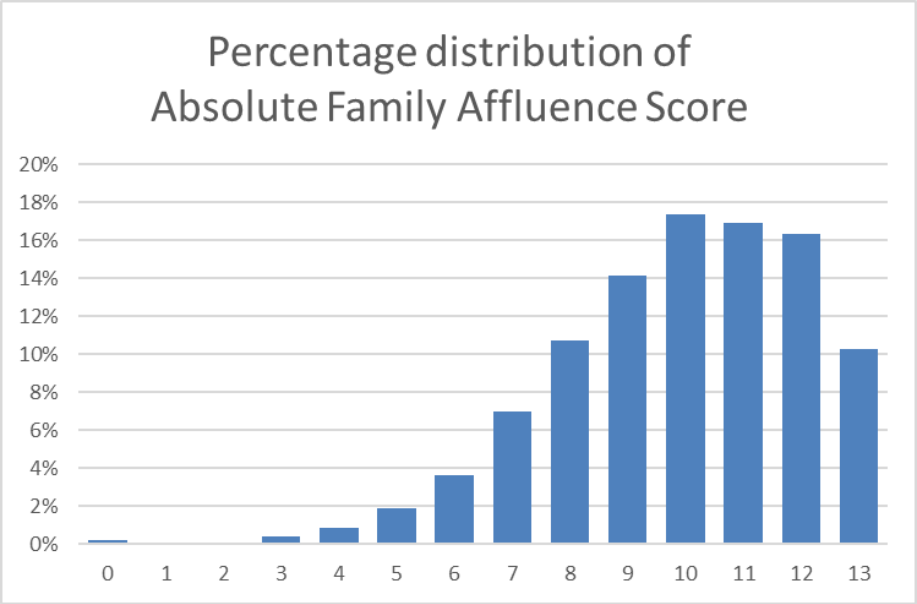
Appendix

Table 26: Negatively Evaluated Measures of Socio-economic Status

Conceptualisation of socio-economic status	Available measure of socio-economic status	Challenges for the available measure
Cultural capital	Parental education	Difficulties of adolescents to assess their parent's education because a high proportion of the adult population in Luxembourg has a migration background and visited foreign education systems
		Parental educational attainment in a foreign country might not translate into socio-economic status in Luxembourg
Occupational status	Parental occupation	Very high proportion of invalid or unclassifiable information: >50% of adolescents for father's occupation and +- 40% of adolescents for mother's occupation in the 2014 HBSC
Multidimensional status	Composite measures	Non-validity of parental education and occupation measures (see above)
Economic resources - poverty	Food insecurity – Going to bed / school hungry	Food insecurity is a separate concept that is linked but not identical to poverty
		Relation between going to bed / school hungry because there is not enough food at home and engaging in weight reduction behaviour (X2 (1, n=6692)=20.1, p=.000) in the 2014 HBSC data indicates that the operationalisation is invalid and unreliable for Luxembourg

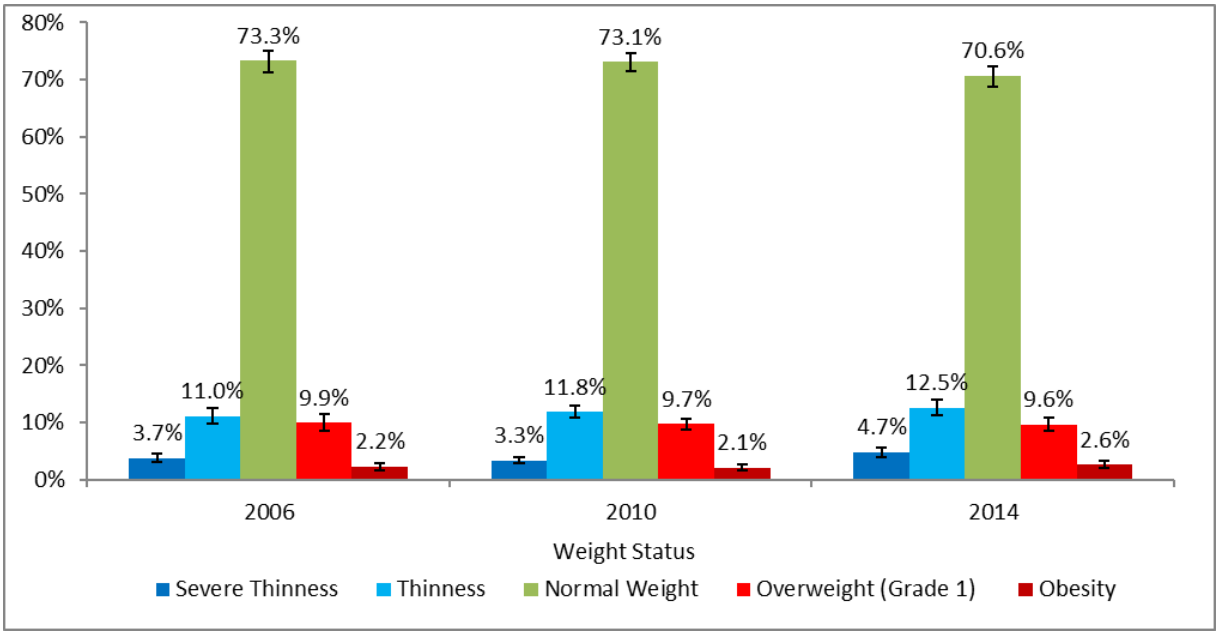
For further Information an references see Diemer et al., 2013; Duncan & Magnuson, 2003; Fram, Bernal, & Frongillo, 2015 and Niclasen, Molcho, Arnfjord, & Schnohr, 2013.

Figure 38: Percentage Distribution of Absolute Family Affluence



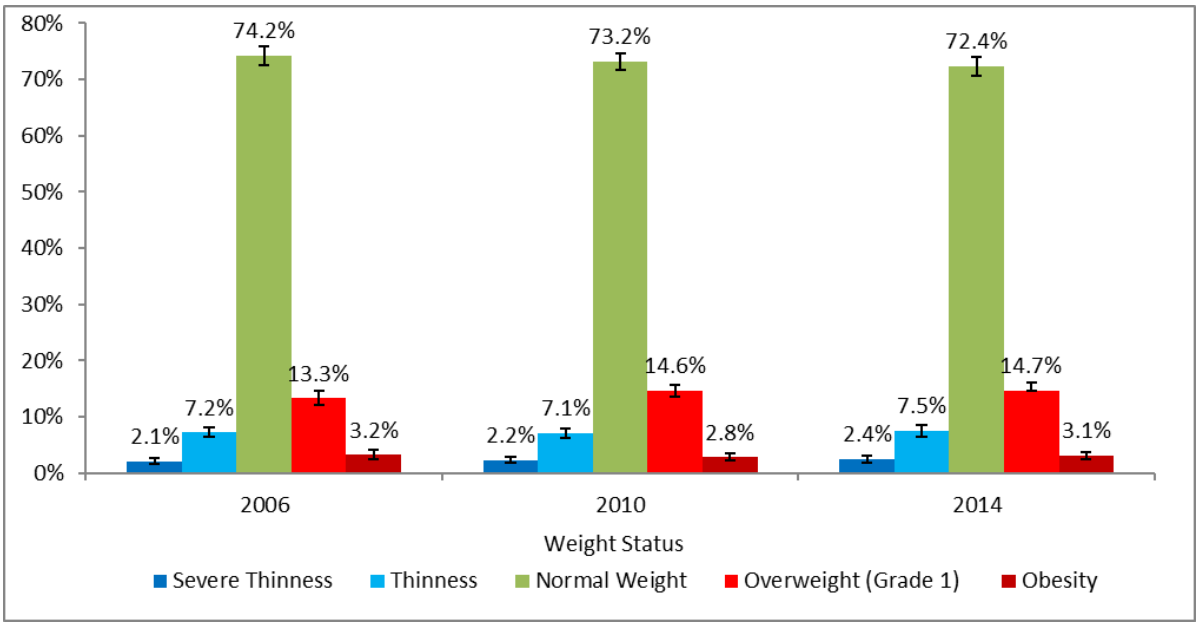
Source: HBSC-LU 2014, *n*=6028

Figure 39: Prevalence of Weight Status of 11- to 17 Year-old Girls in 2006, 2010 and 2014



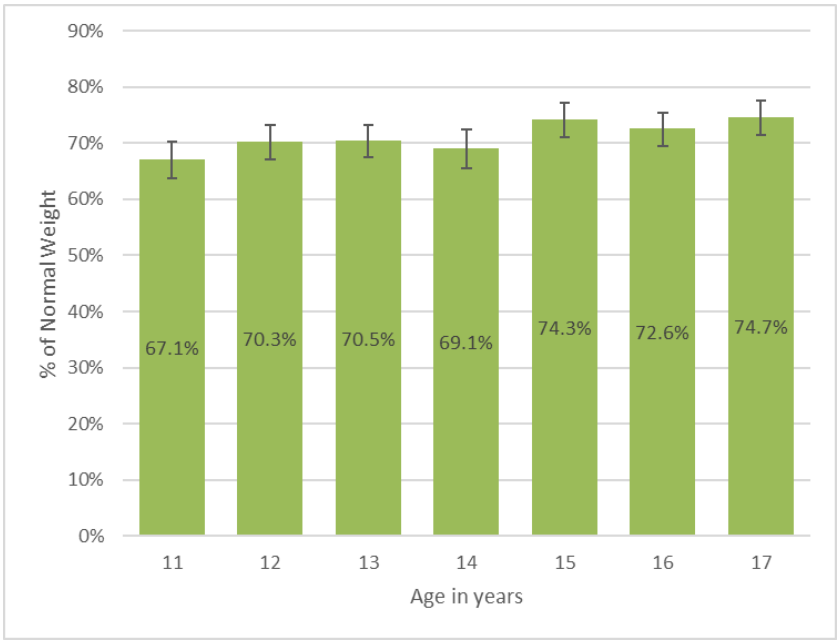
Source: HBSC-LU 2006, *n*=3875; HBSC-LU 2010, *n*=3850; HBSC-LU 2014, *n*=3025, weighted, 95% CI

Figure 40: Prevalence of Weight Status of 11- to 17 Year-old Boys in 2006, 2010 and 2014



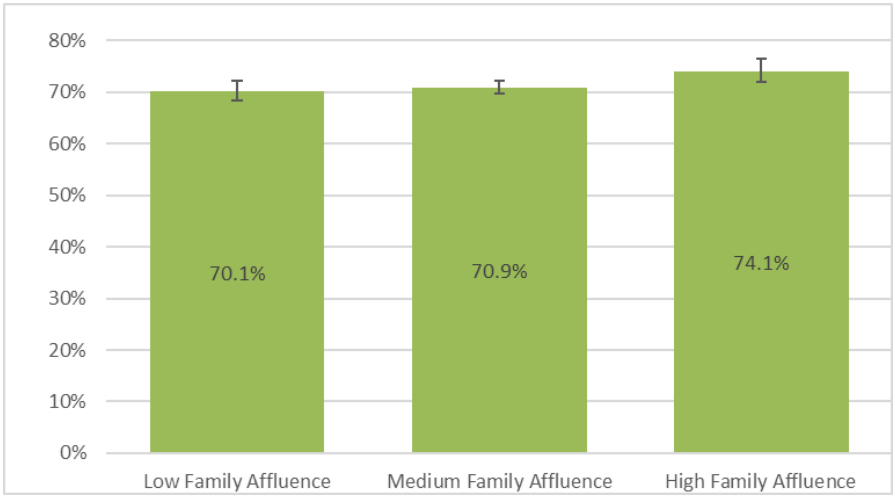
Source: HBSC-LU 2006, *n*=4018; HBSC-LU 2010, *n*=4008; HBSC-LU 2014, *n*=2828, weighted, 95% CI

Figure 41: Prevalence of Normal Weight of 11- to 17-Year-Olds by Age



Source: HBSC-LU 2014, *n*=5853, weighted, 95% CI

Figure 42: Prevalence of Normal Weight of 11- to 17-Year-Olds by Objective SES



Source: HBSC-LU 2014, *n*=3872

Table 27: Overweight, Coefficients, P-value and Odds ratio (95% Confidence Interval) of the Interaction between Age and SES, Gender, Age and SES

	Overweight		
	Coefficient	**p-value**	**Odds ratio (95% CI)**
Model 'Objective SES' with interaction SES / Age			
Relative Family Affluence#Age	.1707033	0.014 *	1.19 (1.04-1.36)
Gender (Female)	-.4340847	0.000 ***	0.65 (0.55-0.76)
Relative Family Affluence	-3.431342	0.001 **	0.03 (0.00-0.23
Age	-.0380544	0.303 ns	0.96 (0.90-1.04)
LR chi2 (DF)[1)]	92.25 (4)	0.000 ***	
AIC[1)] / BIC [1)]	4318 /4351		
Model 'Subjective SES' with interaction SES / Age			
Perceived Wealth#Age	.0359069	0.135 ns	1.04 (0.99-1.09)
Gender (Female)	-.4480711	0.000 ***	0.64 (0.55-0.75)
Perceived Wealth	-.7316216	0.034 *	0.48 (0.24-0.95)
Age	-.0923756	0.269 ns	0.91 (0.77-1.07)
LR chi2 (DF)[1)]	58.44 (4)	0.000 ***	
AIC[1)] / BIC [1)]	4352 / 4385		

Source: HBSC 2014, weighted

ns=p>0.05, *=p<0.05, **=p<0.01, ***=p<0.001

1) AIC, BIC and LR chi2 computed for unweighted data

Table 28: Correlation of Health Relevant Factors

FruitsD	VegiesD	SweetsD	SoftsD	Pressure_SW	LikeSchool	famcomdi	BreakfastD	PCGames2H	TVweek2H	Vigorous_A~i	Classmates~i	RELFAS_CO	M132intui	M1	alter
1	0.4591	0.1105	-0.04	-0.039	0.0985	0.1137	0.0815	0.1069	0.1126	0.1081	0.0323	0.1067	0.0637	0.0631	-0.074
	1	0.1045	-0.049	-0.023	0.0741	0.1072	0.0986	0.0866	0.098	0.0824	0.0058	0.1288	0.078	0.0707	-0.05
		1	0.2498	-0.021	-0.019	0.0166	0.062	-0.044	-0.051	-0.012	0.005	0.0275	0.0017	0.0348	-0.029
			1	0.0587	-0.122	-0.053	-0.103	-0.17	-0.191	-0.054	-0.035	-0.093	-0.038	-0.097	0.1026
				1	-0.269	-0.113	-0.102	-0.052	-0.045	-0.052	-0.11	0.0218	-0.079	0.0872	0.2644
					1	0.1674	0.1358	0.1207	0.0876	0.0542	0.1297	-0.001	0.056	0.0461	-0.177
						1	0.1257	0.0554	0.0741	0.0755	0.1031	0.1011	0.1893	-0.035	-0.132
							1	0.0995	0.1179	0.0519	0.0608	0.0855	0.0864	-0.069	-0.162
								1	0.334	0.003	0.046	0.037	0.037	0.143	-0.09
									1	0.0237	0.0127	0.0483	0.0524	0.0786	-0.147
										1	0.0318	0.1624	0.0784	-0.195	-0.047
											1	0.0601	0.0459	0.0013	-0.06
												1	0.3178	0.0081	-0.015
													1	-0.043	-0.103
														1	0.004
															1

Source: HBSC-LU 2014, *n*=4795

Table 29: Overweight and Underweight by Health Relevant Factors - Coefficients, P-Value and Odds Ratio (95% Confidence Interval

	Overweight			Underweight		
	Coefficient	**p-value**	**Odds ratio (95% CI)**	**Coefficient**	**p-value**	**Odds ratio (95% CI)**
Empty Model						
Gender (results for female)	-.4315873	0.000 ***	0.65 (0.56-0.76)	.6699402	0.000 ***	1.95 (1.66-2.30)
Age	-.4315873	0.054 ns	1.04 (1.00-1.08)	-.1415763	0.000 ***	0.87 (0.83-0.90)
LR chi2 (DF)[1)]	36.01 (2)	0.000 ***		117.75 (2)	0.000 ***	
AIC[1)] / BIC [1)]	4370/4390			4260/4280		
n=5312				*n*=5312		
Model 'Daily Fruit Intake'						
Eating Fruits Daily	-.0540741	0.516 ns	0.95 (0.80-1.11)	-.0392346	0.635 ns	0.96 (0.82-1.13)
LR chi2 (DF)[1)]	37.79 (3)	0.000 ***		119.69 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4328/4354			4221/4248		
n=5267				*n*=5267		
Model 'Daily Vegetable Intake'						
Eating Vegetables Daily	-.0178285	0.836 ns	0.98 (0.83-1.16)	.0605088	0.476 ns	1.06 (0.90-1.25)
LR chi2 (DF)[1)]	36.10 (3)	0.000 ***		119.06 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4299/4326			4216/4243		
n=5238				*n*=5238		
Model 'School Pressure'						
Pressured by School Work	-.1022311	0.250 ns	0.90 (0.76-1.07)	.1343473	0.130 ns	1.14 (0.96-1.36)
LR chi2 (DF)[1)]	39.24 (3)	0.000 ***		118.98 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4333/4359			4232/4258		
n=5275				*n*=5275		
Model 'Attitude towards School						
Liking School	.0499441	0.566 ns	1.05 (0.89-1.25)	.0330246	0.714 ns	1.03 (0.87-1.23)
LR chi2 (DF)[1)]	37.77 (3)	0.000 ***		116.38 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4324/4350			4213/4239		
n=5264				*n*=5264		
Model 'Family Communication'						
Family Communication	.0194791	0.810 ns	1.02 (0.87-1.19)	.1154971	0.157 ns	1.12 (0.96-1.32)
LR chi2 (DF)[1)]	36.70 (3)	0.000 ***		120.79 (3)	0.000 ***	
AIC[1)] / BIC [1)]	4329/4355			4209/4235		
n=5254				*n*=5254		

ns=$p>0.05$, *=$p<0.05$, **=$p<0.01$, ***=$p<0.001$

Source: HBSC 2014, gender and age are included in all of the models, but are not reported in this table

1) AIC, BIC and LR chi2 computed for unweighted data

Table 30: Daily Breakfast and Daily Sweets Consumption by Objective and Subjective SES

	Daily Breakfast			Daily Sweets Consumption		
	Coefficient	**p-value**	**Odds ratio (95% CI)**	**Coefficient**	**p-value**	**Odds ratio (95% CI)**
Basic Model 'Without SES'						
Gender (esults for female)	-.2962549	0.000 ***	0.74(0.66-0.83)	.1662458	0.012 **	1.18 (1.04-1.34)
Age	-.1495914	0.000 ***	0.86 (0.84-0.89)	-.0412129	0.013 *	0.96 (0.93-0.99)
LR chi2 (DF)[1)]	151.68 (2)	0.000 ***		10.35 (2)	0.006**	
AIC[1)] / BIC [1)]	6947/6966			5754/5774		
Model 'Objective SES'						
Relative Family Affluence	.6593477	0.000 ***	1.93 (1.58-2.36)	.2466092	0.034 *	1.02 (0.95-1.10)
LR chi2 (DF)[1)]	192.08 (3)	0.000 ***		15.32 (3)	0.002 **	
AIC[1)] / BIC [1)]	6908/6935			5751/5777		
Model 'Subjective SES'						
Perceived family wealth	.1824742	0.000 ***	1.20 (1.12-1.28)	.0225195	0.565 ns	0.86 (0.80-0.93)
LR chi2 (DF)[1)]	180.43 (3)	0.000 ***		10.54 (3)	0.014 *	
AIC[1)] / BIC [1)]	6820/6946			5756/5782		
Model 'Objective & Subjective SES'						
Relative Family Affluence	.5416185	0.000 ***	1.72 (1.39-2.12)	.2505453	0.041 *	1.28 (1.01-1.63)
Perceived Wealth	.1246172	0.001 **	1.13 (1.05-1.22)	-.0041708	0.920 ns	1.00 (0.92-1.08)
LR chi2 (DF)[1)]	204.48 (4)	0.000 ***		15.40 (4)	0.004 **	
AIC[1)] / BIC [1)]	6898/6931			5753/5786		

ns=p>0.05, *=p<0.05, **=p<0.01, ***=p<0.001

Source: HBSC 2014, *n*=5179 weighted / *n*=5250 weighted, gender and age are included in all of the models, but are not reported in this table

1) AIC, BIC and LR chi2 computed for unweighted data

Table 31: Daily Soft Drink Consumption and Physical Activity by Objective and Subjective SES

	Daily Soft Drink Consumption			Physical Activity		
	Coefficient	**p-value**	**Odds ratio (95% CI)**	**Coefficient**	**p-value**	**Odds ratio (95% CI)**
Basic Model 'Without SES'						
Gender (results for female)	-.4553186	0.000 ***	0.63 (0.56-0.72)	-.8685643	0.000 ***	0.42 (0.37-0.47)
Age	.0958616	0.000 ***	1.10 (1.07-1.13)	-.0412129	0.009 **	0.96 (0.93-0.99)
LR chi2 (DF)[1)]	109.17 (2)	0.000 ***		213.61 (2)	0.006**	
AIC[1)] / BIC [1)]	6235/6254			6355/6375		
Model 'Objective SES'						
Relative Family Affluence	-.7449315	0.000 ***	0.47 (0.38-0.59)	1.264085	0.000 ***	3.54 (2.84-4.41)
LR chi2 (DF)[1)]	156.50 (3)	0.000 ***		353.54 (3)	0.000 ***	
AIC[1)] / BIC [1)]	6189/6216			6218/6244		
Model 'Subjective SES'						
Perceived family wealth	-.0696149	0.065 ns	0.93(0.87-1.00)	.1504654	0.000 ***	1.16 (1.08-1.25)
LR chi2 (DF)[1)]	113.23 (3)	0.000 ***		233.09 (3)	0.000 ***	
AIC[1)] / BIC [1)]	6233/6259			6338/6364		
Model 'Objective & Subjective SES'						
Relative Family Affluence	-.75505	0.000 ***	0.47 (0.37-0.59)	1.244751	0.000 ***	3.47 (2.75-4.38)
Perceived Wealth	.0107037	0.788 ns	1.01 (0.93-1.09)	.0206109	0.595 ns	1.02 (0.95-1.10)
LR chi2 (DF)[1)]	156.53 (4)	0.000 ***		354.09 (4)	0.000 ***	
AIC[1)] / BIC [1)]	6191/6224			6219/6251		

ns=p>0.05, *=p<0.05, **=p<0.01, ***=p<0.001

Source: HBSC 2014, *n*=5250 weighted / *n*=5237 weighted, gender and age are included in all of the models, but are not reported in this table

1) AIC, BIC and LR chi2 computed for unweighted data

Table 32: Sedentary Behaviour – TV and PC-Gaming by Objective and Subjective SES

	Sedentary Behaviour – TV			Sedentary Behaviour PC-Gaming		
	Coefficient	**p-value**	**Odds ratio (95% CI)**	**Coefficient**	**p-value**	**Odds ratio (95% CI)**
Basic Model 'Without SES'						
Gender (results for female)	-.3199389	0.000 ***	0.73 (0.65-0.81)	-.6039673	0.000 ***	0.55 (0.49-0.61)
Age	.1461661	0.000 ***	1.16 (1.12-1.19)	.0840783	0.000 ***	1.09 (1.06-1.12)
LR chi2 (DF)[1)]	153.66 (2)	0.000 ***		148.99 (2)	0.000**	
AIC[1)] / BIC [1)]	6947/6967			6713/6733		
Model 'Objective SES'						
Relative Family Affluence	-.3558921	0.004 **	0.70 (0.57-0.85)	-.2251411	0.031 *	0.80 (0.65-0.98)
LR chi2 (DF)[1)]	165.15 (3)	0.000 ***		153.63 (3)	0.000 ***	
AIC[1)] / BIC [1)]	6938/6964			6710/6736		
Model 'Subjective SES'						
Perceived family wealth	-.1034737	0.003 **	0.90 (0.84-0.96)	-.0748517	0.034 *	0.93 (0.87-0.99)
LR chi2 (DF)[1)]	162.11 (3)	0.000 ***		155.03 (3)	0.000 ***	
AIC[1)] / BIC [1)]	6941/6967			6709/6735		
Model 'Objective & Subjective SES'						
Relative Family Affluence	-.2870741	0.007 **	0.75 (0.61-0.93)	-.1717649	0.118 ns	0.84 (0.68-1.04)
Perceived Wealth	-.072729	0.045 *	0.93 (0.87-1.00)	-.0563472	0.130 ns	0.95 (0.88-1.02)
LR chi2 (DF)[1)]	168.87 (4)	0.000 ***		157.12 (4)	0.000 ***	
AIC[1)] / BIC [1)]	6936/6969			6708/6741		

ns=p>0.05, *=p<0.05, **=p<0.01, ***=p<0.001

Source: HBSC 2014, *n*=5,178 weighted / *n*=5,172 weighted, gender and age are included in all of the models, but are not reported in this table

1) AIC, BIC and LR chi2 computed for unweighted data

Table 33: Class Climate by Objective and Subjective SES

	Class Climate		
	Coefficient	**p-value**	**Odds ratio (95% CI)**
Basic Model 'Without SES'			
Gender (results for female)	.0044629	0.944 ns	1.00 (0.89-1.14)
Age	-.0648055	0.000 ***	0.94 (0.91-0.97)
LR chi2 (DF)[1)]	22.91 (2)	0.000 ***	
AIC[1)] / BIC [1)]	6078/6097		
Model 'Objective SES'			
Relative Family Affluence	.4284148	0.000 ***	1.53 (1.23-1.91)
LR chi2 (DF)[1)]	37.62 (3)	0.000 ***	
AIC[1)] / BIC [1)]	6065/6092		
Model 'Subjective SES'			
Perceived family wealth	.1192497	0.002 **	1.13 (1.04-1.22)
LR chi2 (DF)[1)]	32.51 (3)	0.000 ***	
AIC[1)] / BIC [1)]	6070/6097		
Model 'Objective & Subjective SES'			
Relative Family Affluence	.3508029	0.003 **	1.42 (1.12-1.79)
Perceived Wealth	.0814626	0.045 *	1.08 (1.00-1.17)
LR chi2 (DF)[1)]	41.53 (4)	0.000 ***	
AIC[1)] / BIC [1)]	6063/6096		

ns= p>0.05, *=p<0.05, **=p<0.01, ***=p<0.001

Source: HBSC 2014, *n*=5,266 weighted, gender and age are included in all of the models, but are not reported in this table

1) AIC, BIC and LR chi2 computed for unweighted data

Table 34: Variance Inflation Factor (VIF) for Models predicting Negative Body Image

Variable	**Variance Inflation Factor (VIF)**			
	Model for body image (fat)	**Model for body image (fat) // Overweight**	**Model for body image (thin)**	**Model for body image (thin) // Underweight**
Relative Family Affluence	1.12	1.12	1.11	1.11
Perceived family wealth	1.11	1.12	1.12	1.12
Overweight		1.02		
Underweight				1.03
Gender	1.00	1.01	1.00	1.02
Age	1.01	1.01	1.01	1.02
Mean VIF	1.05	1.05	1.06	1.06

Source: HBSC 2014, *n*=5273, *n*=5266, *n*=5312, *n*=5266

Table 35: Variance Inflation Factor (VIF) for Models predicting Weight Reduction Behaviour

Variable	**Variance Inflation Factor (VIF)**		
	Model for weight reduction behaviour	**Model for weight reduction behaviour // Overweight**	**Model for weight reduction behaviour // Negative fat body image**
Relative Family Affluence	1.11	1.12	1.11
Perceived family wealth	1.12	1.12	1.13
Overweight		1.02	
Negative Fat Body Image			1.04
Gender	1.00	1.01	1.03
Age	1.01	1.01	1.01
Mean VIF	1.06	1.06	1.06

Source: HBSC 2014, *n*=5272, *n*=5265, *n*=5227

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