Authors note

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## Division of Labour

Trough out the process of this graduate thesis the amount of work has been fairly equal between the two of us. In the preparation of the text production, we distributed several topics that we separately had to deepen into. After determining the topic for the thesis we divided the introduction into eight different sections, and wrote the first edition of four sections separately. Stine wrote the first part of the introduction, definitions of body image terms, differences in body size perception with regard to age, gender and weight and predictors of misperception of body size. Pernille wrote the sections development of body image, theoretical understanding of misperception and perception of body size and its relation to eating disorders. As for the section about method used in this thesis Pernille wrote subsection about participants and procedures and statistical analysis. Stine wrote the subsection about measures. When it comes to the results, we worked together to gain a better mutual understanding of the data material and the results. The tables are also designed in company. Finally, we had a conversation about how to work out the discussion section. We discussed the results from the statistical analysis and from there we distributed different assignments/parts in regard to our four research questions. Pernille wrote about the descriptive findings and stability, while Stine wrote about gender differences and predictors.

After writing different parts of this graduate thesis separately, we compounded all the different components to an integrated text. Through the whole process we have given each other feedback on each other's respectively written parts. After we integrated the different parts, we worked through the text together several times. This to make sure that the final text had a consistent and similar composition.

### Our experience of working together

The work of this graduate thesis has mainly been conducted together. This to make sure of a consistent textual flow, a common and shared understanding of the content and an equal ownership to the work we have conducted. We agree that writing this thesis together has worked excellently; as we experience that we had similar expectations to each other's investment and contributions towards this writing process. We have enjoyed working together and appreciated each others support, uplifting and cheering comments throughout the ups and downs in the process of writing this graduate thesis.

Abstract

Overestimation and underestimation of one's body size implies a misperception of body size. Body size misperception is a key element in the development of eating disorders, and an important factor for maintenance of an overweight status. The current study aimed to examine body size misperception and predictors for misperception in a community sample of 6-year olds *(N=797)* who were followed up when they were 8 years old *(N=689*). The following predictors were examined: Body Mass Index (BMI) of children and their parents, depression and body dissatisfaction. Body size perception and body dissatisfaction was measured using the Children's Body Image Scale (CBIS). Children and parental BMI was estimated based on measured height and weight, whereas The Preschool Age Psychiatric Assessment (PAPA) was used to capture children's depression. About two thirds (ranging from 62.4%- 71.9%) of children participated in our study correctly estimated their body size. Those who correctly estimate their body size at age 6 also tended to do so at age 8. A significant gender difference was documented with regard to body size estimation: More girls than boys overestimated the size of their body at age 6, whereas more girls than boys underestimated at age 8. The child's BMI, parental BMI and body dissatisfaction predicted misperception, both cross-sectional and longitudinal, although some of the predictors were no longer significant when tested in a multivariate model. Results of this current study are relevant in providing a better understanding of how children perceive their body size, and contribute to a greater comprehension of the developmental progress of body size estimation.

*Keywords:* body image, body size estimation, body size misperception, children, predictors

Body image is defined as self-evaluation of the appearance and body shape (Banitt et al., 2008). In the research literature body image is often dichotomized into a perceptual component, which concerns the accuracy of body size estimation, and a subjective component which refers to satisfaction or dissatisfaction of one's body weight and shape (Gardner, 1996; Gardner & Brown, 2010; Wood, Becker, & Thompson, 1996). The perceptual component is often referred to as underestimation or overestimation, indicating an inaccurate perception of specific body parts or the size of the whole body (Cash & Deagle, 1997; Stewart & Williamson, 2004). Overestimation and underestimation implies a misperception and can thus be defined as a disturbance of the body image. Misperception is associated with negative feelings towards one's appearance and has shown to be a risk factor for the development of eating disorders as well as an important factor for maintenance of overweight (Garner, 2002; Maximova et al., 2008; Stice, 2002; Tremblay & Limbos, 2009).

The majority of studies on body size estimation have been conducted on adolescents and adult populations (Bergström, Stenlund, & Svedjehäll, 2000; McCabe, Ricciardelli, Sitaram, & Mikhail, 2006; Rolland, Farnill, & Griffiths, 1996; Truby & Paxton, 2002). It is not clear whether this findings holds for children. Further, longitudinal studies are particularly important as they generate knowledge on the developmental course of children's body size perception To the best of our knowledge, there are only two longitudinal studies on body size estimation in children, conducted by Gardner, Friedman, and Jackson (1999) and Gardner, Friedman, Stark, and Jackson (1999), respectively. As noted by Gardner, Friedman, Stark, et al. (1999), knowledge is needed on developmental changes in body size estimation. A better comprehension about predictive factors that contribute to the development of children's body size misperception is also needed to inform our understanding of early precursors of eating disorders. The relatively small number of studies on body size perception in children has mainly been conducted on relatively small samples and with cross-sectional designs, thus conclusions about the causal relationship between body size misperception and potential predictors cannot be drawn. For example, given that overweight predicts body size misperception (Allen, Byrne, McLean, & Davis, 2008), but at the same time, misperception can motivate to weight loss behavior (Liechty, 2010) and this way affect the weight status. With a cross-sectional design applied to this example inference on causal relationships cannot be drawn. In addition to the limitation of using cross-sectional designs, the use of small sample sizes cause

uncertainty and difficulties interpreting the results, increasing the chance that significant differences are false positive or that important differences can be missed. Further, few of the earlier studies include the measurement of children's actual body weight as many studies rather use self-reported height and weight (Gardner, Sorter, & Friedman, 1997; Saxton, Hill, Chadwick, & Wardle, 2009). It has been shown that self-reported weight and height, compared to measured weight and height, can lead to biased body size estimation, which confound the results (Elgar, Roberts, Tudor-Smith, & Moore, 2005; Shannon, Smiciklas-Wright, & Wang, 1991). Studies that do not include measurement of a child's actual weight status cannot with certainty conclude whether or not a child has an accurate perception or if a child misperceives their body size, due to inadequate basis of comparison. Notably, much of the research literature to this date makes assumptions about how different variables are associated with an outcome, looking into age-group differences, rather than age related changes (Smolak, 2002). Examining age group differences can inform us about how different age groups differ in regard to body size perception, but does not increase our knowledge on developmental changes. To examine individual change over time, rather that mean group differences between certain age groups, longitudinal designs must be applied.

To sum up, if we can identify predictors of body size misperception, these factors can be addressed in order to prevent the development of eating disorder symptoms. Due to the need for knowledge on the developmental course of body size perception and the shortcomings of earlier research, the current study aimed to examine the accuracy of body size estimation in a large sample of children from the age of 6 to 8. Gender differences and stability of body size perception are explored and we identify cross-sectional and longitudinal predictors of body size misperception.

**Definition of body image terms**

As mentioned above, body image consists of two components; one perceptual component, which refers to the accuracy of body size estimation of actual body size, and one subjective component, which refers to feelings towards own body size. Many overlapping constructs related to body image are presented in the research literature, resulting in a comprehensive amount of concepts and constructs. Different terms are often being used as interchangeably for one or both components of body image, e.g. body image disturbance, body image distortion, body size dissatisfaction and body size overestimation are often being used as synonyms. The diverse use of body image terms make it a challenge to compare different studies and their results (Pruzinsky &

Cash, 2002; Stewart & Williamson, 2004). We will therefore clarify the terms used in this graduate thesis.

Body image concern is defined as an excessive worry about one's body size and shape, independent of one's actual body size and weight (Thompson, Heinberg, Altabe, & Tantleff-Dunn, 1999a). In contrast, body size perception refers to how an individual perceive their current body size (Williamson, Davis, Duchmann, McKenzie, & Watkins, 1990b). The accuracy of the perceptional component of body image is measured by comparing an individual's actual weight (e.g., body mass index (BMI)) and his/her perception of own body size (Tremblay, Lovsin, Zecevic, & Lariviere, 2011). The greater the discrepancy, the more inaccurate a person perceives his/her body size. Inaccurate perception equals the term misperception.

Body dissatisfaction refers to the subjective negative evaluation of one's body or body parts (Stice & Shaw, 2002), and is often defined as the discrepancy between an individual's perceived current and perceived ideal body size (Thompson, Heinberg, Altabe, & Tantleff-Dunn, 1999b). If there is no discrepancy between perceived current and ideal body size, the term body satisfaction is being used in the research literature and will therefore also be used in the current thesis. Body dissatisfaction and satisfaction are seen as opposites and refer to the subjective component of body image (Wood et al., 1996).

Body image disturbance and body image distortion are used as synonyms and the two terms encompass how an individual's body weight or shape is experienced and the terms also cover an individual's misperception of current body size. A disturbed evaluation of own body image can occur independent of one's actual body weight and shape (Garner & Garfinkel, 1981; Stewart & Williamson, 2004; Williamson et al., 1990b). In the current paper body size misperception equals body image distortion.

**Development of body image in children**

Kearney-Cooke (2002) states that the translation of the physical body into a mental representation of it, as well as attitudes and behaviors towards the body constitutes a developmental process that is both complex and emotionally charged. Cash (2002) has provided a broad theoretical model of the development of body image, which Thompson, Roehrig, Cafri, and Heinberg (2005) later simplified. This simplified model is helpful in conceptualizing the complex construct of body image, and is organized by four principles: 1) Socialization by culture; 2) Personality

characteristics; 3) Interpersonal experiences, and 4) Activating events and situations. Socialization by culture encompasses cultural messages conveyed by mass media, which communicates the standards and expectations about an individual's appearance. In addition to communicating norms about what is attractive and unattractive, the cultural messages also express gender-based expectations tied to appearance and what counts as femininity and masculinity (Cash, 2002; Thompson et al., 2005). These expectations tend to be internalized by individuals and are seen as an important contributing factor in the development of attitudes toward one's body and body image. Some individuals are more sensitive to cultural socialization and personality characteristics (e.g. self-esteem, perfectionism and self-consciousness) seem to modify to which extent individuals are affected by these cultural messages about appearance (Thompson et al., 2005). The family environment also affects the socialization process; expectations, verbal and nonverbal communications within the family contribute to a child's adoption of the significance of appearance (Cash, 2002; Thompson et al., 2005). Being teased about one's physical appearance by peers is another interpersonal experience contributing to the development of body image (Cash, 2002). Exercising, changes in appearance, wearing certain clothing, mood states, body exposure, social feedback and comparisons are examples of events that activate emotion-laden automatic thoughts, and interpretations about one's appearance. If a girl generally evaluates her body negatively and experiences comments on for example, how her new bikini fits, this situation can be seen as an activating event where others comment on the bikini activates negative thoughts regarding her body. A comment (social feedback) such as this can evoke and reinforce negative evaluation of her body image. As suggested by the abovementioned theory, for individuals with a problematic attitude towards own body such activating events may foster unfortunate thought processes consisting of errors and distortions (e.g. biases, overgeneralization and overpersonalization) (Cash, 2002; Thompson et al., 2005).

In summary, socialization, personality characteristics, interpersonal experiences and activating events are assumed to contribute to the development of body image. These four factors have been explored empirically, and it is evidenced that they affect the development of body image (Smolak, 2002). However most of the research has revolved around factors contributing to body *dissatisfaction* as a facet of body image (Wertheim, Paxton, & Blaney, 2009), rather than how the perceptual

component affects the development of body image. Thus, given the lacuna of research on predictors and developmental processes of body size misperception, particularly among children, present work will examine predictors of children's body size estimation in order to contribute with demanded knowledge.

**Theoretical understanding of body misperception**

A person misperceives his/her body size when he or she report that their current body is smaller or larger than it actually is (Cash & Deagle, 1997; Stewart & Williamson, 2004). As noted, body image distortion can be seen as a misperception of body size (Tremblay & Limbos, 2009).

The perceptual component of body image is considered to consist of sensory and non-sensory components. The sensory component refers to responses of the visual system as well as tactile sensations, which both contribute to the perception of one's body (Slade, 1985; Thompson & Gardner, 2002). The non-sensory component refers to the interpretation of the visual input, affected by cognitive and affective factors e.g. how you see your selves in a mirror (visual input) can be affected by how you feel about what you see. For example, if a girl feels overweight, a consequence of this feeling can be that she perceives her own body size to be larger than it actually is. A person's belief, schemas and prior knowledge are cognitive factors that contribute to the perception of one's body image (Thompson & Gardner, 2002; Thompson et al., 1999a). Gardner et al. (1997) propose that the distortion of body image may be a result of sensory factors. Contrary to this Gardner, Friedman, Stark, et al. (1999) found that inaccuracies of estimating one's body size in both directions (over-, and underestimation) was not explained by sensory deficits, such as visual impairment. They claimed that it is associated with non-sensory factors, such as attitudes towards own body, cognitive biases and motivation to perform the task required to measure body size estimation. This can indicate that even though no sensory distortion is present an individual can perceive their body as smaller as or larger than they actually are. In the present inquiry we will therefore pursue non-sensory explanations for misperceptions.

The perceptual component of body image has attained increased interest over the past 30 years (Gardner, Friedman, Stark, et al., 1999; Thompson & Gardner, 2002). This may be due the connection between body image disturbances and eating disorders (Garner & Garfinkel, 1981), and a reconceptualization of the perceptual component: body size misperception is now seen as more than a sensory deficits.

Further, the emergence of the cognitive revolution in psychology has contributed to the research of body image disturbance, focusing on cognitive aspects of body image disturbances in terms of irrational beliefs and cognitive distortions regarding one's appearance (Thompson & Gardner, 2002).

Cognitive and information-processing theories on eating disorders and body distortion began to emerge in the 1990s (Vitousek & Hollon, 1990; Williamson, 1996). These theories aimed to explain misperception, and defined body image distortions as a cognitive bias that occurs without conscious awareness. According to these theories, the unconscious occurrence of this bias causes the person to experience this cognition as real (Williamson, Muller, Reas, & Thaw, 1999). Williamson (1996) argues that body size estimation can be understood in terms of a selective interpretation bias. This form of bias emerges in ambiguous and uncertain circumstances. Trying on clothes can be an example of an ambiguous situation that may trigger negative emotions and memories relating to body size and shape, which can lead to body size misperception and thus resulting in confirmation of already existing negative beliefs about one's body. Situations like these can activate negative emotions and memories linked to body size, which can conduce to a biased estimation of one's body. When individuals are exposed to ambiguous information they will selectively focus on the information confirming their existing beliefs about their bodies. The selective interpretation bias has been observed in individuals with eating disorders as well as in non-clinical samples of adolescents and adults (M. Cooper, 1997; Jackman, Williamson, Netemeyer, & Anderson, 1995). As these findings are related to adolescents and adults, we cannot conclude that the same mechanism is present in children. According to Williamson, Davis, Duchmann, McKenzie, and Watkins (1990a) the judgment of one's actual body size can be seen as a reactive and dynamic variable, indicating that the judgment will vary according to external or emotional events associated with body and weight. Events that activate concerns in regard to one's body size can cause the body image to worsen by increasing how a person perceives their body size and decreasing their ideal body size.

In sum, cognitive and information-processing theories now explain body size misperception in terms of cognitive biases.

**Perception of body size and its relation to eating disorders**

According to DSM-V, anorexia nervosa in adolescents and adults is characterized by intentional weight loss that is maintained by the patient. The disorder

is marked by disturbed body perception, and an excessive fear of gaining weight. For adolescents and adults bulimia nervosa is characterized by repeated episodes of overeating, and the patient's extreme occupation with control over one's weight conducive to compensatory behavior (e.g., self-induced vomiting and misuse of laxative) to prevent weight gain (American Psychiatric Association, 2013).

Body image distortion is often referred to in the literature on eating disorders as a syndrome of perceptual, cognitive, motivational and emotional elements (Garner & Garfinkel, 1981). The research literature generally shows that misperception of body size is a risk factor for the development and maintenance of anorexia nervosa and bulimia nervosa in adolescents and adult populations (Garner, 2002; Stice, 2002).

Eating disorders typically develop over the years of puberty (Ricciardelli & McCabe, 2001), and therefore much of the research has focused on the pubertal period (Attie & Brooks-Gunn, 1989; Holland, Farnill, & Griffiths, 1996). Thus, little is known about the developmental precursor of these disorders in younger children. Longitudinal studies on predictors of eating disorders symptoms have repeatedly shown that the strongest predictors for later symptoms are those already established when the study is conducted (Attie & Brooks-Gunn, 1989; Wichstrøm, 2000). Knowledge is therefore needed on the developmental precursor for eating disorders. As misperception is a characteristic of eating disorders, the development of body size misperception is in need for inquiry.

Within our western society being thin often equals being attractive and successful, especially for girls (Ricciardelli & McCabe, 2001). Ohring, Graber, and Brooks-Gunn (2002) state that the concern over weight and body size is ubiquitous and is now seen as a normal part of a woman's existence and the term "normative discontent" (1984) has been used to describe this phenomenon. Although the majority of studies on eating disorders concern adolescents and young adults, it has been shown that internalization of a thin body ideal takes place in childhood and that many children desire a BMI below the average norm (Truby & Paxton, 2002). Since great importance is placed on being thin, it is not a surprise that children are concerned with their weight and that they engage in weight loss behaviors, such as controlling their eating by regulating their calorie intake and exercising to lose weight (Ricciardelli & McCabe, 2001). Numerous cross-sectional studies have demonstrated the association between body dissatisfaction and dieting, cognitions and behaviors (e.g. unhealthy

exercising) in children, whereas longitudinal studies are still needed (Ricciardelli & McCabe, 2001; Smolak, 2004, 2009).

The exact prevalence of eating disorders among children is unknown, but it is presumed to be very low (Robin, Gilroy, & Dennis, 1998). This may be because eating disorders are difficult to diagnose in prepubescent children since they do not demonstrate the same set of symptoms as adults (Ricciardelli & McCabe, 2001). It is therefore a necessity to further study these early years of childhood so we can enhance our understanding of significant factors playing a role in the developmental psychopathology of eating disorders (Parkinson, Drewett, Le Couteur, Adamson, & Gateshead Millennium, 2012).

Studies of bulimia nervosa and anorexia nervosa have shown that adolescents and adults suffering from these eating disorders tend to estimate their current body size to be larger than their actual body size, and wish for a thinner body size compared to controls (P. J. Cooper & Taylor, 1988; Stice & Shaw, 2002). In contrast Doll and Fairburn (1998) found that adolescents and adults with eating disorders was more accurate in their estimation, although this finding were based on the patients self-reported, rather than measured weight.

Sand, Lask, Hoie, and Stormark (2011) conducted a study on body size estimation in a sample of Norwegian adolescents. They found that individuals at risk for developing eating problems, measured by The Eating Disorders Inventory for Children (EDI-C), were more inaccurate in their estimation of body size compared to those not at risk. High scores on the EDI-C defined the group with individuals at risk for developing clinical eating disorders, thus confirming the link between eating disorder symptoms and body size misperception. The high-risk group included both genders where girls tended to overestimate, and boys showed a trend towards underestimation.

Although the literature thus confirms that adolescents and adults with eating disorders tend to overestimate their body size, it may be problematic to generalize findings from the adult population with a full blown clinical eating disorder to children finding themselves in an early phase of potentially developing body image problems and disturbed eating. It is possible that body image disturbances in children are quantitatively and qualitatively different from adults (Legenbauer, Thiemann, & Vocks, 2014), further underlining the need to study body size perception as a possible precursor for later onset of eating disorders in prepubescent children.

**Differences in body size perception with regard to age, gender and weight**

**Age.** There have only been conducted a handful of studies on body size perception in children, and these seems to agree that children are, as the authors report it, "quite accurate" in their estimation of body size, e.g. Gardner et al. (1997) report that children are accurate in their estimation with an average overestimation of around 2%. Saxton et al. (2009) investigated the accuracy of body size perception in preadolescent children, and found that actual and perceived body size correlated, indicating that even preschool children estimate their body size quite accurately. This finding support the studies conducted by Gardner et al. (1997), Gardner, Friedman, and Jackson (1999) and Gardner, Friedman, Stark, et al. (1999) using non-clinical samples of children. They report that children between the age of 6 and 14 perceive their body size quite accurate, and even more accurate as they grow older (Gardner et al., 1997; Rolland et al., 1996; Saxton et al., 2009; Truby & Paxton, 2002). Gardner, Friedman, Stark, et al. (1999) conducted a longitudinal study on body size estimation in children age 6 to 14. Results from this study showed that overestimation tends to decrease, as the children aged. Truby and Paxton (2002), on the other hand, compared different age groups and found that the oldest age group underestimated more than the youngest age group, which can imply a trend towards underestimation, as children grow older. This implies that underestimation was more prominent in the oldest age group, compared to the youngest children in their sample. Studies presented above, indicate that children are quite accurate, and become even more accurate in their estimation of own body size during childhood. Notably though, four of the seven studies examining body size estimation in children have applied a cross-sectional design comparing the amount of children who correctly estimate their body size at different ages, thus do not report individual stability of body size perception over time (Gardner et al., 1997; Rolland et al., 1996; Saxton et al., 2009; Truby & Paxton, 2002). Thus, only three longitudinal studies on body size perception in children exist (Allen et al., 2008; Gardner, Friedman, & Jackson, 1999; Gardner, Friedman, Stark, et al., 1999), all three using relatively small sample sizes (N ranging from 216 to 259). The current study therefore adds to the existing literature by exploring stability of body size perception in a large sample of children from the age of 6 to 8. This inquiry seeks to describe how children estimate their body size at age 6 and 8.

**Gender.** Gardner et al. (1997) examined body size estimation in a sample of 216 children when they were 6, 9 and 12 years of age. The children showed a slight

overestimation of own body size, but there were no gender differences at any point of time. In contrast, other do report such gender differences: Saxton et al. (2009) found that the association between overweight and underestimation could especially be seen in girls, whereas Zhao et al. (2012) found that a higher percentages of boys underestimated their body weight, compared to girls in a sample of normal weight children. Truby and Paxton (2002) report that girls were more correct in their body size estimation at ages 7 to 12 compared to boys, but the gender difference was most pronounced within the oldest age group. Opposed to this, the youngest boys were not very good in estimating their current body size, although approving could be seen in the oldest age group. Overall, most of the research finds evidence for gender differences in body size estimation, although the findings are mixed.

**Weight.** Satisfaction with one's body has been found to be associated with perceived body weight (Thelen, Powell, Lawrence, & Kuhnert, 1992). In a study of adolescents, girls who expressed most body satisfaction perceived themselves as underweight, whereas those who were less satisfied with their body perceived themselves as overweight (Tobin-Richards, Boxer, & Petersen, 1983). Notably though, overweight children seem to underestimate their body size, whereas children within the normal or at the lower range of normal weight spectrum more often overestimate the size of their body (Gardner et al., 1997; Rolland et al., 1996; Saxton et al., 2009; Truby & Paxton, 2002). Over 90 % of overweight and obese children in a sample studied by Saxton et al. (2009) chose a figure smaller than their actual body size, when they were asked to identify the figure most similar to their own. Children who were under the $50^{th}$ centile of healthy weight for their age, showed a tendency towards perceiving themselves as larger than their actual body size, indicating that thinner children tend to overestimate their body size. The authors conclude that the degree of precision or accuracy of the perception is moderated by the child's weight status (Saxton et al., 2009).

There is evidence for gender differences in body size perception, and it seems that body size perception is age-, and weight dependent. As we studied a large sample of children over time, we can contribute to a better understanding of how gender and the children's weight status contribute to how children perceive their body size over the course of development.

**Predictors of misperception of body size**

In addition to examine age and gender differences in regard to body size estimation, the current study also aims to explore predictors of body size estimation. Based on the theoretical understanding of body image there are several factors assumed to affect estimation of body size, but many of them still remained to be identified as predictors (Gardner, Friedman, & Jackson, 1999; Maximova et al., 2008). Croll (2005) propound self- esteem, self- evaluation and evaluation of others as variables that may influence how an individual perceive one's body image, but have not empirically examined this hypothesis. We will therefore try to expand the existing knowledge of body size misperception by examine children's BMI, parental BMI, depression and body dissatisfaction as predictors of misperception. To the best of our knowledge, only three prospective studies have been conducted examining predictors of body size misperception in children and young adolescents (Allen et al., 2008; Maximova et al., 2008; Sand et al., 2011), and one prospective study examining predictors of misperception in adults (McCabe et al., 2006).

Children's BMI is found to significantly predict body size misperception in longitudinal study of 8 to13 year old boys and girls. BMI was a significant positive predictor of body distortion in terms of underestimation (Allen et al., 2008), thus higher BMI predicted more underestimation. This finding is consistent with previous cross-sectional research, reporting a positive association between BMI and body size misperception (Rolland et al., 1996; Truby & Paxton, 2002). McCabe et al. (2006) investigated body size perception accuracy of different body parts (chest, waist, hips, thighs and calves) in an adult sample. This study confirms that high BMI was a significant predictor for men's overestimation of four out of five body parts. On the other hand BMI was not a significant predictor for women's estimation accuracy.

Parental BMI has also shown to influence children's perception of their own weight status, independently of the child's own weight (Maximova et al., 2008). Notably though, the authors did not control for the child's BMI status. Given that BMI is genetically determined, the child's BMI status might have contributed more to the misperception than the parents BMI.

Studies of adults show that depression affect how an individual estimate his or her body size (McCabe et al., 2006; Slade, 1985; Taylor & Cooper, 1986, 1992). Slade (1985) proposed that persons with low mood have an increased tendency to attend to negative body information and evaluate their body more negatively,

resulting in estimation inaccuracy in their body size. Taylor and Cooper (1986) confirmed the link between depressed mood and the tendency to overestimate one's body size in a student sample of young women. An experimental study on a clinical sample conducted by Taylor and Cooper (1992) found that a depressed mood led to overestimation of body size. McCabe et al. (2006) found that depression was a significant predictor of women's estimation accuracy, but only for three body parts: hips, thighs and calves, respectively. Depression was not a significant predictor of men's accuracy estimation in the same study. To the best of our knowledge, there are no studies investigating depression as a predictor of children's body size estimation. The current study is therefore the first to examine depression as a predictor of body size misperception in children.

Children, as young as 5 and 6 years of age, have expressed body dissatisfaction (Davison, Markey, & Birch, 2000; Ricciardelli & McCabe, 2001). Elgar et al. (2005) found that body dissatisfaction predicted bias in self-reported weight in adolescents, where the adolescents underreported their weight status. Although this finding was based on self- reported, rather than measured weight, it is plausible that body dissatisfaction affects the perceptual accuracy of body size estimation. Notably though, it is not known whether this holds for children. We will therefore address this issue in the current study.

In summary, the research literature confirms that body size estimation is gender-, and weight dependent. Studies have shown that body size misperception is a characteristic often seen in anorexia nervosa and bulimia nervosa, and it is assumed that misperception is a risk factor for the development and maintenance of these disorders in adolescents and adults. Little research has been conducted on prepubescent children, and thus unknown if these findings can also apply for children. Notably, only one longitudinal study has examined predictors of misperception in children (Allen et al., 2008). To address this gap in knowledge, the current study aim to investigate body size estimation in a large and representative sample of Norwegian children and the following research questions will be answered:

1. How many under-, over- and correctly estimate their body size at 6 and 8 years of age?
2. Do boys and girls differ in their body size estimation?
3. Are body size estimation stable from the age of 6 to 8?

4. Are children's BMI, parental BMI, depression and body dissatisfaction predictors of under-, over- and correct body size estimation cross-sectional and longitudinal?

Based on existing research and theory we hypothesize that a higher number of children correctly estimate their body size at age 8 compared to age 6, and that there will be a significant difference between boys and girls at both ages. Given that children at an early age can correctly estimate their body size, we expect body size estimation to be stable from age 6 to 8. We further expect that the children's BMI, parental BMI, depression and body dissatisfaction will predict how children estimate their body size both cross-sectionally and longitudinally.

## Method

### Participants and procedure

This inquiry used data from Trondheim Early Secure Study (TESS), a longitudinal ongoing population study aimed at detecting factors associated with the development of mental health problems in children (Solheim, 2013). A letter of invitation was sent to all parents who had children born in 2003-2004 living in Trondheim, Norway in conjunction with an appointment for the mandatory health checkup for 4-year olds. Together with the invitation parents received a Norwegian version of the Strengths and Difficulties Questionnaire (SDQ) (Goodman, Ford, Simmons, Gatward, & Meltzer, 2000). The staff at the community health clinics informed the families about the study using procedures approved by the Regional Committee for Medical and Health Research Ethics. Parents who consented to participate were asked to bring the completed SDQ to the routine health checkup. As shown in Figure 1, 3456 were invited to participate, whereas 3358 attended the routine health checkup. The health care staff missed asking 166 families, whereas 176 families were excluded from the study because inadequate Norwegian language skills to fill out the SDQ screening (Wichstrøm et al., 2012). Of all the eligible parents N= 3016, 2745 of them agreed to participate.

To increase variability, children high on SDQ were oversampled whereas those with lower scores were undersampled. In order to do so, the children's SDQ scores were divided in to four strata. Using a random number generator 38.1% of the children was drawn from strata 1: 49.1% of the children was drawn from strata 2:

71.4% of the children from strata 3, and 89.2% of the children was drawn from strata 4. With increasing SDQ scores there was an increased probability to be included in the sample (Wichstrøm et al., 2012). The sample recruitment procedure is presented in Figure 1.

/Figure 1/

Children who were included visited the university clinic together with a parent for testing and observation. To this date the participants has been assessed at three times; the initial assessment (T1) at age 4, the second assessment (T2) was conducted two years later (age 6), whereas the third assessment (T3) was conducted at age 8 (Solheim, 2013). Because body size estimations were included only from T2 onwards we used data from T2 (6 years) and T3 (8 years) only.

At age 6 there were 797 respondents (mean age =6.7 years, SD=.17), whereas 689 participated at age 8 (mean age =8.8 years, SD=.24).

The mean BMI for girls at age 6 and 8 was 15.71 (SD=1.59) and 16.87 (SD=2.22) respectively. For boys aged 6 years the mean BMI was 15.73 (SD=1.49), whereas for 8 year olds the mean BMI was 16.72 (SD=2.05). Mean parental BMI at T2 was 25.91 (SD=0.2). See Table 1 for sample characteristics.

/Table 1/

## Measures

### Outcome

***Children's Body Image Scale (CBIS).*** CBIS is a pictorial scale used to measure young children's body size perception and body dissatisfaction (Truby & Paxton, 2002). Figure rating scales and silhouette drawings are two widely used measurements of body size perception, but using these methods without knowing the figure or silhouettes BMI makes it difficult to calculate how accurate or inaccurate an individual perceive their body size. Truby and Paxton (2002) therefore developed a new figure scale for children's body size perception, named Children's Body Image Scale (CBIS), which consists of pictures with known BMI categories.

Separate scales are provided for boys and girls; each scale includes seven photographs of different body sizes for each gender respectively (see Appendices A and B for the scales). Every figure presented in CBIS has a known and standard percentile curves for BMI, picture one representing the lowest BMI category and picture seven has the highest BMI category. CBIS as a measurement technique has prompt evidence for its reliability to measure body size perception in children. The validity of this measurement has also been supported (Truby & Paxton, 2002).

When using CBIS as a method, the child is asked to select the photograph most similar to its own body size. The discrepancy between actual body size and perceived body size is calculated by subtracting the known BMI of the selected picture from the child's actual BMI. The differential score indicates inaccuracy of body size perception, having a possible range from -6 to +6. For example, given that a child has a BMI category that corresponds to CBIS BMI category seven, but perceives herself as a CBIS BMI category number one, the differential score is six, which is the highest differential score possible to obtain. This indicates an underestimation of body size.

In the current study we measured the accuracy of body size perception by comparing the child's actual BMI with the chosen picture with known BMI category from CBIS. We categorized the scores as underestimation (-2 to -6), correct estimation (-1 to 1) and overestimation (2 to 6). Thus the outcome variable of the current study contains three possible scores: A positive score equals overestimation of own body size, no or just a slight differences between the child's actual BMI and how they perceive themselves implies an accurate estimation, whereas a negative score implies underestimation of own body size, that is, assuming one's body to be thinner than it actually is. For example, if a child's actual BMI are equivalent with CBIS figure number three, and the child perceive herself as the figure number five, this child will have a positive score of two, which implies overestimation and therefore inaccurate perception of own body size.

This nominal variable contains three possible scores constituting the main outcome variable of the current study.

**Predictors**

***Child and parent BMI.*** At age 6 and 8 both children and their parents' weight and height was measured. Weight was measured using a digital scale (Tanita BC420MA) and height was measured by a heightronic digital stadiometer

(QuickMedical, Model 235A). For children and their parents correction for light indoor clothing was applied, 0,5 kg and 1,0 kg, respectively. Body Mass Index was estimated based on the formula $kg/m^2$ .

***Depression*.** The Preschool Age Psychiatric Assessment (PAPA) (Egger et al., 2006) was used to measure depression. The PAPA is a semi-structured psychiatric interview with parents of children aged 2 to 6 years. The questions are based on the three previous months. Because major depression was very rare in this sample (Wichstrøm et al., 2012), the number of major depression symptoms along a continuous scale was used as an indication of the children's depressed mood (Wichstrøm, Belsky, & Berg-Nielsen, 2013), thus the higher number, the more symptoms of depression. In total, 9% of the interview audio recordings were recoded by blinded raters. The intrarater reliability between multippel pairs of raters was ICC = .90.

***Body dissatisfaction*.** To measure children's body dissatisfaction CBIS was used. Each child was asked to identify the body figure most like its own (perceived figure). Afterwards they were asked to nominate the body figure they would like to have/obtain (ideal figure). The difference between the category number of their perceived and ideal figure is used to measure body dissatisfaction (perceived-ideal discrepancy). A high discrepancy indicate that the child wish for another body figure than their current body size. A positive score implies a wish for a thinner body, whereas children wanting a larger body size attain a negative score. For example, if a child perceive herself to look like CBIS figure number seven, but whish for a body figure shown as CBIS picture five, this implies a discrepancy of a positive score of two, which implies that the child wish for a thinner body size than their current. On the other hand if a child perceive themselves as equivalent to CBIS picture one, and wish for a body like CBIS picture three the discrepancy score will be minus two, which implies that a child wish for a bigger body size than their current.

**Statistical Analysis**

Because Trondheim Early Secure Study used a screen-stratified sample, weighted analysis had to be conducted to yield correct population estimates. Weights were proportional to the inverse of the probability of selection of each subject, which means that low scores were "weighted up" and high scores were "weighted down" (Solheim, Wichstrøm, Belsky, & Berg-Nielsen, 2013). To arrive at corrected standard errors the Horwitz-Thompson estimator was applied.

Our analysis was performed using SPSS version 21, complex sample module (IBM, 2012) and STATA version 12 (STATA, 2011). Multinominal logistic regression analysis with weighted sample could not be conducted using SPSS, therefore this analysis were conducted using STATA.

Percentages of children who under-, correct- or overestimated their body size at 6 and 8 years are reported in Table 2. Gender differences were explored by multinominal logistic regression analysis using STATA. To assess if there was a significant difference in the proportion of under-, correct- or overestimation in body size between the two measurement points, a Marginal Homogeneity Test was applied. This test is a non-parametric equivalent of the paired sampled t-test. A t-test would be preferred, but as our outcome variables are multinomial the Marginal Homogeneity Test had to be used. Complex sample cross tabs was used to examine stability from 6 to 8 years, whereas Marginal Homogeneity Test was used to test whether the children estimated their body size differently at age 8 compared to when they were 6. These analyses were conducted separately for boys and girls. Notably, it is not possible to perform this test using weighted scale scores; we therefore had to test the difference between non-weighted scores at the two time points. However, there were marginal differences between weighted and non-weighted mean scores, justifying the use of the Marginal Homogeneity test.

Multinominal logistic regression analysis was also applied to examine predictors of children's misperception. As a first step, bivariate analyses were conducted, testing one predictor at the time. Secondly, a multivariate model was tested were all predictors were included. Gender was treated as a covariate in all analyses and both cross-sectional and prospective associations were examined.

We have conducted several analyses and ideally correction for multiplicity should have been carried out, but as some of the analyses conducted in SPSS do not provide exact p-values we had to compensate by adjusting our significance value. As a consequence of this, results that are significant at <.05 but >.01 should be interpreted as indicative and tentative.

## Results

Table 2 presents the children's body size estimation at age 6 and 8, in terms of underestimation, correct estimation and overestimation of own body size.

/Table 2/

As can be seen, 69.3% of boys and 65.7% of the girls correctly estimated their body size at age 6, whereas 62.4% and 71.9% respectively correctly estimated their body size at age 8. At both ages, more children underestimated than overestimated their body size.

Multinominal logistic regression analysis was conducted to explore whether there was a significant difference between boys and girls in terms of body size estimation. Result from this analysis showed that there was a significantly higher number of girls who overestimated at age 6, compared to boys (*B*= .53; *SE* = .26; 95% CI= [.02, 1.05]; *p*=.043). With regard to underestimation, on the other hand, no gender difference in underestimation was found at age 6. However, at age 8, more girls than boys underestimated their own body size (*B*= -.36; *SE*=.18; 95% CI= [.71, -.00]; *p*=.047), whereas no differences were found with regard to overestimation.

To examine stability in body size estimation, complex sample crosstabs was applied for each gender respectively. The results are presented in Table 3.

/Table 3/

As can be seen a high proportion of both boys and girls continue to correct estimate their body size, as they grow older. It appears that underestimation in boys was more stable than in girls. The proportion of children overestimating at age 8 is low compared to age 6. To test if there was a significant difference in the proportion of body size estimation from age 6 to 8 the Marginal Homogeneity Test was applied for each gender respectively (Veierød, Lydersen, & Laake, 2012). Notably, this test only generates a p-value. The results showed that both genders differed in their proportion of body size estimation from the age of 6 to 8.

Table 4 and 5 presents predictors of body size misperception examined cross-sectionally at ages 6 and 8 respectively, whereas Table 6 presents predictors of body size misperception examined prospectively.

/Table 4/

/Table 5/

/Table 6/

As shown in Tables 4 and 5, children's BMI was found to be a significant predictor for both under-, and overestimation at 6 and 8 years, tested bivariate with a cross-sectional design. When the children's BMI was included in the multivariate model the child's BMI still predicted under-, and overestimation at age 6 but only overestimation at age 8. Children's BMI status was also found to be a prospective predictor of underestimation from 6 to 8 years of age ($p < .0001$), both in the bivariate and multivariate analyses. Parental BMI predicted underestimation at age 8 ($p < .0001$), as well as from 6 to 8 years ($p < .001$) when tested bivariate. However, as can be seen in Table 6, when parental BMI was tested prospectively in a multivariate model, the association was no longer significant. Depression did neither predict children's body size estimation cross-sectionally nor longitudinally. Body dissatisfaction, on the other hand, was found to predict both under-, and overestimation when the children were 6 years ($p < .0001$). Those who had a high score indicating dissatisfaction with current body size predicts overestimation, whereas those with low score in regard to body dissatisfaction predicts underestimation. Body dissatisfaction did not prospectively affect body size estimation.

## Discussion

The current study aimed to investigate body size estimation in children from the age of 6 to 8. We explored the prevalence of under-, over- and correct estimation, examined gender differences as well as stability of body size estimation. Cross-sectional and prospective predictors of body size estimation were also investigated.

Our results show that about two thirds of both boys and girls at both ages estimated their body size correctly. As the majority estimated their body size correctly, this finding is consistent with earlier findings (Gardner, Friedman, & Jackson, 1999; Gardner, Friedman, Stark, et al., 1999; Gardner et al., 1997; Saxton et al., 2009). As for those who misperceive at age 8, 36.0% boys and 25.2% girls perceived themselves as thinner than their actual body size, whereas 20.7% and 19.3% misperceived in this direction at age 6, respectively. As expected, more girls than boys overestimated their body size at age 6, although this was not evident at age 8. There was no difference

with regard to underestimation at age 6, but two years later, more girls than boys underestimated their body size. Children who correctly estimated their body size at age 6 also tended to do so two years later. Those who overestimated at age 6, on the other hand, do not tend to do so at age 8. All in all, we found that the children estimated their body size significantly different at age 8 compared to when they were 6, a finding that applied to both boys and girls.

The child's BMI showed to be a strong predictor for how the children estimated their body size, both cross-sectionally and prospectively: children with a relatively higher BMI tend to underestimate their body size. In accordance with our hypothesis, parental BMI and body dissatisfaction also showed to be significant predictors of the children's misperception. High parental BMI predicted underestimation, both cross-sectional and longitudinal. Notably though, in contrast to findings from adult samples (McCabe et al., 2006; Taylor & Cooper, 1986, 1992), depression did not predict body size estimation in any of the analysis preformed.

**Gender differences in body size estimation**

As we did find that more girls than boys overestimated their body size at age 6, whereas more girls underestimated at age 8 compared to boys, our work contrast those of Gardner et al. (1997) and Gardner, Friedman, Stark, et al. (1999). However, our results concord with the findings by Truby and Paxton (2002), Saxton et al. (2009) and Zhao et al. (2012). In our sample a higher number of girls show a correct estimation by increasing age, whereas the same pattern is not seen in boys. Whether this developmental trend is statistical significant needs further exploration. If so, it can imply that girls develop the ability to estimate their body size correctly earlier than boys. Truby and Paxton (2002) claimed that 7-year-old boys tested in their sample were unable to estimate their body size using CBIS, but as the boys grew older they were more able to perform the task. They further claimed that accuracy in body size perception develops earlier in girls compared to boys. It is possible that gender differences in body size perception can be explained by potentially differences in cognitive development during childhood. It has been shown that girls develop the ability to read and write earlier than boys and girls in average are better in these abilities, whereas boys on average have better mathematical abilities (Tetzchner, 2001).

It is reasonable to assume that the higher number of girls who underestimate at age 8, compared to boys, is related to a wish for a thinner body, thus they perceive

their body to be thinner than it actually is. Underestimation may reflect a greater exposure of slim female pictures presented in media, which may imply that our culture place a great value of being thin for girls. This can result in girls identifying themselves with the slim CBIS-picture. As the girls possibly identify themselves with the pictures presented in CBIS, boys on the other hand might not be able to identify themselves with the CBIS –picture (Truby & Paxton, 2002). This may be due to that CBIS is a scale ranging from thin to fat, rather than from thin to muscular, and a muscular body might be the ideal body figure for boys. Ricciardelli, McCabe, Holt, and Finemore (2003) found that boys in the age between 8 and 11, desired a larger body size, placed a greater importance and perceived a greater pressure to increase their muscles. Notably though, this might not be evident for boys in our sample, as they are younger than the sample studied by Ricciardelli et al. (2003). On the other hand, as shown, the small existing numbers of studies discord in regard to finding gender differences. Thus, such differences might not be that evident after all. In addition, the gender differences reported might be related to CBIS as a measurement technique, rather than gender differences in body size estimation per se.

Further, although mean BMI increase by age, the increase starts earlier in girls than in boys, as shown by BMI reference curves in Appendices C and D for each gender. Such differences in BMI status during development can possibly contribute to gender differences in body size perception as well as that girls develop towards a rounder body size at an earlier age and "roundness" is seen as socially undesirable, as the ideal for females tend to be thin. This might explain why girls in our sample underestimate at age 8 compared to boys (Smolak, 2002; Tiggemann, 2002). Notably though, Zhao et al. (2012) found that more boys than girls underestimated their body size in a sample of 2708 Chinese children.

The mixed findings in regard to gender differences might be due to the use of different measurement methods. A diversity of measurement procedures have been applied in the research on body image, thus comparing results is difficult (Gardner, 1996; Smeets, Smit, Panhuysen, & Ingleby, 1997).

**Stability**

Our findings reveal that the proportion of children who under-, over- or correctly estimate their body size are significantly different at age 6 compared to age 8 for both genders. Stability was seen in the children who correctly estimated their body size, whereas underestimation was fairly stable, but only a few of those who

overestimated their body size at age 6 still did so at age 8. Thus our finding imply that overestimation tend to decrease by age. This is supported by the study conducted by Gardner, Friedman, Stark, et al. (1999). Although overestimation seems to decrease with increasing age in childhood, overestimation is prominent in adolescence (Bergström et al., 2000). Puberty is a time where body image and physical appearance are undergoing a rapid change, and at the same time others opinions become exceptionally important (Levine & Smolak, 2002; Wertheim et al., 2009). It is well known that during puberty identity is closely tied to one's body and physical appearance as well as one's body image becomes more important than during childhood (Levine & Smolak, 2002). Your body and physical appearance become an expression of who you are, and a potential marker for status. Since thinness is positive for social status and are perceived as ideal in today's western society. Because our perception might be colored of how we evaluate our body, this can possibly contribute to why adolescents and young adults more often overestimate their body size compared to children. Careful considerations should be taken when measuring body dissatisfaction and body size misperception as two separate constructs. Theoretically, they do overlap, given that both these constructs are different aspects of body image. Thus, it is possible that when measuring body size perception separately, we also tap the construct of body dissatisfaction.

Further, there is a risk that categorizing body size estimation the way we have done camouflages some of the actual differences. For example, a child might have a discrepancy score of + 2, indicating an overestimation at age 6 (e.g. the child's BMI is equivalent with CBIS-picture 4 but perceive that one's body is like a CBIS-picture number 6), and have a discrepancy score of +1 two years later, thus at age 8 being categorized as a correct body size estimator. This implies that the child overestimated at 6 years of age and moved towards correct estimation two years later. Notably though, it is a quantitatively small change in the child's estimation that has a prominent impact on our results. On the other hand, if a child has a discrepancy score of +2 at age 6 and two years later have a discrepancy score of +4, this can be seen as a bigger change in the child's body size estimation, compared to the above-mentioned example. Even though this change is more prominent, our analysis will not capture this change because the child still falls in under the overestimation category. On the other hand, it might be qualitatively differences between those who under-, correct-,

and overestimate, thus treating body size estimation as a continuous variable may not be a better option.

**Predictors of body size estimation**

The current prospective study confirms earlier cross-sectional findings of the association between BMI and body size estimation (Allen et al., 2008; McCabe et al., 2006; Rolland et al., 1996; Truby & Paxton, 2002), by showing high BMI to be a predictor of body size underestimation. Misperception in terms of underestimation may serve as a protective function for the child, as heavier children might avoid the feeling of being heavier than they really are, compared to lighter children (Allen et al., 2008). This self-protective function may be adaptive for heavy children who experience that they are discrepant from the ideal of thinness. The research literature have repeatedly shown that overweight and obesity are stigmatized conditions, associated with a range of negative descriptions (Neumark-Sztainer & Haines, 2004), which might be adaptive to protect oneself from.

We further found parental BMI to predict body size misperception, which have also been reported earlier (Maximova et al., 2008). We expand earlier findings by showing parental BMI to predict body size estimation, even when children's BMI are accounted for. Independent of children's BMI, high parental BMI predicts underestimation at age 8 as well as from 6 to 8 years, when tested bivariate. When parental BMI was included in a multivariate model it predicted children's overestimation at 8 years of age. It is possible that parental BMI contribute to the child's perception of own body through the communicative value of parental BMI, e.g. a parent with high BMI may express dissatisfaction with own body that the child absorb and internalize. As parents with high BMI possibly pass on the association between own body and dissatisfaction, this can affect the child to be more dissatisfied with their body size, and might result in strive towards a thinner body. The internalization of dissatisfaction with own body can contribute to how a child estimates their body size.

Depressed mood is found to predict overestimation of body size in adults when tested cross-sectionally and experimental (McCabe et al., 2006; Taylor & Cooper, 1986, 1992). To the best of our knowledge, this is the first study to examine depression in children as a predictor of body size misperception. The results reveal that depression does not predict children's misperception. This may be due to the different clinical expression of depression in children and adults. Children might

express depression with disturbing behavior and tantrums, guilt or psychomotor changes (Graber, Gallerani, & Frankel, 2009), whereas adults often show symptoms like inhibition, lack of energy and discouragement (American Psychiatric Association, 2013). Adults suffering from depression may also experience hopelessness, as well as situations often feels insuperable and unmanageable. Graber et al. (2009) state that depression have some common set of symptoms across all ages, but other symptoms associated with depression might be dependent of developmental levels, e.g. how cognitive advanced the child is. Depression can affect cognitive function in adults, which may affect perception of body size (Thompson & Gardner, 2002; Thompson et al., 1999a). Depression has also shown to affect children's cognitions as it can cause concentration problems, cognitive distortions, as well as cognitive errors (Abela & Hankin, 2008). Whether depression in children affect cognitive function in the same way as it does in adults is unknown and needs further investigation. In sum, even though it is reasonable to argue that depression affect how one perceives and estimate own body, our results did not support depression as a predictor of body size estimation in children.

Our study is the first to examine body dissatisfaction as a predictor for children's misperception. The results show body dissatisfaction to be a significant predictor of children's misperception in terms of both under-, and overestimation at age 6 when this factor was tested separately. Those who are dissatisfied with their body more often overestimate, whereas those who score low on body dissatisfaction (i.e. are more satisfied with their body size) more often underestimate. Thus, being quite satisfied implies that you estimate your body to be thinner than it actually is. A possible explanation of the finding that body dissatisfaction predicts overestimation might be that people who overestimate experience themselves far away from the thin ideal and see themselves as bigger than they really are. When body dissatisfaction was included in a multivariate model, body dissatisfaction predicted underestimation only. It may be that those who are dissatisfied with their bodies are highly influenced by the cultural messages related to body and thinness. Those who are dissatisfied experience themselves to be far from their ideal, which further can affect how they perceive their own body size. On the other hand, as already mentioned, body dissatisfaction and body size perception might be overlapping constructs, possibly explaining our findings. BMI is included in measures of both body size perception and body dissatisfaction, as the differential scores are based on BMI for both.

The research on body size estimation has received a great deal of critique, due to mixed results and terminological confusion (Pruzinsky & Cash, 2002; Thompson & Gardner, 2002). In addition there seems to be insufficient knowledge about how aspects of body image corresponds to each other and we have little knowledge about to which extend body dissatisfaction and body size perception overlap (Thompson, Penner, & Altabe, 1990). Further investigation is therefore highly needed to acquire a better understanding of how these two constructs relate to each other.

**Strengths and limitations**

Strengths of the current study are the use of a large and representative sample and the longitudinal design, which allow for generalization of findings in addition to that causal relations can be explored. Another strength is the use of measured, rather than self- or parent- reported height and weight, to calculate BMI. Further, figural rating scales are measurement techniques that are simple and quick to use, when examining body size estimation, and require less verbal fluency, thus are easier for the child to comprehend than e.g. questionnaires. Picture scales are appealing in assessment of children because it is easy to administer and it does not require sophisticated equipment (Truby & Paxton, 2002). CBIS, which is a pictorial scale, has the unique feature as each picture presented in the scale has a known BMI.

Despite the strengths of the current study, some limitations must be noted. Because we designed the outcome variables as categorical, some of the children's change in body size perception from 6 to 8 years might be camouflaged. As already mentioned a small change in the child's estimation can have a prominent impact on our results, on the other hand, if a child have a larger discrepancy in the same direction with increasing age, this change will not be captured. It is also criticizable that a large part of our sample is of Norwegian ethnicity and we can therefore say little about cultural diversity regarding body size estimation.

Another limitation concern the fact that the children in our study are quite young of age, and it can therefore be insecurity attached to the children's understanding of the purpose and execution of CBIS. When measuring the perceptual component of body image there is a need to be aware of developmental limitations of younger children. The attentional capacity of children under the age of 7 might be limited, which can make lengthy procedures involving several measurements a challenge (Gardner, 2002). On the other hand, the CBIS only takes a few minutes to administer, thus do not acquire a child's lengthy attention. Using pictures may rather

capture the children's attention, as they can be appealing to them. On the other hand there are conducted few studies on children's early perception of own body, and it is needed further research on this age group and whether young children understand the purpose and execution of CBIS. Investigation of young children's body size misperception and its possible relation to later development of eating disorders is also needed.

As we have conducted several analyses, correction for multiplicity should ideally have been carried out. However, the Multinomic logistic regression option in the Complex Samples Module in SPSS does not provide p-values for individual ORs, just summary statistics for each variable (covering both underestimation and overestimation). Therefore, as an alternative we adjusted our significance value downwards to $p<.01$. Hence, p-values >.01 but <.05 should be interpreted as mere indicative and tentatively suggesting statistical significance. Findings in regard to gender differences at both 6 and 8 years are significant when applying a statistical significance level of .05, and these findings should be interpreted as tentative.

Although this study is longitudinal, a limitation might be that we follow this sample of children only over a two-year period. Future studies should explore larger time intervals, in order to capture the change in body size estimation during the child- and adolescent years.

**Conclusion and summary**

This study aimed to explore body size perception in a large and representative sample of children from the age of 6 to 8, and to investigate stability, gender differences and predictors of misperception. The majority of children in our sample correctly estimated their body size at 6 and 8 years of age. Stability in children's estimation was found for those who correctly estimated their body size. In regard to gender differences, more girls overestimated at age 6 and underestimated at age 8 compared to boys. Children's BMI, parental BMI and body dissatisfaction predicted the children's body size estimation both cross-sectionally and prospectively, whereas depression did not relate to body size estimation.

A greater understanding of the degree and nature of body size estimation in children, as well as what contributes to misperception and its developmental course is of significance in order to prevent the development of full blown eating disorders. Studies show that parents underestimate their children's weight, which is a barrier for children achieving obesity-treatment (Maximova et al., 2008; Miller et al., 2007). For

children who are overweight, recognizing and correctly perceiving their actual weight status might motivate for change. As confirmed in the literature overweight children tend to underestimate their body size. The few existing studies on children's body size perception mainly report correlational data obtained from cross-sectional studies, which cannot separate causes from consequences.

Identification of predictors of body size misperception has slowly begun to emerge, but research is still in demand. Future studies should examine predictors of body size misperception with longer follow-ups, capturing development towards puberty and young adulthood. Identification of early predictors of body size perception is also of importance in regard to overweight children.

If we gain a better understanding of what contributes to the unfortunate development of a disturbed perception of body size, we will have an opportunity to intervene and correct this misperception and possibly its severe consequences.

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*Figure 1.* Flowchart of sample recruitment (Wichstrøm et al., 2012)

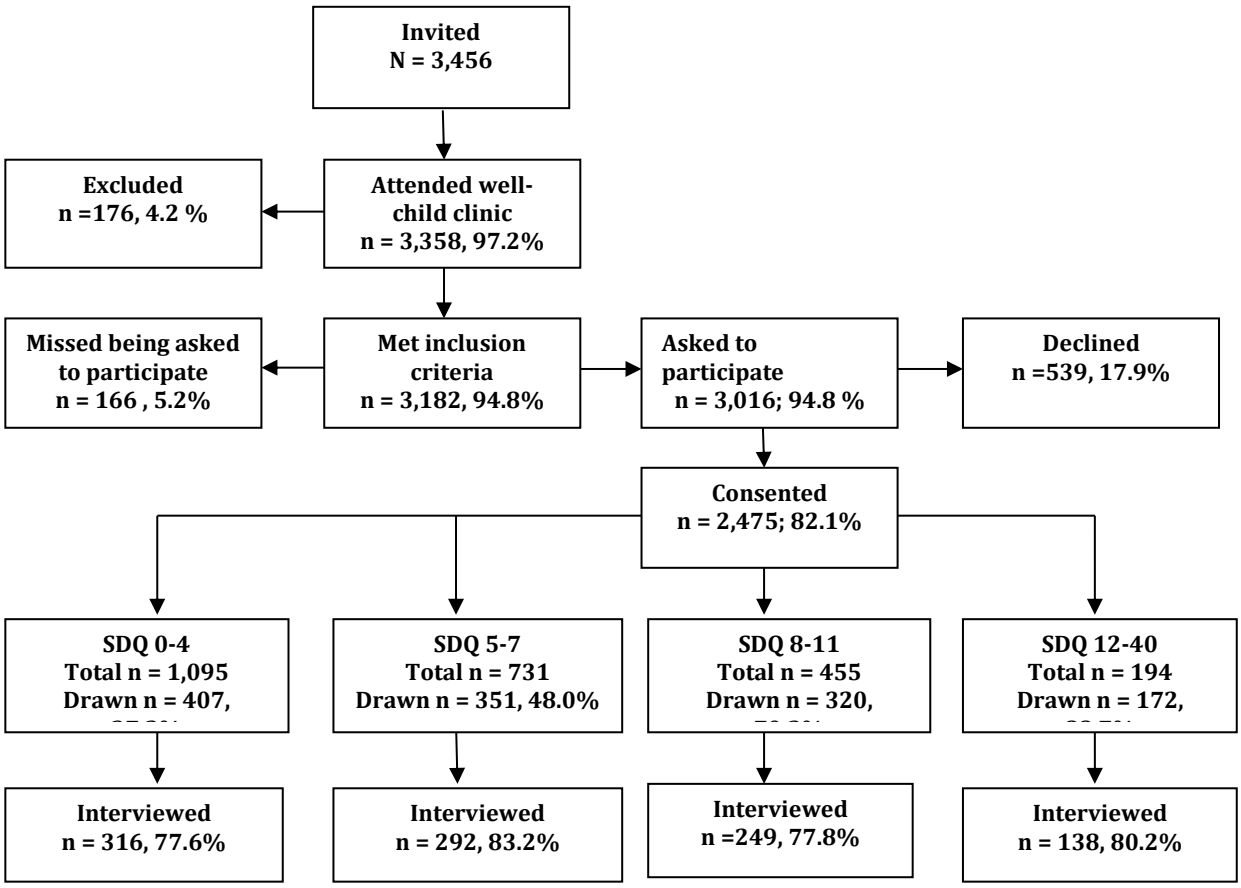


Table 1. *Sample characteristics at age 6*

| Characteristic | | % |
|---|---|---|
| Gender of child | Male | 50.1 |
| | Female | 49.9 |
| Gender of parent informant | Male | 18.9 |
| | Female | 81.1 |
| Ethnic origin of biological mother | Norwegian | 93.0 |
| | Western Countries | 2.7 |
| | Other Countries | 4.3 |
| Ethnic origin of biological father | Norwegian | 91.0 |
| | Western Countries | 5.8 |
| | Other Countries | 3.2 |
| Biological parents' marital status | Married | 52.1 |
| | Cohabitating > 6 months | 9.5 |
| Informant parent's socio-economic status | Leader | 5.7 |
| | Professional, higher level | 25.7 |
| | Professional, lower level | 39.0 |
| | Formally skilled worker | 26.0 |
| | Farmer/fisherman | 0.5 |
| | Unskilled worker | 3.1 |
| | Master degree or similar | 20.3 |
| | PhD completed or ongoing | 4.4 |
| | Hospitalized | 10.0 |

Table 2. *Prevalence of children who underestimate, correctly estimate, or overestimate their body size at ages 6 and 8.*

| Age | Gender | Underestimation | Correct estimation | Overestimation | Total |
|---|---|---|---|---|---|
| 6 years | Boys | 20.7% | 69.3% | 10.0% | 100% |
| | | (N=143) | (N=479) | (N=69) | (N=691) |
| | Girls | 19.3% | 65.7% | 15.0% | 100% |
| | | (N=137) | (N=465) | (N=106) | (N=708) |
| 8 years | Boys | 36.0% | 62.4% | 1.6% | 100% |
| | | (N=246) | (N=426) | (N=11) | (N=683) |
| | Girls | 25.2% | 71.9% | 2.8% | 100% |
| | | (N=184) | (N=524) | (N=21) | (N=729) |

Table 3. *Stability of estimation from age 6 to 8.*

| | Boys | | | | Girls | | | |
|---|---|---|---|---|---|---|---|---|
| | Underestimation 8 years | Correct estimation 8 years | Overestimation 8 years | Total | Underestimation 8 years | Correct estimation 8 years | Overestimation 8 years | Total |
| Underestimation | | | | | | | | |
| 6 years | 79.26% (N=107) | 20.74% (N=28) | 0% (N=0) | 100% (N=135) | 55.15% (N=74) | 44.85% (N=61) | 0% (N=0) | 100% (N=135) |
| Correct estimation | | | | | | | | |
| 6 years | 30.75% (N=159) | 67.12% (N=347) | 2.13% (N=11) | 100% (N=517) | 19.96% (N=99) | 75.60% (N=375) | 4.44% (N=22) | 100% (N=496) |
| Overestimation | | | | | | | | |
| 6 years | 17.95% (N=13) | 76.92% (N=60) | 5.13% (N=4) | 100% (N=77) | 5.22% (N=6) | 94.78% (N=109) | 0% (N=0) | 100% (N=115) |

Table 4. *Predictors of body size estimation at age 6*

| | Underestimation | | Overestimation | |
|---|---|---|---|---|
| Predictor | B | 95% CI | B | 95% CI |
| Children's BMI | | | | |
| Unadjusted | 0.77** | [0.54, 1.00] | -0.71** | [-0.97, -0.45] |
| Adjusted | 1.46* | [1.18, 1.74] | -1.13* | [-1.42, -0.84] |
| Parental BMI | | | | |
| Unadjusted | 0.42 | [-0.00, 0.08] | -0.03 | [-0.08, 0.02] |
| Adjusted | 0.02 | [-0.03, 0.07] | 0.03 | [-0.03, 0.08] |
| Depression | | | | |
| Unadjusted | 0.02 | [-0.05, 0.37] | 0.00 | [-0.26, 0.26] |
| Adjusted | -0.05 | [-0.32, 0.22] | 0.14 | [-0.14, 0.41] |
| Body dissatisfaction | | | | |
| Unadjusted | -0.47** | [-0.64, -0.30] | 0.48** | [0.25, 0.71] |
| Adjusted | -1.12* | [-1.38, -0.85] | 0.87* | [0.62, 1.13] |

*Note.* CI = confidence interval. Unadjusted = bivariate analyses of predictors. Adjusted = adjusted for all other predictors.

*$p < .05$. **$p < .01$.

Table 5. *Predictors of body size estimation at age 8*

| | Underestimation | | Overestimation | |
|---|---|---|---|---|
| Predictor | B | 95% CI | B | 95% CI |
| Children's BMI | | | | |
| Unadjusted | 0.59** | [0.43, 0.75] | -0.56** | [-0.94, -0.18] |
| Adjusted | 0.93* | [0.74, 1.11] | -1.12* | [-1.71, -0.52] |
| Parental BMI | | | | |
| Unadjusted | 0.07** | [0.03, 0.10] | 0.04 | [-0.09, 0.17] |
| Adjusted | 0.00 | [-0.04, 0.04] | 0.11* | [0.02, 0.19] |
| Depression | | | | |
| Unadjusted | 0.02 | [-0.05, 0.37] | 0.00 | [-0.26, 0.26] |
| Adjusted | 0.11 | [-0.18, 0.40] | -0.19 | [-1.01, 0.63] |
| Body dissatisfaction | | | | |
| Unadjusted | -0.05 | [-0.25, 0.14] | 0.38 | [-0.09, 0.85] |
| Adjusted | -0.89* | [-1.13, -0.65] | 0.69* | [0.13, 1.25] |

*Note*. CI = confidence interval. Unadjusted = bivariate analyses of predictors. Adjusted = adjusted for all other predictors.

*$p < .05$. **$p < .01$.

Table 6. *Predictors at age 6 of body size estimation at age 8*

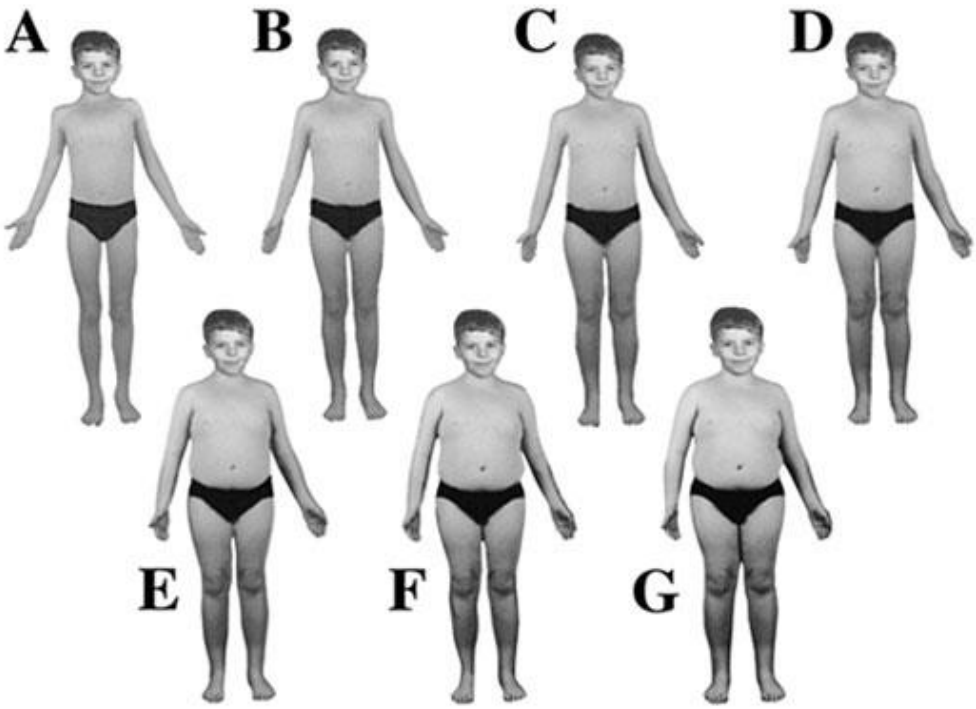
| | Underestimation 8 years | | Overestimation 8 years | |
|---|---|---|---|---|
| Predictors at age 6 | B | 95% CI | B | 95% CI |
| Children's BMI | | | | |
| Unadjusted | 0.73** | [0.50, 0.97] | -0.37 | [-1.02, 0.29] |
| Adjusted | 0.78** | [0.55, 1.01] | -0.28 | [-1.13, 0.56] |
| Parental BMI | | | | |
| Unadjusted | 0.07** | [0.03, 0.11] | 0.00 | [-0.13, 0.14] |
| Adjusted | 0.03 | [-0.02, 0.09] | 0.02 | [-0.11, 0.15] |
| Depression | | | | |
| Unadjusted | 0.01 | [-0.19, 0.21] | -0.05 | [-0.36, 0.26] |
| Adjusted | 0.05 | [-0.21, 0.32] | -0.49 | [-1.28, 0.30] |
| Body dissatisfaction | | | | |
| Unadjusted | 0.03 | [-0.11, 0.17] | 0.10 | [-0.35, 0.55] |
| Adjusted | -0.15 | [-0.31, 0.01] | 0.02 | [-0.48, 0.53] |

*Note.* CI = confidence interval. Unadjusted = bivariate analyses of predictors. Adjusted = adjusted for all other predictors.

*$p < .05$. **$p < .01$.

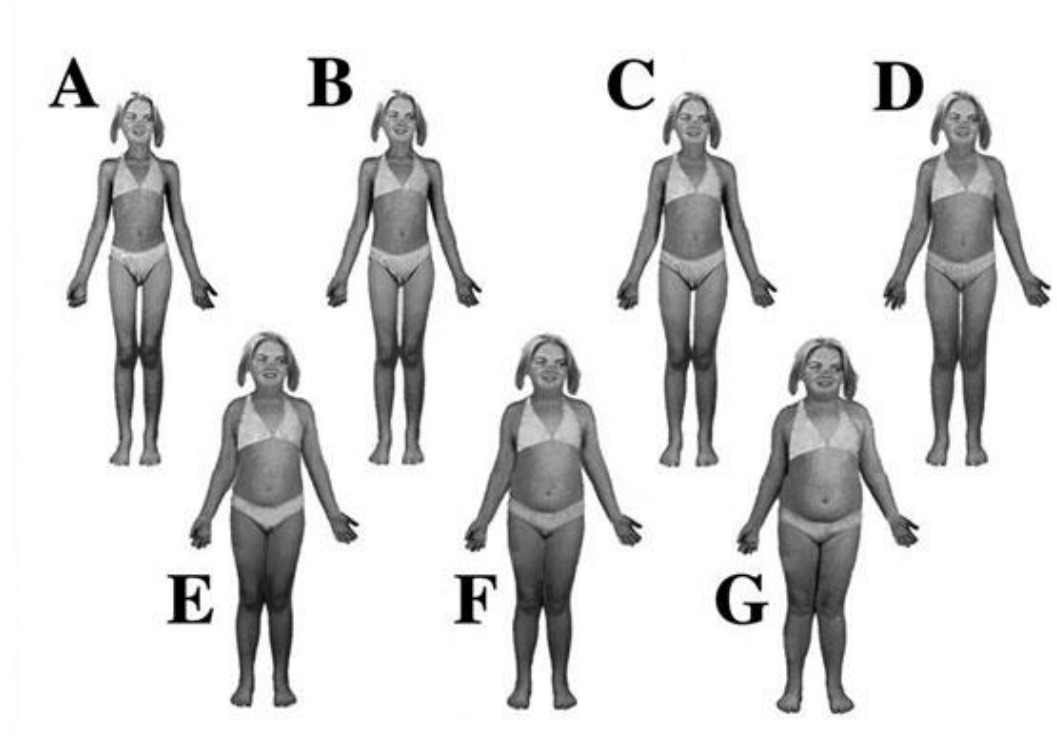
*Appendix A*

Children's Body Image Scale for boys (Truby & Paxton, 2002)



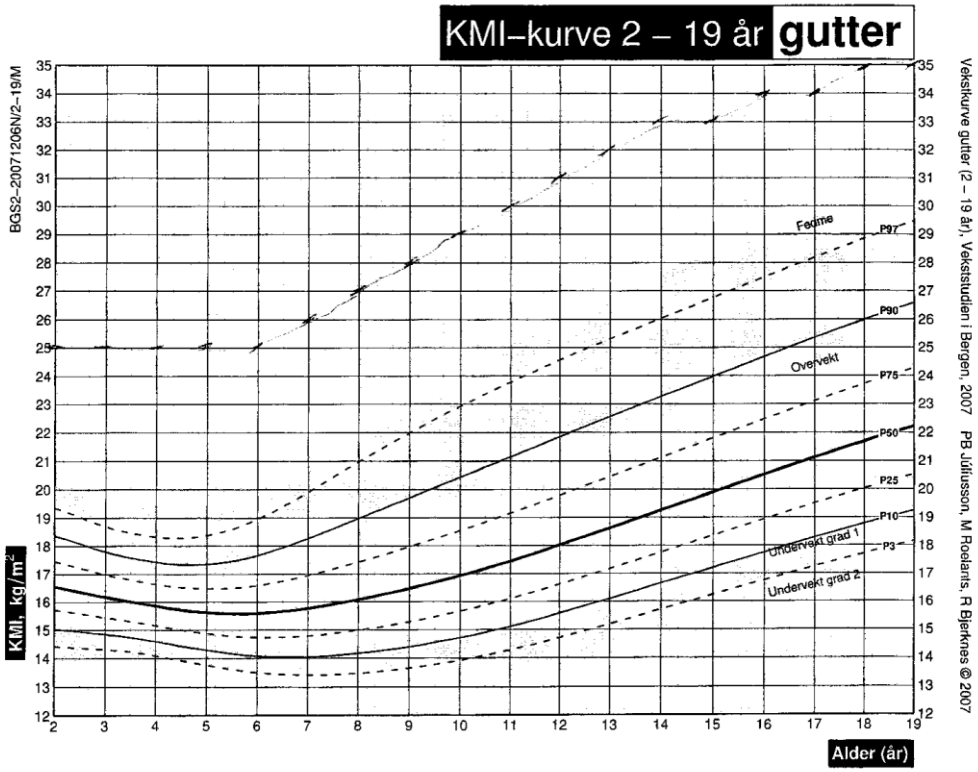
*Appendix B*

Children's Body Image Scale for girls (Truby & Paxton, 2002)



*Appendix C*

Developmental BMI curves for boys (Júliusson, Roelants & Bjerknes, 2007)




| Alder | Vekt | Høyde | KMI |
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**Forklaringer**

- P = Prosentiler.
- *s* = Standardavvik.
- P2-4 = Tanner-stadier for pubesbehåring.
- T4 ml = Testikkelstørrelse 4 ml.
- KMI = Kroppsmasseindeks (kg/m²) bør beregnes ved mistanke om over- eller undervekt. Overvekt og fedme er her angitt i henhold til "The International Obesity Task Force" (IOTF) sine kriterier; dvs. henholdsvis KMI 25 kg/m² og 30 kg/m² ved 18 års og ekstrapolert ned i alder. Definisjonen av undervekt grad 1 og 2 tar utgangspunkt i WHO sine kriterier; KMI 18,5 kg/m² og 17 kg/m² ved 18 år og ekstrapolert ned i alder. Disse definisjonene er statistiske. Det betyr at de kan brukes som skreeningverktøy, men at de ikke er diagnostiske verken for overvekt eller undervekt for det enkelte barn. KMI-vurderinger må alltid knyttes opp mot klinisk undersøkelse.

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*Appendix D*

Developmental BMI curves for girls (Júliusson, Roelants & Bjerknes, 2007)