Perception of Weight Status in Australian Adolescents

by

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Submitted in partial fulfilment of the requirements for the degree of

Doctor of Psychology (Health)

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June, 2014
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Acknowledgments

For their support and guidance in preparing this thesis, I would like to thank my supervisors. I am grateful for Marita McCabe for her sharing her considerable knowledge and for generously giving her time throughout the project. I’d like to thank Dr Peter Kremer for his valuable advice, and for being instrumental in helping me to overcome obstacles that I came across along the way. I would also like to thank Professor Boyd Swinburn and Dr Andrea de Silva for their expertise and insights into the project.

I would also like to acknowledge the friendships that I made during the DPsych program. I am grateful to Lyndel, Natalie, Siobhan, Emily, Bronwyn and Laura, among others, for being there to share commiserations, advice and encouragement. I would like to thank Alex for being incredibly supportive and being a sympathetic ear when I needed it. I am thankful to thank my parents, Ellen, Graeme, and the rest of my family; Emma, Amy, Sean, Damon, Bek, Simon and Sally for their consistent support; practically, emotionally and financially.
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Abstract

This thesis examines perception of weight status in adolescents. Self reported weight correlates poorly with measured weight for some adolescents. Although there are certain factors that are known to be associated with misperception of weight, there is no organising framework to explain how these factors are associated and how they may contribute to weight misperception. When adolescents describe their weight it is unclear whether they are referring to their size, their estimated fat mass or some other feature. Understanding which anthropometric measurement of weight correlates with weight perception may help to determine what adolescents are assessing when they report their weight status. To date, only one study has assessed which anthropometric measure is most closely aligned with adolescents’ perception of their weight. Perception of weight has the potential to impact on the weight related behaviours of adolescents; for example, those who are overweight but are not aware of it may not make necessary lifestyle change to curb further weight gain. This thesis aimed to examine the measurement and correlates of weight status perception and whether it impacts on weight related behaviour. Three studies were conducted in order to address these aims. The first article presents a biopsychosocial model of weight status perception. The second article explores which anthropometric measures of weight best align with perceived weight. The third article considers the impact of weight misperception on body change intentions, dieting and exercise behaviours. Finally, this thesis presents a discussion of the integrated findings of the three articles, the limitations of the data used and the implications for research and health promotion. Overall this thesis indicated that misperception of weight is related to gender specific body ideals and that accurate perception of
overweight does not promote positive health behaviours in relation to diet and activity.
Chapter 1

Childhood Overweight and Weight Status Perception

Childhood obesity is a global issue that has serious implications for the health of future generations. In Australia, the prevalence of overweight and obesity among children aged 2-18 has been estimated at 5-6% and 21-25%, respectively (Olds, Tomkinson, Ferrar, & Maher, 2010). Among Australian adolescents aged 12 to 18, the prevalence of overweight has been reported at 27% in females and 26% in males (Utter et al., 2008), indicating that over one quarter of Australian adolescents are at elevated risk of developing obesity related conditions such as type 2 diabetes, hypertension and sleep apnoea. In addition, obesity tends to track into adulthood, meaning overweight children and adolescents are at a greater risk of developing ischemic heart disease, osteoarthritis and certain cancers as adults (Deshmukh-Taskar et al., 2005). There is also a significant economic burden associated with obesity and overweight. Taking into account the loss of productivity, the burden on the health system and on carers, the current cost of obesity to the Australian economy has been estimated at over $3 billion annually (Diabetes Australia, 2006). These costs will only increase as the current generation of children move into adulthood (Lobstein, Baur, & Uauy, 2004). Preventing excessive weight gain in childhood and adolescence is therefore crucial to tackling this public health issue.
Potential Impact of Perception of Weight Status

While the ‘obesity epidemic’ is well publicised by the media, adolescents continue to receive conflicting messages about their weight. Some groups, such as educational and community organisations, encourage adolescents to accept their body shape; but adolescents are also presented with an aesthetic ideal by weight loss companies, magazines and celebrities. This ideal tends to emphasise thinness for girls and muscularity for boys (Ogden, 2010). Many adolescents show excessive concern and preoccupation with their body weight and shape (Neumark-Sztainer, Paxton, Hannan, Haines, & Story, 2006), however despite this preoccupation, evidence suggests that many do not have an accurate perception of their weight. Adolescents’ reports of their weight status have been shown to correlate poorly with objective measurements of their weight (Maximova et al., 2008; Strauss, 1999), while some adolescents tend to underestimate their weight status others overestimate. Both types of misperception have implications for health.

Perception of weight has been found to be a better correlate than actual weight in determining weight loss behaviour (Strauss, 1999; Wang, Liang, & Chen, 2009). Some healthy weight and underweight adolescents perceive themselves to be overweight and consequently are at risk of developing eating disorders (Keel, Baxter, Heatherton, & Joiner, 2007) or unhealthy weight loss behaviours such as restrictive dieting and excessive exercise (Fox, Page, Armstrong, & Kirby, 1994). In addition, compared to their healthy weight and underweight peers, overweight and obese adolescents are relatively more likely to misperceive their weight status (Viner et al., 2006). Such individuals may not be aware of the health risks associated with their current weight and may be less
inclined to make changes to their diet and activity levels (Duncan, Duncan, & Schofield, 2011). Thus distorted perceptions of weight status creates two distinct risk groups; those who engage in maladaptive eating and behavioural practices to fix a problem that does not exist; and those who do not make necessary changes to reduce a real threat to their health.

The purpose of this thesis was to examine weight status perception in adolescents and investigate whether misperception of weight status impacts upon weight related behaviour. In order to achieve these aims three studies were conducted which were designed to assess the correlates, measurement and impact of weight misperception. Firstly, this thesis will provide a rationale for these three studies based on the literature regarding accuracy of weight status perception. Specifically, Chapter 2 will examine the measurements and methods that are used to assess accuracy of weight status perception. Chapter 3 will examine the empirical evidence for the biopsychosocial model of weight status perception. Chapter 4 will assess the evidence relating to the impact of body weight misperception on body change intentions, and dieting and exercise behaviours. Chapter 5 will provide an overview of the articles included in this thesis. The first article, presented in Chapter 6 describes a biopsychosocial model of weight status perception. The second article, presented in Chapter 7, explores which anthropometric measures of weight best align with perceived weight. Chapter 8 presents the third article, which examines the impact of weight misperception on body change intentions, and dieting and exercise behaviours in overweight adolescents. Chapter 9 presents a discussion of the integrated findings of the three articles and finally, the limitations of the data used and the implications for research and health promotion are presented.
Chapter 2

Objective and Subjective Measurements Used to Assess Accuracy of Weight Perception

In order to assess the accuracy of an individual’s weight perception it is necessary to 1) obtain an objective measurement of their body composition, 2) measure the individual’s perception of their weight status and 3) examine the concordance of these two measurements to determine the accuracy of their perception. There are a range of methods that can be used to assess both body composition and an individual’s perception of weight status however it is unclear which methods are the most appropriate to determine misperception of weight status. Very few studies have examined which tools are the most appropriate for assessing accuracy of an individual’s weight perception. This chapter will outline the various methods available to objectively measure body composition and review the methods that previous studies have used to determine weight status perception and assess the accuracy of that perception.

Objective Measures of Body Adiposity

To assess accuracy of weight status perception, it is necessary to determine whether an individual is underweight, healthy weight, overweight or obese. In the past, overweight and obesity have been defined as being equivalent to an excess of total body fat or, alternatively, an excess of fat in certain areas of the body (Visscher, Snijder, & Seidell, 2010). A range of methods exist to measure body fat in adolescents, some provide a better measure of total body fat and others provide a better measure of where body fat is distributed. The relative advantages of each type of measurement will be discussed in this section. For
each of these measures it is also necessary to define excess body fat. For adults, a single value can be used to define overweight or obese, however adolescents’ body composition varies by age, gender and stage of maturation (Goodman, Hinden, & Khandelwal, 2000; Lobstein et al., 2004). Consequently, reference data, including growth charts and cut offs, are needed to determine each category of weight. Growth charts contain a series of percentile curves to illustrate the distribution of the selected body measurements in adolescents. Cut offs describe the value that can be used to classify individuals into weight categories i.e. overweight may be defined as the 85th percentile. The availability of such reference data will be considered in this chapter. In addition, there are a number of practical considerations which need to be taken into account when determining which method to use. The ideal method should be accurate and precise, however it also needs to fulfil the dual practical requirements of being easy to utilise in research and acceptable to participants (Lobstein et al., 2004). This section will outline some of the objective measurements of body fat that are used and the relative strengths and weaknesses of each method.

**Body mass index.** Body Mass Index (BMI) is defined as weight in kilograms divided by the square of height in metres (Lobstein et al., 2004). This method is the most widely used measurement of body adiposity, and although it does not directly measure body fat percentage, in most individuals it correlates well with measurements of total body fat (Pietrobelli et al., 1996; Sardinha, Going, Teixeira, & Lohman, 1999). It also has good reliability, is acceptable to participants and relatively easy to obtain in a large research setting. Consequently the vast majority of research on weight status misperception has been conducted using BMI. However, BMI does not provide any information about body fat
distribution, it can conflate fat and fat free mass in individuals who are particularly muscular, and it is less sensitive in people who are particularly tall or short (Lobstein et al., 2004). BMI’s ability to predict body adiposity in adolescents also differs by gender and maturation, due to differences in body fat distribution and musculature (Daniels, Khoury, & Morrison, 1997).

The International Task Force for Obesity (IOTF) developed reference values based on the accepted adult cut off points (Cole, Bellizi, Flegal, & Deitz, 2000). However reference data are limited by the population they were developed in, and are used under the assumption that the individual being classified is comparable to that population (Lobstein et al., 2004). The IOTF reference data was defined in a mostly Caucasian sample and is of limited use in some populations such as Pacific Islanders (Swinburn, Ley, Carmichael, & Plank, 1999). The Centre for Disease Control (CDC) has developed growth charts; however these were developed exclusively in US samples and so their usefulness is limited to the United States (C. Ogden et al., 2002). The World Health Organisation (WHO) has developed reference charts based on broader international data and adjusted for age and pubertal maturation. These charts allow the identification of percentiles where overweight is often defined as above the 85th percentile and obesity is classified above the 95th percentile (de Onis et al., 2007). BMI is converted to a z score (BMI-z) and plotted on a chart based on a standard reference population, where a z score of 0 is equivalent to the median. This method allows for a more detailed description of an individual or population.

**Bio electrical impedance analysis (BIA).** This measurement provides an estimate of percentage body fat (BF%). It measures the conductivity of an electrical current through the body and assumes that the opposition to the flow or
electrical impedance reflects fat mass (Lobstein et al., 2004). It is relatively non-invasive and has a high inter- and intra-observer reliability making it useful for large population studies, however it may vary with hydration level and ethnicity (Wabitsch et al., 1996). BF% has the potential to provide an estimate of body adiposity, however, it appears to have greater specificity and sensitivity in groups than in individuals (Houtkooper, Lohman, Going, & Howell, 1996).

There are no established cut off points for BF% in adolescents. In a study of adolescent Caucasian and Japanese girls 15% body fat was considered low or underweight and 30% was considered high or overweight (Sampei, Novo, Juliano, & Sigulem, 2001). A 2011 study of adolescent weight status perception used percentiles that were defined by the distribution of the sample surveyed. Overweight was defined as a body fat percentage above the 85th percentile (Duncan et al., 2011). However, there are inherent problems with this method, as it assumes that the sample surveyed contains a similar distribution of body fat percentage as the general population. Sex-specific reference values have also been developed in British children where underweight, healthy weight, overweight and obesity are set at the 2nd, 85th and 95th centiles, (McCarthy, Cole, Fry, Jebb, & Prentice, 2006). These reference values are appropriate for use in Caucasian children; however additional values are needed for children of other ethnicities. Despite the difficulties in defining cut off points, BIA has the potential to provide information about the relationship of percentage body fat with weight status perception.

**Waist circumference.** Central obesity is strongly associated with type 2 diabetes, elevation of blood pressure and increased mortality rates (Visscher et al., 2010). However, it is not captured well by BMI, those with more central obesity
tend to have lower BMI’s than those with peripheral obesity (Daniels et al., 1997). Waist circumference (WC) has been found to correlate well with central adiposity in adolescents aged to 3-19 (Goran, Gower, Treuth, & Nagy, 1998). Measured midway between the iliac crest and lower rib, it has good reliability and validity and can be easily administered in large studies (Lobstein et al., 2004). Waist circumference will be reduced by physical exercise, whereas BMI may not be reduced because of a concurrent increase in muscle mass (Visscher et al., 2010). A 1997 study into 7 to 17 year olds found that measurement of central adiposity mediated the relationship of BMI with fat mass. In individuals with equivalent BMI, those with central obesity had more fat mass than those with peripheral obesity, and the levels of body fat associated with BMI varied by gender (Daniels et al., 1997). This suggests there is utility in using waist circumference to determine an individual’s level of body fat. Waist circumference percentiles have been developed for the classification of overweight and obesity in adolescents in many countries including Australia (Eisenmann, 2005). These percentiles have been developed in large representative samples and vary by age and gender. However, there is no international standard cut off points for waist circumference, and suggested cut offs for overweight range from the 70th (Moreno et al., 2002) to the 90th or 95th percentile (Katzmarzyk, 2004; van Vliet, Kjölhede, Duchén, Räsänen, & Nelson, 2009).

**Other types.** There are other methods for estimating body composition that are relatively easy to employ in large research settings. A child’s weight-for-height can be compared to reference standards to assess whether their weight excessive or below average for their height. However this method is not appropriate for adolescents as weight-for-height charts are inaccurate beyond the
age of 10 to 11 (Lobstein et al., 2004). Another measure is waist-to-hip ratio (WHR); WHR calculates the ratio of an individual’s waist to their hip, measured at the maximum circumference of their buttocks. However, there is a lack of reference data for WHR and it has been found to be a poorer correlate of central adiposity compared to waist circumference (Taylor, Jones, Williams, & Goulding, 2000).

There are other objective measurements of body fat that are more sophisticated and very precise, such as underwater weighing (densitometry), and imaging techniques such as Magnetic Resonance Imaging (MRI) and Computerised Tomography (CT). However these methods tend to be very expensive and time consuming to administer and require highly trained personal, and thus are less useful for large scale research studies (Lobstein et al., 2004).

Self-report measures. Not all research on weight misperception has used an objective estimate of body weight/adiposity with some studies using self-report height and weight to calculate BMI (Edwards, Pettingell, & Borowsky, 2010; Pritchard, King, & Czajka-Narins, 1997; Talamayan, Springer, Kelder, Gorospe, & Joye, 2006). While this method has some utility when there is no source of objective data available, a comprehensive review of this method suggested that it is limited by individuals’ inherent tendency to underreport their weight and overestimate their height (Sherry, Jefferds, & Grummer-Strawn, 2007). It is a particularly problematic method in studies where the dependent variable is perception of weight status, as weight perception itself may mediate the under or over reporting of weight and height. In a study by Brener and colleagues (2004) the concordance of perception of weight status was significantly higher with self-reported BMI than with objective BMI. This suggests that the use of self-reported
height and weight is inappropriate in studies of weight status misperception as it may underestimate the magnitude of weight misperception.

**Measuring Perception of Weight Status**

In terms of measuring perceived weight status among adolescents, there is no one method that has repeatedly demonstrated good reliability or validity. One method that has been used is a visual rating scale such as the Stunkard Body Rating Scale. This consists of seven sex-specific silhouettes of the same height ranging from overweight to obese that have been found to be highly correlated with corresponding BMI percentiles (Maximova et al., 2008). However, the majority of studies of weight perception have simply asked participants one question to evaluate their perception of their weight. The most common wording is; “How do you think of yourself in terms of weight” (Martin, Frisco, & May, 2009; Perrin, Boone-Heinonen, Field, Coyne-Beasley, & Gordon-Larsen, 2010; Yost, Krainovich-Miller, Budin, & Norman, 2010) or “How do/would you describe your weight” (Abbott, Lee, Stubbs, & Davies, 2010; Brener, Eaton, Lowry, & McManus, 2004; Wang et al., 2009). Studies have provided either three response categories, for example, underweight, about right or overweight (Abbott et al., 2010; Desmond, Price, Gray, & O’Connell, 1986; Desmond, Price, Hallinan, & Smith, 1989; Isomaa, Isomaa, Marttunen, Kaltiala-Heino, & Björkqvist, 2011; Viner et al., 2006; Yan, Zhang, Wang, Stoesen, & Harris, 2009) or five categories on a Likert-type scale, for example, very underweight, slightly underweight, healthy weight, slightly overweight or very overweight (Al Mamun et al., 2007; Goodman et al., 2000; Jansen, van de Looij-Jansen, de Wilde, & Brug, 2008; Martin, May, & Frisco, 2010; Perrin et al., 2010; van Vliet et al., 2009; Xie et al., 2006; Yost et al., 2010).
Among studies that used a five point scale, many condensed the five categories into three to conduct analysis on the accuracy of individual’s perceptions. In two studies this was because too few participants had weight perceptions that were at either extreme of the scale (Al Mamun et al., 2007; Brener et al., 2004) and in other studies it provided ease of comparison with an equal number of objective weight categories (Martin et al., 2009; Xie et al., 2003). Various words have been used to describe both underweight (thin, slim or light) and overweight (heavy or fat). It is possible that different words may elicit different responses; however this has not been examined.

In addition, very few studies have investigated the reliability and validity of questions that ask about perceived weight. Standley and colleagues (2009) found that a question about perceived weight (much too thin, too thin, about right, too fat, much too fat) correlated well with the Contour Drawing Scale which had previously been found to have sound reliability and construct validity (Wertheim, Paxton, & Tilgner, 2004). Another study investigated the reliability of the question, “How do you see yourself?” (slim, normal, overweight). They found that in 20 adolescents, 85% to 95% of participants agreed with their initial assessment six months later (Tienboon, Rutishauser, & Wahlqvist, 1994). However, the psychometric properties of the questions used to assess weight perception have not been comprehensively examined and consequently there is a lack of information on which is the most valid and reliable form.

Assessing Accuracy of Perception of Weight Status

Various methods have been employed to determine how well a participant’s self-reported weight status aligns with their anthropometrically measured weight status. A commonly used method is to assign participants to one
of three categories based on the concordance of their objective weight with their perceived weight, typically (1) correct perception – perceived weight is equivalent to objective weight; (2) underestimation – perceived weight is in a lighter category than their objective weight; (3) overestimation - perceived weight is in a heavier category than the objective weight (Abbott et al., 2010; Standley, Sullivan, & Wardle, 2009; Yan et al., 2009). This method allows for comparison of individuals based on the direction of their misperception. However, it does not provide information about the magnitude of the discrepancy between weight perception and objectively measured weight, for example whether someone who is obese perceives themselves as underweight or just overweight.

To analyse the accuracy of individual’s weight perception, some studies have created a binomial variable whereby participants are classified as having accurate perception or not (Viner et al., 2006). The direction of the misperception (whether it is over- or underestimation) can be inferred by the participant’s objective BMI, participants who are in the underweight BMI category and have inaccurate perception must have overestimated their weight and participants who are overweight by BMI and have inaccurate perception must have underestimated their weight. However, this type of analysis does not provide information about the magnitude of the misperception or the direction of misperception among those with healthy weight according to BMI. This may be a crucial detail to understanding weight loss behaviours as previous research suggests the direction of the discrepancies are significant correlates of body weight control (Wang et al., 2009).

Other studies focussed on a specific direction of weight perception. For example, Isomaa and colleagues (2011) focused on perceptions that were gender
typical, for girls, this equated to perception of overweight despite being healthy or underweight and for boys, perception of underweight despite being healthy or overweight. All other types were excluded from analysis. Other studies have focussed on various perceptions by each objective BMI category, and in doing so, did not group people based on the accuracy of their perception, but treated each weight category differently (Al Mamun et al., 2007; Brener et al., 2004; Yost et al., 2010). Strauss (1999) and Perrin and colleagues (2009) focussed on those who considered themselves overweight at each level of four BMI categories; underweight, healthy, overweight, obese. These methods provide information in the specific direction that the authors were interested in, however they are not suitable for investigating the full spectrum of weight status misperception.

All of the above mentioned methods for assessing accuracy require that objective measurements of body adiposity are classified into categorical variables, usually, underweight, normal weight or overweight. Maximova and colleagues (2008) overcame this issue by assigning values from subjects’ weight perception scores with corresponding z scores (-3, -2, -1, 0, 1, 2, 3). This enabled them to calculate misperception of weight as the difference between the BMI-z score and the perceived weight z score and resulted in a misperception score that was a continuous measure of misperception (Maximova et al., 2008). This method gave an indication of the direction of the misperception and the magnitude of the misperception.

**Reliance on BMI in Measuring Weight Status Perception**

When adolescents report their perception of their weight status it is unclear whether they are providing an estimate of their body size, an estimate of their body fat or some combination of the two. The use of different objective
measurements of weight status to assess the accuracy of adolescent perception of weight may help to clarify this issue, however; few studies have used measures other than BMI. One study of weight status perception in adolescent girls found little difference in accuracy regardless of whether weight was defined by BIA or BMI (Duncan et al., 2011).

Waist circumference may be better aligned with adolescent perceptions of their weight status. A study by van Vliet et al. (2009) verified weight perception by BMI and WC in adolescent Finnish girls. To categorise weight status by waist circumference they used percentiles developed in a British sample (McCarthy, Jarrett, & Crawley, 2001) and set the cut offs at the following percentiles; >95th (obese), 90th to 95th (overweight), 10th to 90th (healthy weight), 5th to 10th (underweight) and <5th (very underweight). BMI was also classified into five categories based on the WHO definitions, and a five point scale of weight perception (much too fat to much too thin) was used. In this study, girls displayed a tendency to overestimate their weight in relation to BMI but not in relation to waist circumference, suggesting that waist circumference is more strongly associated with weight status perception than BMI. The authors suggested that this may be because WC represents a characteristic of body shape and girls are more likely to be aware of how ‘normal’ their body shape is rather than how ‘normal’ their calculated index of height and weight is. In addition, classification of the girl’s weight by BMI put them in a lower weight category than when WC was used, suggesting that BMI underestimated participants weight status. This study suggested that weight status perception may vary depending on the objective measurement used; however, there is currently a lack of studies that have used objective methods other than BMI.
Conclusion

There are a range of methods available to measure body adiposity. In terms of selecting a measurement tool for research in weight status perception, the ability of a method to provide an accurate estimate of body adiposity is balanced against the ease of administration and acceptability to participants. When assessing accuracy of weight status perception, a method that describes both the magnitude and the direction of the perception is most informative for investigating all weight groups. Verifying weight status perception against a range of appropriate measurements of weight may clarify what adolescents are referring to when they report their weight status.
Chapter 3

Misperception of Weight Status: Application of the Biopsychosocial Model

Perception of weight status may not be a purely sensory process. Thompson, Heinberg, Altabe and Tantleff-Dunn (1999) suggested that weight perception originates from two sources; sensory information that is processed by the retina and visual cortex; and cognitive information such as attitudes, beliefs and thoughts. These attitudes, beliefs and thoughts are in turn influenced by exposure to cultural weight ideals and comparisons to others (Gardner & Bokenkamp, 1996). This combination of sensory, cognitive and social factors is consistent with the biopsychosocial model. This framework encompasses biological, psychological and social features and was first proposed by Engel (1977) as an expansion on the biomedical model of health and illness. Since then, it has been used to explain many weight related attitudes and behaviours including; body image (Ricciardelli, McCabe, Holt, & Finemore, 2003), body change strategies (Ricciardelli & McCabe, 2003) and body size estimation (McCabe, Ricciardelli, Sitaram, & Mikhail, 2006). This framework is also appropriate for describing adolescent weight status perception, as it is able to encompass the many factors that have been found to influence perception of weight status. The empirical evidence for the biological, psychological and social components of weight status perception is detailed below.

Biological Factors

Body weight status. Weight status influences accuracy of weight perception, research suggests that overweight and obese adolescents are more likely to misperceive their weight status compared to healthy weight or
underweight peers (Maximova et al., 2008; Viner et al., 2006). The prevalence of underestimation of weight varies by study, from around one third (Wang et al., 2009) to 40% (Edwards et al., 2010) of overweight adolescents. A recent Australian study of children and adolescents (aged 6-18) found that 64% of overweight participants did not perceive themselves to be overweight, in addition, almost 40% of those who met the definition for obesity considered themselves to be ‘about right’ (O’Dea & Amy, 2011). A similar magnitude of misperception has been found in a US population where one quarter of those who were obese believed themselves to be “normal weight” (Wang et al., 2009). For boys, this figure may be even higher, in a study by Viner and colleagues (2006), two thirds of overweight teenage boys did not recognise that they were overweight. Whilst this is concerning, some clarification is needed on the reasons why male and female adolescents differ in terms of weight status perception.

**Gender.** The literature on weight status perception reports consistent gender differences. In particular, girls tend to overestimate their weight and boys tend to underestimate their weight. This trend has been found in both international (Desmond et al., 1986; Standley et al., 2009; Talamayan et al., 2006; Xie et al., 2006; Yan et al., 2009) and Australian samples (Abbott et al., 2010; O’Dea & Amy, 2011; Tienboon et al., 1994). There is a complex interaction between gender and weight status when it comes to weight status perception; and the relative accuracy of each gender depends on the weight group being examined. That is, among overweight or obese adolescents, girls are more accurate (Wang et al., 2009) and among healthy weight or underweight adolescents, boys are more accurate (Martin et al., 2009). A 2009 study found that adolescent girls perceive themselves to be heavier compared to boys with the
same BMI (Martin et al., 2009). Further evidence for this trend was described by 
Perrin et al. (2009), who reported that the prevalence of misperception of 
overweight was similar between females with a low BMI and males with an 
average BMI. In addition, another study observed that the relationship between 
accuracy of weight perception and BMI-z is an inverse relationship in boys and a 
direct relationship in girls (Viner et al., 2006). That is, as girls’ BMI-z increased, 
their weight status perception was more likely to be accurate, whereas increased 
BMI-z in boys was associated with reduced accuracy.

While these findings may reflect differences in perception between boys 
and girls it may also reflect the finding that a high BMI in boys is a less accurate 
estimate of excess body fat than in girls, as girls have more body fat than boys at 
the same level of BMI (Daniels et al., 1997; Fox et al., 1994). Viner et al., (2006) 
reported that accuracy of weight status perception was worse for overweight boys 
than for obese boys and suggested that this may be because the overweight 
category may contain boys with high lean mass. This suggests that some boys 
who are classified as underestimating their weight status in these studies may in 
fact, have an accurate perception of their weight status. Despite this known 
limitation of BMI, few studies of weight status perception have used any other 
measurement to determine weight status. Previously mentioned studies by Van 
Vliet et al. (2009) and Duncan et al. (2011) suggest that waist circumference may 
be a better predictor of weight status perception than BMI and BIA, however such 
comparisons have not been made with boys. This indicates a need to examine 
differences in weight status perception using objective measurements other than 
BMI in both genders.
**Age.** Another contributor to the differences between males and females may relate to age and pubertal development. A 1998 study by Page and Fox used various objective measurements of body composition, including height, weight, waist and hip circumference, shoulder and hip girth and skinfold thickness. They found that measures of skeletal breadth were the best predictors of weight loss desire in teenage girls. However for boys, body adiposity appeared to be the driver of weight loss intention. This finding led the authors to suggest that girls confuse the physical development that occurs naturally during puberty, as weight gain (Page & Fox, 1998). If this were the case, it would be expected that girls would be more likely to overestimate their weight with increasing age and pubertal development. In contrast to this, a 2011 longitudinal study of weight perception among adolescents found that misperception was fairly stable over time; with over half of participants who misperceived their weight at baseline still incorrect 3 years later. In girls this meant persistent overestimating of weight and in boys persistent underestimating (Isomaa et al., 2011). In this study, however, the age of participants at baseline was 15, and many of the girls would have already gone through most of their pubertal growth. In contrast, a cross sectional study of girls aged 13 to 16 found that older participants were more likely to overestimate their weight status (Maximova et al., 2008). This suggests that examining the full spectrum of the adolescent age range, from the pre-pubertal stage at 10 to near adulthood at 18, would give the greatest chance of detecting any age related differences in weight status perception.

**Psychological Factors**

*Satisfaction with weight and body shape.* Longitudinal research following individuals from early adolescence into adulthood found that women
display more dissatisfaction with their weight than men across this part of their lifespan, and that dissatisfaction is greatest during adolescence (Keel et al., 2007). Girls are also twice as likely to be dissatisfied with their weight compared to boys, in particular, overweight girls are more dissatisfied with their weight than overweight boys (Wang et al., 2009). Girls in Western societies have a propensity to internalise a ‘thin’ ideal which tends to be below a healthy weight (Thompson & Stice, 2001). This may affect their perception of their weight, as when asked to make a judgement about their size or weight, the standard that they automatically compare themselves to is this unrealistic “thin” ideal (Brener et al., 2004). Thus misperception may be a manifestation of the discrepancy between an individual’s real and ideal body image (Eisenberg, Neumark-Sztainer, & Paxton, 2006).

Research examining misperception of weight has primarily focused on girls and their body weight concerns. This is not justified, as boys do display body dissatisfaction, it is just that this dissatisfaction manifests differently to girls.

Previous research into male body image suggests that they tend to focus on muscularity rather than weight (Gray & Ginsberg, 2007). Body satisfaction in male adolescents has been found to decrease as they move closer to an underweight BMI (Eisenberg et al., 2006) and some studies have found that boys tend to consider themselves too thin and want to gain weight (Kurdak et al., 2010; Strauss, 1999). There is evidence to suggest that boys may feel inadequate if they are not physically ‘large’ regardless of their relative amount of muscle mass or muscular strength (Lubans & Cliff, 2011). Just as misperception of weight status in girls may be related to the discrepancy between their actual weight and an unrealistic ideal, the tendency of boys to underestimate weight status (Edwards et al., 2010; Goodman et al., 2000; Xie et al., 2003; Yan et al., 2009) may reflect
dissatisfaction with musculature and perceived failure to achieve an ideal ‘large’ body (Isomaa et al., 2011). Dissatisfaction with body weight and shape may mediate both male and female misperception of weight status; however the difference in ideal body shapes means that misperception is exhibited in opposite directions. In addition, this dissatisfaction may be heightened in adolescent boys as some girls may be taller and physically stronger than they are (Desmond et al., 1989).

Few studies have directly looked at the relationship that misperception of weight status has with satisfaction with body weight and body shape, with many studies using misperception as a proxy for dissatisfaction, without explicitly measuring how the two factors are related. Isomaa and colleagues (2011), examined weight status perception that was gender characteristic, thus, they only considered females who overestimated their weight status and males who underestimated. Dissatisfaction with body shape was more prevalent among females who overestimated their weight, however in males there was no relationship between underestimation of weight and body shape dissatisfaction. This suggests that amongst girls, misperception of weight status may be related to dissatisfaction with their body weight or shape; however more information is needed on the nature of this relationship in boys.

**Social Factors**

**Socio economic status.** A range of approaches are used to measure socio economic status (SES). For school aged children, SES may be measured from a range of metrics including parental income, education, and/or occupation. This can be measured at the household, school or area level. SES is linked to weight status, a higher prevalence of obesity has been observed in individuals with a
lower education and/or income level (Sobal, 1995; Visscher et al., 2010).

However, the association of SES with accuracy of perception of weight status is unclear. A 2004 study by Wardle and colleagues found that adolescents with a higher household SES identified figures as ‘fat’ at a thinner size than lower SES adolescents, however this study did not qualify whether participant’s perception of their own body size was accurate. Studies that have examined household income, education and occupation, report no association between misperception of weight and socio economic status (Goodman et al., 2000; Viner et al., 2006; Yan et al., 2009) while others suggest that it may be a factor but it is difficult to separate from ethnicity (Strauss, 1999). A study of weight status perception in children aged 6 to 19 in New South Wales, examined school SES, as determined by relative levels of family income and parental education. They found that children attending low SES schools were more likely to perceive themselves ‘too thin’ compared to children at schools classified as middle and high SES (O'Dea & Caputi, 2001). This suggests that trends in weight perception by SES may exist and require further investigation.

Peer comparison. The tendency of adolescents to misperceive their weight status is widespread and has been reported in many countries including the US (Desmond et al., 1986; Martin et al., 2010; Strauss, 1999; J. Wang et al., 1994; Yan et al., 2009; Yost et al., 2010), Canada (Maximova et al., 2008) the UK (Fox et al., 1994; Standley et al., 2009; Viner et al., 2006), Finland (Isomaa et al., 2011), the Netherlands (Jansen et al., 2008; ter Bogt et al., 2006), China (Xie et al., 2006) and Australia (Abbott et al., 2010; Al Mamun et al., 2007; Tienboon et al., 1994). Studies conducted in the 1980’s and 1990’s focused on the tendency of adolescents to overestimate their weight status (Desmond et al., 1986; Desmond
et al., 1989; Fox et al., 1994) however, more recently, research has shifted to highlight a tendency amongst teens to underestimate their weight status (Maximova et al., 2008; Standley et al., 2009; Yost et al., 2010). This shift may have occurred because an adolescent’s estimation of their weight status is not based simply on their own size; rather, it reflects the adolescent’s perception of where they are on the spectrum of body weight. So as teenage waistlines have expanded, the subjective observation of what is ‘normal weight’ may have also shifted (Wardle, Haase, & Steptoe, 2006).

A serial, cross-sectional study of Finnish adolescents from 1979 to 1999, found that, despite an increasing number adolescents meeting the criteria for overweight, the proportion of those perceiving themselves to be overweight decreased over time. The authors suggested that this may be due to the effects of social comparison (Kaltiala-Heino, Kautiainen, Virtanen, Rimpelä, & Rimpelä, 2003). This study used self-report measurements for weight and height, which is less accurate than directly measured methods (Sherry et al., 2007). Nonetheless, it indicates social comparison is a potential mechanism for the widespread underestimation of weight status seen in adolescents.

The theory of social comparison, first described by Festinger (1954), suggests that an individual’s self-evaluation is based on comparisons with others around them. Krayer and colleagues (Krayer, Ingledew, & Iphofen, 2008) built on this social comparison theory to describe a grounded theory approach to body image. This approach suggests that adolescents compare themselves to images found in media, however this is balanced against comparisons with their peers, which tend to be more salient. As an adolescent’s peers are now more likely to be overweight, self-perceptions may be more in line with this new ‘normal’ than
with cultural ideals (Kaltiala-Heino et al., 2003). To date, there is only one study of adolescent perception of weight status that has used objective measurements of height and weight and has looked at the contribution of peer comparison. This study found evidence for the role of peer comparison, as adolescents attending school with overweight or obese schoolmates were more likely to underestimate their own weight status (Maximova et al., 2008). This indicates that being exposed to overweight peers influences perception of weight status and a consequence of the obesity epidemic may be that a growing number of adolescents underestimate their weight.

Conclusion

A range of biological, psychological and social factors have been found to contribute to weight status misperception. These factors have the potential to assist the understanding weight status misperception. Consistent trends have been reported in terms of weight status and gender; however, there is a need to clarify how these factors are influenced by the use of objective measurements of weight besides BMI. Few studies have used objective measurements of weight status to examine how body dissatisfaction, age, SES and peer comparison mediate weight status misperception. There is a need to further investigate the relationship of these factors with weight status misperception.
Chapter 4

Consequences of Misperception of Weight Status: For Intentions and Behaviour

Failure to accurately perceive weight status may have implications for an individual’s weight related behaviour. For example, adolescents who do not recognise that they are overweight may not be motivated to make changes to their diet or activity levels to prevent further weight gain. Accordingly, some researchers have suggested that the promotion of accurate perception of weight status should be a priority in order to encourage the widespread adoption of healthy weight related behaviours (Brener et al., 2004; Duncan et al., 2011; Maximova et al., 2008). However, before following such recommendations, it is important to understand whether weight misperception has an impact on weight related intentions and behaviour. This chapter will outline the theoretical basis for the influence of weight misperception on weight related intentions and behaviour. It will also review the existing evidence for a relationship between weight perception, body change intentions, and weight related behaviour and examine whether these relationships differ by gender and by body satisfaction.

The Health Belief Model

According to many theories of health behaviour, an individual’s perceived susceptibility a certain disease or condition impacts on their decisions about their lifestyle (Conner & Sparks, 2001). The health belief model proposes that behaviour results from core beliefs including; perceived susceptibility to a condition (such as obesity), the severity of the condition (knowing that obesity is related to serious health problems), the costs and benefits of change, and the cues
to action (J. Ogden, 2004). Despite the fact that many long-term health consequences related to lifestyle do not manifest for years after adolescence, the health belief model does seem explain a range of adolescent health behaviours including; self-care in relation to food allergies (C. Jones et al., 2014); risky sexual behaviour (Tenkorang, 2013) and smoking (Mantler, 2013). In addition, O’Connell and colleagues (1985) used the health belief model to investigate adolescent exercise and dietary behaviour and found that perceived susceptibility to the causes of obesity explained adolescents’ dieting behaviour. It is therefore possible that adolescents who do not think that they are at risk of becoming obese may not engage in healthy weight related behaviour.

Research suggests that people are reluctant to acknowledge personal susceptibility to harm, even when they can acknowledge the risks faced by others (Weinstein, 1987). Failure to recognise one’s vulnerability to harm is a major barrier to taking positive action to prevent harm (Glanz, Rimer, & Viswanath, 2008). This suggests that individuals who are unaware of their overweight status will not be taking action to lose weight. To determine whether accurate weight status perception impacts on weight related behaviours it is necessary to first understand how weight status perception affects body change intentions.

**Intention to Lose Weight or Gain Muscle**

**Impact of weight perception on body change intentions.** Adolescents who perceive themselves to be overweight are more likely to report trying to lose weight regardless of their weight status (Strauss, 1999; Yost et al., 2010). In a 2010 study of US females, those who considered themselves overweight (accurately or not) were 13 to 25 times more likely to report wanting to lose weight, and weight perception was a significantly better predictor of wanting to
lose weight than BMI (Yost et al., 2010). A similar finding was reported in a study of urban, low-income, African-American adolescents, where perception of overweight was associated with a desire to lose weight and perception of underweight was associated with intention to gain weight (Wang et al., 2009).

**Gender differences in body change intentions.** Studies of weight perception in adolescents have found that girls are more likely than boys to want to weigh less regardless of their BMI (Strauss, 1999; Yan et al., 2009) and some girls want to lose weight despite having a perception of healthy weight (Duncan et al., 2011). In contrast, perception of healthy weight in boys has been equally associated with a desire to lose weight and a desire to gain weight (Kurdak et al., 2010). This difference in body change intentions may reflect the differences in ideal body image between the genders. Girls are aware of a thin ideal (Keel et al., 2007), and consequently, girls who are aware of their overweight status and dissatisfied with their body are typically trying to lose weight (Neumark-Sztainer et al., 2006; Wang et al., 2009). In contrast, the lean, muscular ideal requires boys to gain both muscle mass and weight (McCreary & Sasse, 2000). Accordingly, boys are more likely than girls to want to gain muscle (McCabe, Ricciardelli, Waqa, Goundar, & Fotu, 2009; O’Dea & Amy, 2011), and poor size acceptance has been associated with a drive to gain muscle in boys (McVey, Tweed, & Blackmore, 2005). However it is unknown how intentions to gain muscle relate to boys’ weight perceptions. Although many studies of weight status perception have examined the intention to change weight (Tienboon et al., 1994; Wang et al., 2009; Yan et al., 2009; Yost et al., 2010), there are no studies that have investigated the association between intention to gain muscle and weight status perception.
Weight Related Behaviour

**Impact of weight perception on weight related behaviour.** There is evidence to suggest that perception of weight may promote adolescents to engage healthy weight change behaviours. In studies that used self-reported weight and height to calculate BMI, perception of overweight has been associated with increased physical activity in both healthy weight (Ursoniu, Putnoky, & Vlaicu, 2011) and overweight adolescents (Edwards et al., 2010; Khamalia, Hardy, & Bauman, 2012; Lenhart, Daly, & Eichen, 2011), by contrast, underestimation of weight has been associated with a lowered likelihood of engaging in exercise (Al Sabbah et al., 2010; Maximova, 2011). However, there is additional evidence to suggest that perception of overweight is related to lowered engagement in physical activity (Felts, Parrillo, Chenier, & Dunn, 1996; Gillison, Standage, & Skevington, 2006).

Similarly, the influence that weight perception has on dietary behaviours is uncertain. A study by Xie et al., (2006) suggested that a perception of weight outside the healthy weight range, that is, either overweight or underweight was associated with greater consumption of unhealthy foods. Duncan et al., (2011), found that perceived overweight (correct or not) was a stronger predictor of dieting to lose weight than weight status itself. Studies in overweight adolescents suggest that those who are aware of their weight status are more likely to engage in physical activity to lose weight (Edwards et al., 2010; Lenhart et al., 2011). This suggests that failing to recognise overweight status may have a direct impact on an individual’s capacity to make healthy changes to their lifestyle. However, there is contrary evidence for this. Overweight adolescents who accurately perceive their weight status have been found to have poorer diets than those who
In addition, a study of obese US adolescents (Thunfors, Hanlon, & Collins, 2011), found that underestimation of weight status was associated with healthier dietary intake and greater engagement in physical activity. These studies suggest that misperception of weight in obese and overweight adolescents may be a protective factor and actually promote positive health behaviour. However, another explanation for the link between misperception and exercise may be found in the previously discussed limitations of BMI. In the study by Thunfors et al., those who underestimated their weight status had significantly lower BMIs than those who accurately perceived themselves as obese. This suggests some of those classified as ‘underestimating’ may have had a high level of lean mass and a corresponding high level of participation in health behaviours.

**Gender differences in weight related behaviour.** Some studies suggest that there are similarities between boys and girls in terms of the methods that they use to lose weight. These studies indicate that both boys and girls try eating less and exercising more (Tienboon et al., 1994) and reducing their intake of high calorie, low nutrient food (Middleman, Vazquez, & Durant, 1998) in order to lose weight. However, other studies suggest that there are gender differences in weight related behaviours, and in particular, girls are more likely to employ unhealthy weight control methods. While weight loss is a desirable outcome in tackling obesity the challenge is to promote healthy behaviours that lead to long term, healthy, weight maintenance. Unhealthy weight control practices, such as fasting or purging can be profoundly damaging to health and have been found to be more prevalent in girls who want to lose or stay the same weight (Forman-Hoffman, 2004). Other studies have suggested that girls are less likely than boys to eat fruits
and vegetables (Xie et al., 2006) or engage in vigorous physical activity as a weight loss method (Yost et al., 2010). These differences in behaviour may exist because girls and boys aim to achieve different body ideals. Unhealthy weight control behaviour may be more prevalent amongst girls because they have an aesthetic aim – to look ‘thin’, rather than a functional aim. In contrast, boys may be more likely to engage in healthy weight loss behaviours, such as exercise because they intend to gain weight or muscle (Desmond et al., 1986; Felts et al., 1996). Therefore, it is important to take gender differences into account when evaluating the impact that weight perception has on behaviour.

**Impact of dissatisfaction on weight related behaviour.** There is evidence to suggest that weight related behaviour may also be influenced by body dissatisfaction. Research suggests that body dissatisfaction is a predictor of unhealthy weight related behaviour, such as binge eating, reduced fruit and vegetable intake and lowered levels of physical activity (Neumark-Sztainer et al., 2006; Skemp-Arlt, 2006). Such studies indicate that body dissatisfaction has a negative influence on adolescents’ diet and activity levels. An alternate view was offered by Heinberg and colleagues (2001), who proposed that the relationship of weight related behaviours to body satisfaction can be represented by a u-shaped curve. This model acknowledges that very high levels of dissatisfaction are associated with maladaptive weight related practices but also suggests that very low levels of body dissatisfaction are associated with poor engagement in exercise and healthy dietary habits. Thus, experiencing some degree of body dissatisfaction may actually motivate individuals to engage in the lifestyle changes that are needed to manage their weight. This approach suggests that body
dissatisfaction may actually be beneficial for the health of overweight adolescents.

Weight related behaviours are likely to be influenced by a complex interplay between weight perception, satisfaction, body change intentions and gender. Perception of weight and body satisfaction may influence an adolescent’s intention to make changes to their body in order to achieve gender specific ideals. In addition, perceived weight and body satisfaction may also influence the type of dietary and physical activity behaviours that adolescents engage in. Previous studies suggest there is a clear link between perception of weight and weight loss intentions; however the impact that weight perception has on weight related behaviours is uncertain. Understanding how other factors impact on weight related behaviours may provide a greater insight into how important perception of weight status is in terms of influencing behaviour.

Conclusion

In summary, evidence suggests that misperception of weight status is widespread among Australian adolescents. However, our understanding of why adolescents misperceive their weight is limited. Possible reasons for our lack of understanding include; 1) there is no model with which to conceptualise adolescent perception of weight status, 2) few studies have looked at the effect of potentially important factors such as; social comparison, SES, age and body dissatisfaction on perception of weight and 3) it is unknown which anthropometric measures of weight status are most closely aligned with adolescents perception of their weight. In addition, it is unclear whether weight misperception is associated with diet and activity, very few studies have examined how weight perception interacts with weight loss intentions and body
satisfaction to influence behaviour, and no studies have examined the association with intention to gain muscle. Furthermore, only a small number of studies into weight perception have been conducted in Australia; these have generally had a small sample size (Tienboon et al., 1994) or have not examined the consequences of adolescent misperception in terms of diet (Abbott et al., 2010; Al Mamun et al., 2007) or exercise behaviours (O’Dea & Amy, 2011).
Chapter 5

Description of Publications

Three studies were conducted in order to address the questions raised by previous research into adolescent weight perception. These studies aimed to enhance our understanding of why adolescents misperceive their weight status and how this misperception impacts upon weight related intentions and behaviour. Specifically, in order to understand adolescent misperception of weight status, this thesis examined the biopsychosocial factors and the anthropometric measurements that correlate with adolescents’ weight perception. To understand the impacts of weight misperception on behaviour, this thesis examined the association of weight perception with intention to lose weight, intention to gain muscle, diet and physical activity.

The project involved secondary analysis of data obtained from the It’s Your Move! study; a quasi-experimental, longitudinal intervention study conducted between 2005 and 2008. It’s Your Move! targeted weight gain in adolescents, and was conducted among secondary student’s aged 11 to 18, in 12 secondary schools in the Barwon-South Western Region of Victoria, Australia. Secondary data from this study was analysed in order to examine adolescent weight perception in terms of its measurement and biopsychosocial correlates and the association with body change intentions and behaviour. This chapter will describe the three articles that were written in order to address the overall aims of the thesis.
Article 1: Biopsychosocial Correlates of Weight Status Perception in Australian Adolescents (Julia Fredrickson, Peter Kremer, Andrea de Silva Sanigorski, Boyd Swinburn and Marita McCabe, Published in Body Image, 2013, Volume 10, pp. 552-557)

There is currently no organising framework for the array of factors that are associated with adolescent weight misperception. This study aimed to develop and evaluate a biopsychosocial model of weight status perception. The differences in accuracy of perception were examined by age, gender, socio economic status, peer weight, and satisfaction with body weight and shape. This study also described the prevalence of misperception in a large sample of Australian adolescents. Perceived weight status was verified using BMI-z and classified as accurate, overestimation or underestimation. This article considered the utility of a biopsychosocial model to describe accuracy of weight status perception; this includes a discussion of how each factor in the model was associated with weight perception. In addition, a discussion of how the model varied between the overweight and healthy weight subgroups and by the type of misperception is presented. The implications of the model, the limitations of the study and directions for future research are also presented.

Article 2: Which measures of adiposity are related to Australian adolescent’s perception of their weight? (Julia Fredrickson, Peter Kremer, Andrea de Silva Sanigorski, Boyd Swinburn and Marita McCabe, Published in Acta Paediatrica, 2014, Volume 103, Issue 7, pp. e317-e324)

In terms of the literature on weight status perception, the majority of studies have only used BMI as the objective measurement of weight; therefore, it is unknown what adolescents are referencing when they report their perception of
weight, whether it is their body size, their body fat or some other factor. This article explored how perception of weight status in adolescents is related to the different objective indicators of weight status. Perceived weight status was compared against three different measurements of body adiposity; body mass index, waist circumference and body fat percentage as measured by bio-electrical impedance analysis. A discussion of the correlation of each measurement with weight perception is presented in this article, as well as consideration of the impact of gender and weight status on perceived weight. The prevalence of misperception in the sample is also discussed. The limitations of the research and the implications for measurement of weight perception were also considered.

Article 3: Weight perception in overweight adolescents: The association with body change intentions, diet, and physical activity (Julia Fredrickson, Peter Kremer, Andrea de Silva Sanigorski, Boyd Swinburn and Marita McCabe, submitted to the Journal of Health Psychology)

The evidence for the impact of weight misperception on weight related behaviour is mixed and it is unknown how weight perception relates to intention to gain muscle. This study examined the impact of weight misperception, gender and weight satisfaction on intention to lose weight, intention to gain muscle, diet and physical activity in a sub sample of overweight adolescents. The study focussed on overweight adolescents because they are most likely to misperceive their weight status, and they are most at risk of future harm by not making changes to their lifestyle. This article discussed the association of perceived weight status, gender and weight satisfaction with intention to lose weight and gain musculature, dietary behaviour and physical activity. In light of these findings, this article also presents the implications in terms of encouraging
accurate weight perception in overweight adolescents and the strengths and limitations of the study.
AUTHORSHIP STATEMENT – ARTICLE 1

1. Details of publication and executive author

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<td>Body Image 10 (2013) 552-557</td>
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2. Inclusion of publication in a thesis

Is it intended to include this publication in a higher degree by research (HDR) thesis?  
Yes  
If Yes, please complete Section 3  
If No, go straight to Section 4.

3. HDR thesis author’s declaration

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Conducted the literature search, contributed to the conception of the study and the planning of the analysis, conducted all of the statistical analysis, contributed to data interpretation and drafted the full manuscript and incorporated the revisions of the other authors.

I declare that the above is an accurate description of my contribution to this paper, and the contributions of other authors are as described below.

Signature and date  
27/02/2014

4. Description of all author contributions

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<tr>
<td>Marita McCabe</td>
<td>Contributed to the conception of the study and design of the methodology, and also redrafting and critical revision of the manuscript</td>
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<tr>
<td>Peter Kremer</td>
<td>Contributed to the conception of the study, design of the methodology, planning of the analysis, provided critical feedback and guidance on analysis and redrafting and critical revision of the manuscript.</td>
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Boyd Swinburn | Contributed to the interpretation of analysis, redrafting and critical revision of the manuscript.

Andrea de Silva | Contributed to interpretation of analysis, redrafting and critical revision of the manuscript

5. **Author Declarations**

   I agree to be named as one of the authors of this work, and confirm:

   i. that I have met the authorship criteria set out in the Deakin University Research Conduct Policy,

   ii. that there are no other authors according to these criteria,

   iii. that the description in Section 4 of my contribution(s) to this publication is accurate,

   iv. that the data on which these findings are based are stored as set out in Section 7 below.

   If this work is to form part of an HDR thesis as described in Sections 2 and 3, I further

   v. consent to the incorporation of the publication into the candidate’s HDR thesis

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<td>Andrea de Silva</td>
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6. **Other contributor declarations**

   I agree to be named as a non-author contributor to this work.

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7. **Data storage**

   The original data for this project are stored in the following locations. (The locations must be within an appropriate institutional setting. If the executive author is a Deakin staff member and data are stored outside Deakin University, permission for this must be given by the Head of Academic Unit within which the executive author is based.)
<table>
<thead>
<tr>
<th>Data format</th>
<th>Storage Location</th>
<th>Date lodged</th>
<th>Name of custodian if other than the executive author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original electronic data is stored in de-identified SPSS and Stata data files</td>
<td>On password protected computers at WHO-CC Deakin Waterfront Campus</td>
<td>2008</td>
<td>Prof Boyd Swinburn</td>
</tr>
<tr>
<td>Original hard copy information</td>
<td>Locked filing cabinets at WHO-CC Deakin Waterfront Campus</td>
<td>2008</td>
<td>Prof Boyd Swinburn</td>
</tr>
</tbody>
</table>

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Chapter 6

Article 1: Published in Body Image, 2013, Volume 10, Pages 552-557

Biopsychosocial Correlates of Weight Status Perception in Australian Adolescents

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Abstract

This study examined the utility of the biopsychosocial model to predict accuracy of weight status perception among Australian adolescents. The factors included in this framework were: age, gender, and BMI-z (biological factors); satisfaction with body weight and shape, (psychological factors); socioeconomic status, peer weight (social factors). Cross-sectional data, including measured height and weight, and self-reported weight status, was obtained from 2,954 adolescents (mean age = 14.6, 56% male) who participated in the It's Your Move! study. Accuracy of weight status perception was associated with gender, BMI-z, SES, and weight and shape satisfaction. Gender differences in weight status perception were moderated by satisfaction with weight. In boys, weight satisfaction was associated with perceived healthy weight; in girls, it was associated with perceived healthy weight and underweight. Moderately overweight adolescents are most at risk of underestimating their weight status and could benefit from education about the boundaries of the healthy weight range.

Keywords: weight status, perception, adolescent, biopsychosocial model

Highlights

- A biopsychosocial model of weight status perception was examined.
- Biological, psychological, and social variables were associated with misperception.
- Moderately overweight adolescents are at most risk of underestimating their weight status.
- Healthy weight boys tended to perceive themselves as underweight.
- Boys are most satisfied with a perceived weight within the healthy weight range.
Biopsychosocial Correlates of Weight Status Perception in Australian Adolescents

The prevalence of obesity and overweight in Australian adolescents is estimated at 5-6% and 21-25% respectively (Olds, Tomkinson, Ferrar, & Maher, 2010). Obesity tends to track into adulthood, putting overweight children and adolescents at greater risk of developing obesity related conditions later in life (Deshmukh-Taskar et al., 2005). Perception of weight is a better determinant of weight loss behavior than actual weight (Strauss, 1999; Wang, Liang, & Chen, 2009). However, adolescents’ perception of their weight status often correlates poorly with objective measurements of their weight (Maximova et al., 2008; Strauss, 1999). While some adolescents overestimate (perceive themselves to be heavier than their measured weight status) others underestimate (perceive themselves lighter than their measured weight status). This can lead to serious health consequences for adolescents; those who overestimate may engage in unnecessary weight loss behaviors and those who underestimate may not make the necessary changes to their lifestyle to prevent obesity related disease (Keel, Baxter, Heatherton, & Joiner, 2007).

Previous studies of weight status perception identified a wide variety of factors that influence perception of weight status. However, to our knowledge no organizing framework has been applied to describe adolescent misperception of weight status. The biopsychosocial model has previously shown utility to predict body image concerns (Ricciardelli, McCabe, Holt, & Finemore, 2003) and inaccurate body size estimation in males and females (McCabe, Ricciardelli, Sitaram, & Mikhail, 2006). This framework may also be appropriate for
predicting adolescent weight status perception, as it encompasses the range of factors that have been found to influence perception of weight status. In particular, the biological factors of age and gender, social factors of socioeconomic status and peer weight, and psychological factors of satisfaction with body weight and shape will be examined in this study.

Weight status influences accuracy of weight perception. Adolescents with overweight or obesity tend to misperceive their weight status compared to their underweight and healthy weight peers (Maximova et al., 2008; Viner et al., 2006). Previous studies have estimated between one third (Wang et al., 2009) and 40% (Edwards, Pettingell, & Borowsky, 2010) of overweight adolescents underestimate their weight, and in a recent Australian study 64% of adolescents sampled did not recognize they were overweight (O’Dea & Amy, 2011).

The literature on weight status perception also indicates consistent gender differences; in particular, girls tend to overestimate their weight status and boys tend to underestimate (Abbott, Lee, Stubbs, & Davies, 2010; Brener, Eaton, Lowry, & McManus, 2004; Xie et al., 2003). In addition, the relative accuracy of perception of each gender depends on the weight group being examined. That is, among overweight or obese adolescents, girls have been found to be more accurate (Wang, Liang, & Chen, 2009) and among normal weight or underweight adolescents, boys have been found to be more accurate (Martin, Frisco, & May, 2009; Viner et al., 2006). A proposed reason for this gender difference is that girls in Western societies have a propensity to internalize a ‘thin’ ideal which tends to be below a healthy weight (Thompson & Stice, 2001). Perceived failure to conform to this ideal may explain the higher levels of body dissatisfaction in girls, particularly amongst those who are overweight (Wang et al., 2009). And it may,
in turn, affect perception of their weight as when girls make a judgment about their size or weight, the standard that they automatically compare themselves against is this unrealistic ‘thin’ ideal (Brener et al., 2004). Similarly, there is evidence to suggest that boys may be influenced by a muscular ideal (Gray & Ginsberg, 2007). Body satisfaction in male adolescents has been found to decrease as they move closer to an underweight body mass index (BMI) (Eisenberg, Neumark-Sztainer, & Paxton, 2006) and compared to girls they are more likely to consider themselves to be too thin (Strauss, 1999; Thomas, 1977; Yan, Zhang, Wang, Stoesen, & Harris, 2009). The tendency of boys to underestimate their weight status may reflect dissatisfaction with their muscularity and perceived failure to achieve an ideal ‘large’ body (Isomaa, Isomaa, Marttunen, Kaltiala-Heino, & Björkqvist, 2011). Thus, dissatisfaction with body weight and shape may influence both male and female misperception of weight status; however the difference in ideal body shapes means that misperception is exhibited in opposite directions.

Adolescent estimation of weight status may reflect an adolescent’s perception of where they are on the spectrum of body weight relative to their peers. As teenagers have become increasingly heavier, the subjective observation of what is ‘normal weight’ may have also shifted (Wardle, Haase, & Steptoe, 2006). Maximova et al. (2008) found that adolescents who attended school with peers who were overweight or obese were more likely to underestimate their own weight status. The association of age and socioeconomic status (SES) with accuracy of weight status perception is limited and requires further investigation. Misperception of weight status may be stable between the ages of 15 and 18 (Isomaa et al., 2011), however there is also evidence to suggest that it changes
between the ages of 13 and 16 (Maximova et al., 2008). It is therefore necessary to examine weight status perception across the adolescent age span. An Australian study found underestimation of weight status was more prevalent in schools classified as lower SES (O'Dea & Caputi, 2001). However, studies that measured SES by household income, education or occupation found no associations with weight status perception (Goodman, Hinden, & Khandelwal, 2000; Viner et al., 2006; Yan et al., 2009), while other research suggests that SES may be a factor but it is difficult to separate from ethnicity (Strauss, 1999).

The current study aimed to examine the utility of the biopsychosocial framework to predict accuracy of weight status perception among Australian adolescents. We hypothesized that a greater proportion of overweight and obese adolescents would misperceive their weight compared to their normal weight and underweight peers. We also expected that females would be more likely to overestimate their weight status and males would be more likely to underestimate it. Furthermore, we predicted that the relationship with gender would be moderated by satisfaction with body weight and shape, and that body dissatisfaction would be associated with overestimation in females and underestimation in males. We also hypothesized that participants from a lower socioeconomic background or with a higher aggregate peer weight would be more likely to underestimate their weight status, and that older adolescents would be more likely to overestimate their weight status.

**Method**

**Procedure**

The data were sourced from the It’s Your Move! study, a quasi-experimental, longitudinal intervention study conducted in 12 Victorian schools
between 2005 and 2008. Detailed information about study methods has been reported previously (Millar et al., 2011; Swinburn et al., 2011). Ethics approval for the present study was provided by the University Human Research Ethics Committee.

Participants

The baseline data from both the intervention and comparison groups (N = 3040) were used in this study. Of this sample of adolescents, 86 were excluded from the analysis because of missing data on height, weight or weight perception. The final sample for analysis consisted of 2,954 male and female adolescents aged between 11 and 18 years (M = 14.5 ± 1.4). The sample was ethnically homogeneous, 94.5% of participants were European Australian, 1.5% were Indigenous Australian, and the remaining four percent identified with a range of other ethnicities.

Measures

Weight and height were measured by trained researchers using standardised methods (Millar et al., 2011). Body mass index (BMI; weight in kg / (height in m)^2) and standardized BMI (BMI-z) were calculated using the World Health Organization definition (de Onis et al., 2007). BMI-z was used in the analysis because it adjusts for variations in rates of physical development by gender, ensuring that differences in perception by gender reflect true differences in perception rather than differences in body size (Martin, May, & Frisco, 2010). The WHO BMI-z score cut-offs were used to classify adolescents’ weight status as underweight, healthy weight or overweight/obese (de Onis et al., 2007).

Demographic information, weight perception, and weight and shape satisfaction were derived from the Adolescent Behaviour, Attitudes and
Knowledge Questionnaire (ABAKQ) (Mathews et al., 2009). The ABAKQ was developed for the Pacific Obesity Prevention in Communities (OPIC) study and it was pilot tested for acceptability, appropriateness, and feasibility of completion prior to implementation. It was not formally tested for reliability and validity. It consisted of 87 questions which focused on eating habits and physical activity. The question about shape satisfaction asked, “How happy or unhappy are you with your body shape”, the question about body weight was phrased the same way. Both questions were measured on a scale from 1 (very unhappy) to 5 (very happy). As the distribution of responses across this scale was not normally distributed, the 5-point scale for satisfaction with weight and shape was dichotomized into satisfied (points 4 and 5) and not satisfied (points 3, 2 and 1). Participants were also asked how they would describe their weight; very underweight, underweight, healthy weight, overweight or very overweight. To determine the accuracy of their perception, these five categories and were collapsed into three categories. These categories were associated with a numerical value; underweight (-1), healthy weight (0) or overweight (1). Weight misperception was calculated by subtracting weight status from weight perception. Each participant therefore received a score that was either; greater than 0, less than 0 or equal to 0; these scores were equivalent to underestimation, overestimation, and accurate perception, respectively.

Peer weight was determined by calculating the average student BMI-z in every year level, for each of the 12 schools in the study. In this study, households with less than two parents were a proxy for lower socio economic status. According to the Australian Bureau of Statistics (2007), one parent families are at a higher risk of economic disadvantage and have a lower level of educational
attainment compared to dual parent families. Adolescents were asked whether they live with their parents/step-parents during the week; two parents, one parent or don’t live with parents. This was dichotomized into High SES (live with two parents) and Low SES (live with one parent or no parents). All analyses were performed using SPSS (V20) and statistical significance was accepted as $p < .05$.

**Results**

**Participant Characteristics**

A summary of participant characteristics is presented in Table 1. Just over half the sample was male and a majority of the sample was classified as higher SES. Chi square tests were used to test the association of gender with weight and shape satisfaction. A significantly higher proportion of males were satisfied with their weight, $\chi^2 (1) = 154.52, p < .001$, and shape, $\chi^2 (1) = 141.42, p < .001$ compared to females. Based on the odds ratio, males were 2.58 times more likely to be satisfied with their weight, and 2.47 times more likely to be satisfied with their shape compared to females. The majority of participants were a healthy weight, almost one third of participants were overweight or obese, and less than one percent of the sample was underweight. There was no significant association between the distribution of weight status and gender, $\chi^2 (2) = 0.59, p = .75$.

**Misperception by Objective Weight Status and Gender**

Participants’ perception of their weight at each level of objective weight status, stratified by gender, is presented in Table 2. A majority of underweight adolescents and two thirds of healthy weight adolescents had an accurate perception of their weight; overweight adolescents had a comparatively lower proportion of accurate perception. A chi-square test was used to assess the relationship of accuracy of perceived weight status with objective weight status.
Adjusted standardized residuals were used to interpret the relative influence of each cell on the overall relationship. The association of weight status with weight perception was significant, $\chi^2 (2) = 452.34, p < .001$, with overweight adolescents more likely to underestimate, $z = 14.1, p < .001$. Cramer’s $V$ indicated that the association between perceived and objective weight status was moderate ($V = .31$). An additional chi-square test was used to assess the relationship of accuracy of perceived weight status with gender. There was a significant association between gender and weight status perception, $\chi^2 (2) = 52.41, p < .001$.

Examination of the adjusted standardized residuals revealed that girls were more likely to underestimate, $z = 4.2, p < .001$ and boys were likely to overestimate $z = 2.9, p = .002$. However, overall, gender had a weak relationship ($V = .13$) with weight status perception.

**Association between Biopsychosocial Variables and Weight Status Perception**

Research suggests that the factors that influence weight status perception differ by weight status (Brener et al., 2004; Martin et al., 2010), so the association of the biopsychosocial variables with weight perception was evaluated within each weight category. Analysis was performed for the healthy weight and overweight subgroups only, due to insufficient underweight participants, and examination of overestimation was only performed for the healthy weight subgroup. The analysis was conducted via logistic regression and included all biopsychosocial variables; gender, BMI-z, age, socioeconomic status, peer BMI-z, satisfaction with weight and shape, as well as the interactions of gender and satisfaction with weight and shape. The Nagelkerke $R^2$ statistic was used to
indicate the power of the biopsychosocial variables to predict the weight perception status.

**Biospsychosocial correlates of misperception in overweight adolescents.**

Table 3 presents the results of the logistic regression model for the overweight subgroup. There was a moderate association of accuracy of weight status perception with the biopsychosocial variables, Nagelkerke $R^2 = .42$. The model indicated that at higher levels of BMI-z, overweight adolescents were significantly less likely to underestimate their weight. In addition, satisfaction with weight and shape was associated with underestimation of weight status. There were no significant interactions between satisfaction with weight and shape.

**Biospsychosocial correlates of misperception in healthy weight adolescents.**

Table 4 presents the model for underestimation of weight status among healthy weight adolescents. There was a moderate association of accuracy of weight status perception with biopsychosocial variables, Nagelkerke $R^2 = .31$. Males and adolescents from lower SES backgrounds were more likely to underestimate their weight status. As BMI-z decreased, healthy weight adolescents were more likely to underestimate. There was also a significant interaction between gender and satisfaction with weight. Healthy weight males who were dissatisfied with their weight were more likely perceive themselves underweight than their female counterparts.

Table 5 presents the logistic regression model for overestimation of weight status among healthy weight adolescents. There was a moderate
association between accuracy of weight status perception and biopsychosocial variables, Nagelkerke $R^2 = .39$. As BMI-z increased, the likelihood that healthy weight adolescents would overestimate their weight increased. Healthy weight adolescents who were dissatisfied with their weight and shape were also more likely to believe that they were overweight. There were no significant interactions between satisfaction with weight and shape, and gender.

**Discussion**

Over a third of participants in this sample perceived their weight status inaccurately and the biopsychosocial variables were moderately associated with accuracy of weight status perception in both overweight and healthy weight adolescents. In particular, gender, BMI-z, SES, satisfaction with weight and satisfaction with shape were associated with accuracy of weight status perception. Peer weight and age were not associated with accuracy of weight status perception. These results indicate that a large proportion of adolescents perceived their weight status inaccurately and that misperception is related to biological, psychological, and social factors.

Overweight adolescents had the highest prevalence of inaccurate perception. Almost 40% of overweight participants in the current sample reported that they were a healthy weight or underweight. This is consistent with previous studies that have found between one third (Wang et al., 2009) and 40% (Edwards et al., 2010) of overweight adolescents misperceive their weight status. However, when the association of BMI-z with weight perception was examined within each weight category, adolescents who were on the extreme edges of their weight category were more likely to misperceive their weight status. For example, adolescents who were classified at the lower end of the BMI-z scale within their
weight category were more likely to believe that they belonged to a lower weight category. This suggests that many adolescents may not realize that they are overweight until they are well within the overweight category or even obese. By this stage it may have become more difficult to make the changes necessary to move back into the healthy weight range and prevent obesity from continuing into adulthood (Lobstein, Baur, & Uauy, 2004).

The relationship of weight status perception with gender varied within each weight category. Among overweight adolescents, females and males were equally likely to underestimate their weight status. This is at odds with previous findings that girls with overweight or obesity are more accurate at estimating their weight (Edwards et al., 2010; Wang et al., 2009), and indicates that girls who are overweight are just as susceptible as boys in terms of underestimating their weight. Among healthy weight adolescents, there were no gender differences in terms of overestimation of weight status.

Healthy weight boys had a greater tendency to perceive themselves as underweight compared to their female counterparts. This finding is consistent with previous research (Brener et al., 2004; Strauss, 1999; Xie et al., 2003). In this study, healthy weight boys who perceived themselves as underweight were also likely to be dissatisfied with their weight. This suggests that comparison with an unrealistic ‘large’ or muscular ideal is driving underestimation of weight in boys. However, in both genders, perceived overweight was also associated with weight and shape dissatisfaction, and perceived healthy weight was associated with weight and shape satisfaction. Overall, these findings suggest that boys tend to be satisfied with their weight when they perceive themselves to be a healthy weight – and perception of overweight and underweight are associated with
dissatisfaction. However, for girls, dissatisfaction with weight and shape is associated with perceived overweight and perception of underweight does not generate dissatisfaction. These findings are consistent with the tendency of girls to internalise a ‘thin’ ideal where being underweight is just as desirable as healthy weight (Mathews et al., 2009). However, it also suggests that for boys, their ideal is more complex than simply wanting to be large. Satisfaction with healthy weight may be more consistent with aspiring to a lean, muscular ideal (McCreary & Sasse, 2000), rather than wanting to be ‘large’ regardless of muscle mass or adiposity (Lubans & Cliff, 2011). This may explain why both overestimation and underestimation of weight is associated with dissatisfaction in healthy weight boys.

In this study, healthy weight adolescents who lived with one or less parents were more likely to perceive that they were underweight. This is consistent with the finding that adolescents of low SES are more likely to consider themselves as ‘too thin’ (O'Dea & Caputi, 2001). As the sample in this study was ethnically homogeneous; it is unlikely that this is due to cultural norms that value larger body sizes. Given that there are relatively higher BMIs in single parent households (Schmeer, 2012), it is possible that there is some effect of comparison with people in their household which leads to underestimation of their own weight status. However, among overweight adolescents there was no association of family structure with underestimation. This suggests that if such a comparison does occur it is not a strong a determinant of weight perception.

There was no evidence that comparison with peer’s weight influenced accuracy of weight perception. This may be a result of the age of the adolescents sampled in this study. Maximova et al. (2008) found that 9 year olds were more
influenced by the BMI of their peers and family, than 13 and 16 year olds were. This prompted the authors to speculate that adolescents’ perceptions are influenced by media and cultural expectations rather than a peer-reference effect. As the youngest participants in this study in this sample were 11, it is possible that most participants in this study are at an age where they are more influenced by media than they are by the weight of their peers.

As this study used cross-sectional data it could not provide any information about the causes of weight status perception. The construct of weight and shape satisfaction in this study was limited, as it was measured by a single item measurement which was dichotomized. As a result, this construct lacked the strength of more comprehensive measures. In addition, the questions extracted for this study had not been assessed for reliability and validity. The sample was ethnically homogeneous; as such it is difficult to generalize these findings beyond adolescents of European descent. In addition, the measure of SES used in this study was family structure. This is a proxy for some aspects of individual level SES however it is possible that other factors that are common to single parent households but are not strictly related to socioeconomic disadvantage, such as parental involvement or family stability influenced the relationship with weight perception.

The study was also limited by the very small number of underweight participants in this sample. As a consequence, it was not possible to determine whether the trends that existed in the overweight and the healthy weight groups were also relevant to underweight adolescents. It also limited the investigation of overestimation of weight status as this could only be examined within the healthy weight adolescents. The lack of underweight participants in this sample may be
explained by limitations of BMI defined weight categories. BMI does not provide information about body fat distribution, and can conflate fat and fat free mass in individuals who are particularly muscular (Freedman et al., 2004; Lobstein et al., 2004). Thus, it is possible that participants who were particularly tall or muscular were misclassified into higher weight categories in this study. Indeed, the higher relative level of mismatch between perceived and measured weight status on the boundaries of the weight categories suggests that some adolescents may have been classified into weight categories that do not accurately reflect their body composition. This also relates to the inherent problem of using categorical variables to classify a continuous spectrum. At some point along the scale, individuals are divided into separate categories even though their BMI may only be slightly different, and the difference in their body composition may be negligible.

**Conclusions**

In this study, biological, psychological, and social variables were associated with misperception of weight status. Gender differences in terms of weight perception were moderated by weight satisfaction. The findings in this study provided more evidence to suggest that overweight adolescents are most at risk of inaccurate weight perception. Further investigation into what overweight adolescents are judging when they report their weight status, whether it is their size, their weight or their level of muscularity may lead to further understanding of their tendency to underestimate their weight.
References


Australian Bureau of Statistics. (2006). *An Introduction to Socio-Economic Indexes for Areas (SEIFA).* Canberra, ACT.


Weight perception and psychological factors in Chinese adolescents.


## Table 1

**Participant characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Overall ((N = 2954))</th>
<th>Male ((n = 1660))</th>
<th>Female ((n = 1294))</th>
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<tbody>
<tr>
<td>Age</td>
<td>14.6 (1.4)</td>
<td>14.6 (1.3)</td>
<td>14.7 (1.4)</td>
</tr>
<tr>
<td>Weight (kg), mean ((SD))</td>
<td>59.6 (13.4)</td>
<td>61.1 (14.3)</td>
<td>57.6 (11.8)</td>
</tr>
<tr>
<td>Height (cm), mean ((SD))</td>
<td>164.9 (9.7)</td>
<td>167.6 (10.5)</td>
<td>161.4 (7.1)</td>
</tr>
<tr>
<td>BMI (kg/m(^2)), mean ((SD))</td>
<td>21.8 (3.8)</td>
<td>21.6 (3.7)</td>
<td>22.0 (3.9)</td>
</tr>
<tr>
<td>WHO classification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>9.4%</td>
<td>10.2%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Overweight</td>
<td>22%</td>
<td>21.2%</td>
<td>23%</td>
</tr>
<tr>
<td>Healthy weight</td>
<td>68%</td>
<td>68.1%</td>
<td>67.9%</td>
</tr>
<tr>
<td>Underweight</td>
<td>0.6%</td>
<td>0.5%</td>
<td>0.7%</td>
</tr>
<tr>
<td>High SES (Live with two parents)</td>
<td>77.8%</td>
<td>77.8%</td>
<td>78.1%</td>
</tr>
<tr>
<td>Satisfied with weight</td>
<td>53.2%</td>
<td>63.4%</td>
<td>40.2%</td>
</tr>
<tr>
<td>Satisfied with shape</td>
<td>50.6%</td>
<td>60.4%</td>
<td>38.1%</td>
</tr>
</tbody>
</table>

*Note. BMI = body mass index; SES = socioeconomic status.*
### Table 2

*Objective weight status versus perceived weight status for the full sample and by gender*

<table>
<thead>
<tr>
<th>Objective status</th>
<th>Perceived weight status</th>
<th>Total</th>
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<tbody>
<tr>
<td></td>
<td>Underweight</td>
<td>Healthy weight</td>
</tr>
<tr>
<td></td>
<td>$n$ (%)</td>
<td>$n$ (%)</td>
</tr>
<tr>
<td>All</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>14 (82.4)†</td>
<td>3 (17.6)</td>
</tr>
<tr>
<td>Healthy weight</td>
<td>427 (21.3)</td>
<td>1391 (69.2)†</td>
</tr>
<tr>
<td>Overweight</td>
<td>28 (3)</td>
<td>340 (36.6)</td>
</tr>
<tr>
<td>Total</td>
<td>469 (15.9)</td>
<td>1734 (58.7)</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>6 (75)†</td>
<td>2 (25)</td>
</tr>
<tr>
<td>Healthy weight</td>
<td>286 (25.3)</td>
<td>777 (68.7)†</td>
</tr>
<tr>
<td>Overweight</td>
<td>20 (3.8)</td>
<td>200 (38.4)</td>
</tr>
<tr>
<td>Total</td>
<td>312 (18.8)</td>
<td>979 (59)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight</td>
<td>8 (89)†</td>
<td>1 (11)</td>
</tr>
<tr>
<td>Healthy weight</td>
<td>141 (16.1)</td>
<td>614 (69.9)†</td>
</tr>
<tr>
<td>Overweight</td>
<td>8 (2)</td>
<td>140 (34.4)</td>
</tr>
<tr>
<td>Total</td>
<td>157 (12.1)</td>
<td>755 (58.3)</td>
</tr>
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</table>

*Note.* †Accurate perception
Table 3

Biopsychosocial factors associated with underestimation of weight status for overweight participants (n = 905)

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>95% CI</th>
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<tr>
<td>Gender (ref female)</td>
<td>0.86</td>
<td>[0.58, 1.28]</td>
</tr>
<tr>
<td>BMI-z</td>
<td>0.078***</td>
<td>[0.05, 0.13]</td>
</tr>
<tr>
<td>Age</td>
<td>0.93</td>
<td>[0.82, 1.04]</td>
</tr>
<tr>
<td>SES (ref high)</td>
<td>0.93</td>
<td>[0.64, 1.36]</td>
</tr>
<tr>
<td>Peer BMI-z</td>
<td>1.97</td>
<td>[0.66, 5.92]</td>
</tr>
<tr>
<td>Weight satisfaction (ref not satisfied)</td>
<td>6.83***</td>
<td>[2.72, 17.13]</td>
</tr>
<tr>
<td>Shape satisfaction (ref not satisfied)</td>
<td>1.72</td>
<td>[0.75, 3.94]</td>
</tr>
<tr>
<td>Gender x Weight satisfaction</td>
<td>0.60</td>
<td>[0.20, 1.80]</td>
</tr>
<tr>
<td>Gender x Shape satisfaction</td>
<td>1.34</td>
<td>[0.46, 3.77]</td>
</tr>
</tbody>
</table>

Note. OR = odds ratio; CI = Confidence Interval; BMI = body mass index; SES = socioeconomic status.

*p < .05. **p < .01. ***p < .001.
Table 4

Biopsychosocial factors associated with underestimation of weight status for healthy weight adolescents (n = 1763)

<table>
<thead>
<tr>
<th></th>
<th>OR</th>
<th>95% CI</th>
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<tr>
<td>Gender (ref female)</td>
<td>3.40***</td>
<td>[2.03, 5.60]</td>
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<tr>
<td>BMI-z</td>
<td>0.14***</td>
<td>[0.11, 0.18]</td>
</tr>
<tr>
<td>Age</td>
<td>0.95</td>
<td>[0.87, 1.04]</td>
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<tr>
<td>SES (ref high)</td>
<td>1.43*</td>
<td>[1.05, 1.94]</td>
</tr>
<tr>
<td>Peer BMI-z</td>
<td>1.75</td>
<td>[0.76, 4.02]</td>
</tr>
<tr>
<td>Weight satisfaction (ref not satisfied)</td>
<td>1.48</td>
<td>[0.81, 2.68]</td>
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<tr>
<td>Shape satisfaction (ref not satisfied)</td>
<td>0.69</td>
<td>[0.39, 1.22]</td>
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<tr>
<td>Gender x Weight satisfaction</td>
<td>0.25***</td>
<td>[0.11, 0.52]</td>
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<tr>
<td>Gender x Shape satisfaction</td>
<td>1.72</td>
<td>[0.83, 3.59]</td>
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</tbody>
</table>

Note. OR = odds ratio; CI = Confidence Interval; BMI = body mass index; SES = socioeconomic status.

*p < .05. **p < .01. ***p < .001.
Table 5

**Biopsychosocial factors associated with overestimation of weight status for healthy weight adolescents (n = 1533)**

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<tr>
<td>Gender (ref female)</td>
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<td>[0.67, 1.55]</td>
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<tr>
<td>BMI-z</td>
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<td>Age</td>
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<tr>
<td>Shape satisfaction (ref not satisfied)</td>
<td>0.34**</td>
<td>[0.15, 0.75]</td>
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<tr>
<td>Gender x Weight satisfaction</td>
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<td>[0.50, 8.01]</td>
</tr>
<tr>
<td>Gender x Shape satisfaction</td>
<td>0.74</td>
<td>[0.23, 2.40]</td>
</tr>
</tbody>
</table>

Note. OR = odds ratio; CI = Confidence Interval; BMI = body mass index; SES = socioeconomic status.

*p < .05. **p < .01. ***p < .001.
# AUTHORSHIP STATEMENT – ARTICLE 2

## 1. Details of publication and executive author

<table>
<thead>
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<th>Title of Publication</th>
<th>Publication details</th>
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<tr>
<td>Which measures of adiposity are related to Australian adolescent’s perception of their weight?</td>
<td>Published in Acta Paediatrica, Vol 103, Issue 7, pp e317 – e324</td>
</tr>
</tbody>
</table>

| Name of executive author | School/Institute/Division if based at Deakin; Organisation and address if non-Deakin | Email or phone |
|--------------------------|---------------------------------|----------------|---|
| Julia Fredrickson | Psychology | 0415 878 514 | |

## 2. Inclusion of publication in a thesis

<table>
<thead>
<tr>
<th>Is it intended to include this publication in a higher degree by research (HDR) thesis?</th>
<th>If Yes, please complete Section 3 If No, go straight to Section 4.</th>
</tr>
</thead>
<tbody>
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## 3. HDR thesis author’s declaration

<table>
<thead>
<tr>
<th>Name of HDR thesis author if different from above. (If the same, write “as above”)</th>
<th>School/Institute/Division if based at Deakin</th>
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<tbody>
<tr>
<td>As above</td>
<td>Psychology</td>
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<table>
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<th>Thesis title</th>
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<tbody>
<tr>
<td>Perception of weight status in Australian Adolescents</td>
</tr>
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</table>

If there are multiple authors, give a full description of HDR thesis author’s contribution to the publication (for example, how much did you contribute to the conception of the project, the design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)

Conducted the literature search, contributed to the conception of the study and the planning of the analysis, conducted all of the statistical analysis, contributed to data interpretation and drafted the full manuscript and incorporated the revisions of the other authors.

I declare that the above is an accurate description of my contribution to this paper, and the contributions of other authors are as described below.

Signature and date: 27/02/2014

## 4. Description of all author contributions

<table>
<thead>
<tr>
<th>Name and affiliation of author</th>
<th>Contribution(s) (for example, conception of the project, design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marita McCabe</td>
<td>Contributed to the conception and design of the study, and also redrafting and critical revision of the manuscript</td>
</tr>
<tr>
<td>Peter Kremer</td>
<td>Contributed to the conception of the study, design of the methodology, planning of the analysis, provided critical feedback and guidance on analysis and redrafting and critical revision of the manuscript.</td>
</tr>
<tr>
<td>Boyd Swinburn</td>
<td>Contributed to the interpretation of analysis, redrafting and critical revision of the manuscript.</td>
</tr>
<tr>
<td>Andrea de Silva</td>
<td>Contributed to interpretation analysis, guidance on analysis, redrafting and critical revision of the manuscript</td>
</tr>
</tbody>
</table>
5. Author Declarations

I agree to be named as one of the authors of this work, and confirm:

vi. that I have met the authorship criteria set out in the Deakin University Research Conduct Policy,

vii. that there are no other authors according to these criteria,

viii. that the description in Section 4 of my contribution(s) to this publication is accurate,

ix. that the data on which these findings are based are stored as set out in Section 7 below.

If this work is to form part of an HDR thesis as described in Sections 2 and 3, I further

x. consent to the incorporation of the publication into the candidate’s HDR thesis submitted to Deakin University and, if the higher degree is awarded, the subsequent publication of the thesis by the university (subject to relevant Copyright provisions).

<table>
<thead>
<tr>
<th>Name of author</th>
<th>Signature*</th>
<th>Date</th>
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<tr>
<td>Marita McCabe</td>
<td></td>
<td>5/3/2014</td>
</tr>
<tr>
<td>Peter Kremer</td>
<td></td>
<td>27/2/2014</td>
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<tr>
<td>Boyd Swinburn</td>
<td></td>
<td>13/3/2014</td>
</tr>
<tr>
<td>Andrea de Silva</td>
<td></td>
<td>5/3/2014</td>
</tr>
</tbody>
</table>

6. Other contributor declarations

I agree to be named as a non-author contributor to this work.

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<thead>
<tr>
<th>Name and affiliation of contributor</th>
<th>Contribution</th>
<th>Signature* and date</th>
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</thead>
<tbody>
<tr>
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</table>

* If an author or contributor is unavailable or otherwise unable to sign the statement of authorship, the Head of Academic Unit may sign on their behalf, noting the reason for their unavailability, provided there is no evidence to suggest that the person would object to being named as author.

7. Data storage

The original data for this project are stored in the following locations. (The locations must be within an appropriate institutional setting. If the executive author is a Deakin staff member and data are stored outside Deakin University, permission for this must be given by the Head of Academic Unit within which the executive author is based.)

<table>
<thead>
<tr>
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<td>Original electronic data is stored in de-identified SPSS and Stata data files</td>
<td>On password protected computers at WHO-CC Deakin Waterfront Campus</td>
<td>2008</td>
<td>Prof Boyd Swinburn</td>
</tr>
</tbody>
</table>
This form must be retained by the executive author, within the school or institute in which they are based.

If the publication is to be included as part of an HDR thesis, a copy of this form must be included in the thesis with the publication.
Chapter 7

Article 2: Published in Acta Paediatrica, Volume 103, Issue 7, pp e317 – e324

Which measures of adiposity are related to Australian adolescents’ perception of their weight?

Julia Fredrickson\textsuperscript{a}, Peter Kremer\textsuperscript{b}, Boyd Swinburn\textsuperscript{cd}, Andrea de Silva\textsuperscript{e,f}, Marita McCabe\textsuperscript{a}

\textsuperscript{a}Deakin University, Australia
\textsuperscript{b}School of Exercise and Nutrition Sciences, Deakin University, Australia
\textsuperscript{c}WHO Collaborating Centre for Obesity Prevention, Australia
\textsuperscript{d}School of Population Health, University of Auckland, New Zealand
\textsuperscript{e}The McCaughey Centre, Melbourne School of Population and Global Health, Australia
\textsuperscript{f}Dental Health Services Victoria, Australia
Abstract

Aim: To determine which measurement of adiposity - standardised body mass index (BMI-z), waist circumference or body fat percentage - is most closely correlated with adolescents’ weight perception and whether this differs by gender.

Methods: Weight and height (used to calculate BMI-z), waist circumference and body fat percentage was measured in 2,278 adolescents aged between 12 and 16 and compared with self-reported weight status. Results: The distribution of subjects across the three weight categories (underweight, healthy weight, overweight) differed significantly between BMI-z, waist circumference and body fat percentage \( (p < .001) \). BMI-z was most closely aligned with perceived weight status in boys and girls and waist circumference was also a good correlate of weight perception in boys. Boys were more likely than girls to underestimate their weight when it was defined by BMI-z, however girls were equally likely to underestimate their weight when it was defined by waist circumference. The majority of adolescents underestimated their weight status when it was defined by BF%. Conclusion: BMI-z is the closest correlate of self perceived weight status. In the absence of internationally accepted reference values for waist circumference, BMI-z is the most appropriate measure to verify weight perception.

Keywords: adolescent, measurement, perception, weight,
Key Notes

- This study examined which measurement of adiposity was most closely correlated with adolescents perceived weight status: standardised body mass index, waist circumference or percentage body fat.

- Standardised body mass index was the best correlate of perceived weight status for both boys and girls; waist circumference was an equally good correlate for boys only.

- Adolescents frequently underestimated their weight, particularly if they were overweight.
The prevalence of overweight and obesity in Australian adolescents has been reported at 27% in females and 26% in males (1). As obesity tends to track into adulthood, overweight children and adolescents are at a greater risk of developing serious obesity related conditions in later life (2). Adolescence and childhood is therefore an opportune time to make lifestyle changes to curb further weight gain. Perception of weight may be crucial here because it is a stronger determinant of weight loss intentions than actual weight (3). Despite the potential impact on health, adolescent weight perception is not well understood. In order to understand why certain adolescents misperceive their weight, it is necessary to determine what they are referring to when they report their weight status and whether it is an estimate of their body size, their body fat or another factor.

Body mass index (BMI) based on age and gender defined reference values is the measurement most commonly used to verify accuracy of adolescents’ weight status perception. BMI is defined as weight (in kilograms) divided by the square of height (in metres), and in most individuals it correlates well with direct and indirect measurements of total body fat (4). However, using BMI to estimate adiposity has several limitations, including that it does not provide any information about body fat distribution. It can conflate fat and fat free mass in individuals who are particularly muscular and the measurement is less sensitive in people who are particularly tall or short (4). As a result, using BMI to classify weight status might result in misclassification, which is important when trying to examine the accuracy of individual perceptions of weight status.

In addition to BMI, there are other measurements of body adiposity that have relative advantages and disadvantages in terms of their utility to classify adolescent weight status. In order to be a useful measure of adiposity a measure
needs to be accurate, precise and simple to use with accepted reference values and, currently, there is no one measure that fulfils all those requirements (5).

Waist circumference provides a measure of central adiposity. Although there are no internationally accepted reference values for waist circumference (4) and the relation of waist circumference to overall body fatness in adolescents is unclear (5), it may be a good correlate of weight status perception. Waist circumference represents visible fatness in a certain area that may be easier to judge than overall body size. In adolescents with an equivalent BMI, those with central obesity have been found to have more total fat mass than those with peripheral obesity (6). In addition, waist circumference will be reduced by physical exercise, whereas BMI may not be because of a concurrent increase in muscle mass (7). A recent study indicated that adolescent girls have a tendency to overestimate their weight in relation to BMI, but are more accurate in relation to waist circumference (8). This indicates that waist circumference may be a superior correlate of weight perception in adolescents compared to BMI. However, it requires further examination, particularly in adolescent boys.

Another method of estimating body adiposity is body fat percentage. Bioelectrical Impedance Analysis (BIA) is one technique that provides an estimate of body fat percentage. BIA measures the flow of an electrical current through body tissues, and provides an estimate of fat free mass based on electrical conductivity and an estimate of fat mass based on impedance of the electrical current (4). The ability of BIA to provide estimate of body adiposity may vary with hydration level (9) and be better for groups than for individuals (10). The evidence that adolescents take their percentage body fat into account when assessing their body is equivocal. Body fat percentage has been found to be more
strongly associated with body image in young adults than either BMI or waist circumference (11), however, in adolescent girls it was no better than BMI in terms of its correlation with perceived weight (12). In addition, the correlation of body fat percentage with perceived weight has not been examined in adolescent boys.

There are noted gender differences in the way that boys and girls perceive their weight status. Girls tend to overestimate their weight and believe that they are heavier than they are. Boys tend to underestimate their weight and believe that they are lighter than they are (13). However, these differences may be due, in part, to the way that weight categories are classified. BMI overestimates the weight status of muscular boys (14) and, compared with waist circumference, underestimates the weight status of girls (8). Thus, the differences between boys and girls may be due to misclassification by BMI rather than a tendency to misperceive weight. Categorising weight status by more direct measurements rather than standardised BMI may alter the way adolescents are classified and consequently reduce the apparent gender differences in perception of weight. Another notable feature of weight perception research in adolescents is that overweight and obese individuals are more likely to misperceive their weight status in relation to their healthy weight or underweight peers (15). Overweight boys, in particular are most likely to perceive that they are lighter than their measured weight status (16). This is a particular concern, because overweight adolescents are the most at risk of further health complications if they do not make lifestyle changes prevent further weight gain. It is unclear whether the high prevalence of misperception amongst overweight adolescents is due to
misclassification by BMI or whether it is consistent across other measures of body adiposity.

Most studies of weight perception use BMI to examine perception of weight in adolescents. However few studies have examined which measurement of weight status is best aligned with adolescents’ perceived weight. One study has compared waist circumference with BMI in girls only (8), another study compared body fat percentage with BMI in girls only (12), and, to our knowledge, there are no studies that have compared BMI with BF% and waist circumference in both genders. This study aimed to examine the relative correlation of weight status perception with different measures of body adiposity in a large sample of boys and girls. Verifying weight status perception against a range of appropriate measurements of body adiposity may clarify what adolescents are referring to when they report their weight status. In addition, it may clarify the extent to which gender and weight status differences in weight perception are real and the extent to which they are an artefact of BMI, the most commonly used measurement. Finally, this study will seek to determine which anthropometric measurement is the most suitable to use in adolescent weight perception research.

This study aimed to determine which measurement of adiposity was the best correlate of weight perception in adolescents and whether this differed by gender. Perceived weight status was compared against measured weight status as determined by: body mass index, waist circumference and percentage body fat. It was expected that subjects’ perception of their weight status would be more accurate when verified by waist circumference compared with standardised BMI and body fat percentage, since waist circumference is a visible indicator of body size. As BMI tends to overestimate a boy’s weight status and underestimate a
girl’s weight status, it was hypothesised that there would be fewer gender differences in perception of weight status when weight was classified by alternate measurements to BMI. That is, approximately equal numbers of girls and boys would be found to underestimate and overestimate their weight status by percentage body fat and waist circumference.

**Subjects and Methods**

**Subjects**

The study population consisted of girls and boys aged between 12 and 16 who participated in the *It’s Your Move!* Study, a quasi-experimental, longitudinal intervention study conducted in 12 Victorian schools between 2005 and 2008. The baseline data from both the intervention and comparison groups (n = 2,278) were used in this cross-sectional analysis. Detailed information about the study methods has been reported previously (17). Ethics approval for the present study was provided by the Deakin University Human Research Ethics Committee.

**Anthropometric measurements**

Anthropometric data were collected by trained researchers using standardised methods. A portable stadiometer (Surgical and Medical PE87) was used to measure height and a TANITA Body Composition Analyser (Model BC418, Wedderburn Australia) measured weight and bioimpedence (body composition). Body mass index (BMI; weight in kg / (height in m)²) and standardised BMI (BMI-z) were calculated and the World Health Organization (WHO) cut-offs were used to classify adolescents’ weight status as underweight, healthy weight or overweight/obese (18). These cut-offs are based on BMI-z, which adjusts for variations in physical development by age and gender.
Measured bioimpedence was used to calculate percentage body fat, using gender specific equations that were validated in a multiethnic adolescent population (19). Body fat reference curves and cut-offs developed in British children were used to define underweight and overweight at the 2nd and 85th percentiles respectively (20).

Waist circumference was measured to the nearest 0.1cm at the level of the umbilicus at the end of a normal expiration. Australian percentiles were used to define weight categories by waist circumference (21). There are no internationally accepted cut off points for waist circumference, however, there is some consensus regarding the 90th percentile as a cut-off point for overweight (22). In accordance with this and previous weight perception research (8), and using the Australian percentiles, cut-off points were set at the > 90th, 90th to 10th and <10th percentiles to represent overweight, healthy weight and underweight respectively.

Self-report measures

Demographic information and weight perception were derived from the Adolescent Behaviour, Attitudes and Knowledge Questionnaire (ABAKQ). The ABAKQ was developed for the Pacific Obesity Prevention in Communities study and was pilot tested for acceptability, appropriateness and feasibility of completion prior to implementation (23). It consisted of 87 questions that focused on eating habits and physical activity and included a question which asked subjects how they would describe their weight according to five categories: very underweight, underweight, healthy weight, overweight or very overweight. These five categories were then reduced to three categories: underweight, healthy weight and overweight.
To determine the accuracy of their perception, both measured weight status and self-reported weight status were assigned a numerical value; underweight (-1), healthy weight (0) or overweight (1). The accuracy of weight perception was calculated by subtracting weight status from weight perception. Subsequently, each participant received a score that was either; above, below or equal to zero, representing overestimation, underestimation and accurate perception, respectively. This process was conducted independently for each of the three methods of deriving weight status from anthropometric measurements (BMI-z, waist circumference and body fat percentage).

Statistical analysis

An original dataset of 2,383 subjects was reduced to 2,278 following the exclusion of 105 cases due to missing data on BMI, waist circumference or body fat percentage. Descriptive statistics were used to describe the weight status classification of subjects by the three anthropometric measurements. Partial correlation coefficients, adjusted for age, assessed the relationship between the three measurements of body composition by gender. To determine whether the strength of these associations differed by gender, the difference between the correlation coefficients was calculated as a z-score. The marginal homogeneity test assessed whether differences existed in the distribution of weight classification (underweight, healthy weight, overweight) across the three anthropometric measurements. It was also used to assess whether the accuracy of weight perception (underestimate, accurate, overestimate) differed between the three measurements. Chi-square tests assessed the association of weight status and gender with accuracy of weight status perception within each anthropometric measurement. Adjusted standardised residuals were used to interpret the relative
influence of each cell on the overall relationship. Cramer’s V was used to assess the strength of the association of gender and weight status with perceived weight by each anthropometric measure. All analyses were conducted using IBM SPSS Version 21, and the level of significance was set at $p < .05$.

**Results**

**Participant characteristics and correlation of three anthropometric measurements**

Table 1 shows the physical characteristics of the adolescents in this study. In this sample boys and girls had a similar BMI, on average the waist circumference of girls was 1 cm smaller than boys, but they had a higher body fat percentage. Partial correlation ($pr$) analysis controlling for age and split by gender revealed significant positive correlations for waist circumference and BMI-z of $pr = .83$ for boys and $pr = .79$ for girls ($p < .001$ for both), for body fat percentage and waist circumference, $pr = .74$ boys and $pr = .81$ for girls and for body fat percentage and BMI-z, $pr = .74$ boys and $pr = .92$ for girls ($p < .001$ for all). Overall, these adjusted correlations indicate moderate to strong positive correlations among the three measures of body adiposity for both boys and girls. The correlation between waist circumference and BMI-z was significantly higher in boys $z = 2.75$, $p < .01$. In contrast, the correlation between body fat percentage and waist circumference was significantly higher in girls, $z = -4.16$, $p < .001$, as was the correlation between body fat percentage and BMI-z, $z = -15.06$, $p < .001$.

**Classification of weight status by perceived weight and three anthropometric measurements**
Table 2 displays how subjects’ weight was categorised by the three measurements. Tests of marginal homogeneity revealed that body fat percentage categorised subjects significantly differently to BMI-z and waist circumference, for boys \( p < .001 \), and for girls \( p < .001 \). In comparison to BMI-z and waist circumference, body fat percentage classified more subjects as overweight. The classification of subjects into weight categories differed significantly between BMI-z and waist circumference for girls, \( p < .001 \). Waist circumference classified more girls as overweight compared to BMI-z. The proportions of boys classified as underweight, healthy weight and overweight was not significantly different between waist circumference and BMI-z, \( p = .143 \).

**Prevalence of weight misperception**

Table 2 also demonstrates how adolescents perceived their weight. Compared to the anthropometric measures of weight, a relatively high proportion of adolescents perceived themselves to be underweight and a relatively low proportion perceived themselves to be overweight. Of the subjects who perceived they were underweight, 96%, 97% and 92% were classified as healthy weight or overweight by BMI-z, waist circumference and body fat percentage respectively. In contrast, of the subjects who were classified as overweight, the proportion of adolescents who also perceived overweight was 78% for BMI-z, 64% for waist circumference and 40% for body fat percentage.

**Comparison of weight misperception across three anthropometric measurements**

Table 3 displays the overall proportions of accuracy, underestimation and overestimation for each anthropometric measurement by gender. Among boys there was no significant difference in the distribution of accuracy of weight
perception between waist circumference and BMI-z, \( p = .17 \), however, the
distribution by body fat percentage was significantly different from both waist
circumference and BMI-z, \( p < .001 \). Fewer boys had an accurate perception of
their weight when weight status was classified by body fat percentage. Among
girls, accuracy of weight perception differed significantly between BMI-z and
waist circumference, \( p < .001 \), BMI-z and body fat percentage, \( p < .001 \), and
between body fat percentage and waist circumference, \( p < .001 \). The highest
proportion of accurate perception occurred when weight was classified by BMI-z.
In comparison to BMI-z, when weight was defined by waist circumference a
higher proportion of girls underestimated their weight. The proportion of girls
who underestimated their weight was greatest when weight was classified by
body fat percentage.

Overall, the percentage of subjects who had an accurate perception of their
weight status was 66% for BMI-z, 61% for waist circumference and 49% for
body fat percentage. Overestimation of weight status (i.e., perceiving overweight
when objectively classified as healthy weight) accounted for less than 10% of
weight perception by any measurement.

**Differences in weight perception by gender**

There was a significant association between gender and accuracy of
weight perception when weight categories were defined by BMI-z, \( \chi^2(2, N=2278) = 37.96, p < .001 \), with girls more likely to overestimate (adjusted standardised
residual \( Z = 3.90, p < .01 \)) and boys more likely to underestimate \( (Z = 2.20, p < .05) \). Cramer’s V revealed a weak association (\( V = .13 \)) between gender and
weight perception as defined by BMI-z. When accuracy of weight perception was
defined by waist circumference, there was a significant association between type
of weight perception and gender, $\chi^2(2, N=2278) = 10.67, p < .01$, with girls more likely to overestimate, ($Z = 2.20, p < .05$). There was no difference in terms of underestimation and overall there was a weak association ($V = .07$) between gender and weight perception as defined by waist circumference. There was also a significant association between gender and accuracy of weight perception as defined by body fat percentage, $\chi^2(2, N=2278) = 21.82, p < .001$, with boys more likely to underestimate ($Z = 2.0, p < .05$) and girls more likely to be accurate ($Z = 2.10, p < .05$). The association between gender and BIA defined weight perception was weak ($V = .10$).

### Comparison of weight misperception by weight status category

Table 4 displays a comparison of the adolescents’ perception of their weight within each weight category across the three objective measurements of weight. Across all three measurements and for both genders, approximately 68% of adolescents who were classified as healthy weight also perceived that they were a healthy weight. However, within the overweight categories, accuracy varied across the measurements. Only one-third of boys who were defined as overweight by BF% had a perception of overweight, compared to over half in BMI-z and waist circumference. Approximately 60% of girls who were defined as overweight by BMI-z were accurate compared to less than half of those who were defined as overweight by waist circumference and body fat percentage. Chi square tests revealed that accuracy of weight status perception differed across weight status categories. When weight was defined by BMI-z, $\chi^2(2, N=2278) = 23.55, p < .001$, overweight adolescents were more inaccurate ($Z = 3.1$) than healthy weight or underweight adolescents. The relationship between weight status and misperception was weak ($v=.10$) for BMI-z. Overweight adolescents

<table>
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<th>Weight Status Category</th>
<th>Healthy Weight</th>
<th>Overweight (BMI-z)</th>
<th>Overweight (Waist)</th>
<th>Overweight (BF%)</th>
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<td>Perception</td>
<td>68%</td>
<td>33%</td>
<td>60%</td>
<td>33%</td>
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were also more likely to misperceive when weight status was defined by waist circumference, \( \chi^2(2, N=2278) = 63.0, p < .001, Z = 4.8, p < .01 \) and by body fat percentage, \( \chi^2(2, N=2278) = 191.13, p < .001, Z = 5.8, p < .01 \). Cramer’s V revealed a weak association for waist circumference (v=.17) and a moderate association for body fat percentage (v=.29).

**Discussion**

The current study examined the correlation of weight status perception with three measurements of weight status in a large sample of adolescents. Of the three anthropometric measurements used, BMI-z was the best correlate of perceived weight for both boys and girls. Waist circumference was an equally good correlate of weight perception for boys; however, for girls it was associated with reduced accuracy. Consequently, the hypothesis that waist circumference would be the best predictor of weight perception was only partially supported. The hypothesis that there would be fewer gender differences when weight was defined by waist circumference and BF\% was only partially supported. Girls were more likely to overestimate when weight was defined by BMI-z and waist circumference but not by body fat percentage. Boys were more likely to underestimate when weight was classified by BMI-z and body fat percentage, but not by waist circumference. Underestimation was highly prevalent in this sample, and overweight adolescents were most likely to misperceive their weight status regardless of the measurement used.

BMI-z was the best correlate of weight perception for girls and was an equally good correlate for boys. BMI-z is significantly related to overall fatness in adolescents (5), so this indicates adolescents assess their overall body size when
making judgements about their weight. The correlation of BMI-z with perceived weight also indicates that the majority of adolescents in this sample had a body fat distribution that was well described by BMI-z, that is, not particularly muscular and with a normal body fat distribution. However, BMI-z may underreport overweight status, particularly amongst girls. Compared to waist circumference and body fat percentage, a smaller proportion of adolescent girls were classified as overweight when their weight status was defined by BMI-z. Also, for girls, the smallest prevalence of underestimation occurred when weight was defined by BMI-z. This suggests that BMI-z aligned with girls perceptions of their weight because both methods underestimated their weight status. BMI-z may not detect the prevalence of underestimation in a sample, particularly amongst girls.

Waist circumference was a good correlate of weight perception amongst boys but not amongst girls, suggesting that boys may consider their central adiposity as well as their overall body fat. It is possible that males have greater awareness of their central adiposity because they tend to gain weight around the abdominal area, and girls may be more aware of weight that is distributed in other areas including their hips and thighs (24). There were no significant differences in weight classification between waist circumference and BMI-z for boys, suggesting that abdominal fat was a good indicator of their overall adiposity. However, there were differences in weight classification between waist circumference and BMI-z for girls. Waist circumference classified girls into a heavier weight category compared to BMI-z; this is consistent with the findings of Van Vliet et al (8). This suggests that girls in both studies carried excess weight centrally rather than peripherally. However in the study by Van Vliet et al (8), girls were more accurate by waist circumference, and tended to overestimate
their weight by BMI-z, suggesting they were aware of their central adiposity. In the current study girls were more accurate by BMI-z and tended to underestimate their weight by waist circumference, suggesting they were not aware of their central adiposity. Overall waist circumference may provide a good indication of adolescent’s perception of their central adiposity, which is a leading indicator of morbidity.

Of all the anthropometric measures, body fat percentage classified the highest proportion of adolescents as overweight. According to BMI-z or waist circumference, a majority of participants were classified as healthy weight. However, according to body fat percentage the majority were overweight. This suggests that most adolescents in this study had a body size that was in the healthy range but also had a proportionally large amount of fat mass in relation to fat free mass. Percentage body fat may be difficult for individuals to detect because unlike weight in relation to height or waist circumference it cannot be visually assessed. This may explain why greater proportions of adolescents underestimated their weight status when it was classified by body fat percentage compared to BMI-z and waist circumference. The tendency of individuals to underestimate fat mass may not be limited to adolescents, as research in young adults suggests that perception of body fatness is more closely aligned with BMI rather than body fat percentage (25). The current study indicates that body fat percentage may not be suitable for weight perception research because it corresponds relatively poorly with both perceived weight and with other anthropometric measurements of body adiposity, particularly amongst boys. Use of body fat percentage in weight perception research is likely to result in very high prevalence of underestimation.
When weight status was defined by BMI-z, girls were more likely than boys to overestimate and boys were more likely to underestimate. This is consistent with previous studies that used BMI-z or BMI to classify weight status (13). However, in this study the relationship between gender and type of weight perception (overestimating or underestimating) was weak and differed by the measurement method used. When weight was defined by waist circumference, girls were equally as likely as boys to underestimate their weight. BMI-z and BMI tends to classify muscular boys into a heavier weight category (12), thus increasing the chance that healthy weight boys will be classified as overweight. Thus it is possible that some of the boys who were classified as underestimating by BMI-z were incorrectly classified as overweight. However, as discussed earlier, girls in this sample had a tendency to underestimate their central adiposity, so the equivalence with girls here may just suggest they were equally poor as girls at detecting central adiposity. In addition, boys were also more likely to underestimate compared to girls in terms of body fat percentage. Overall this indicates that boys do have a tendency to view themselves as lighter than they actually are.

Girls were more likely than boys to overestimate their weight status when weight was classified by BMI-z and waist circumference, and were more accurate by body fat percentage. It is possible that girls who overestimated by BMI-z and waist circumference were aware of excess fat mass that was not detected by these measurements and consequently were accurate by body fat percentage. Alternatively, increased accuracy by body fat percentage may indicate that many girls assume they are overweight even if they do not have visible evidence. Viner et al observed that because girls have a tendency to overestimate, they are more
accurate when they are classified at heavier weight status (16). Overall, it appears that some gender differences do exist in relation to weight perception. Some gender differences observed in weight perception studies may be due to the way that BMI and BMI-z classify weight status; however across all measurements there appears to be a trend for boys to underestimate their weight and a trend for girls to overestimate their weight.

There was a high level of underestimation of weight status in this sample. Between 30 and 60% of adolescents were classified as overweight depending on the measurement used, however, only one quarter of adolescents perceived themselves to be overweight. Most adolescents who perceived themselves as underweight were not underweight by any anthropometric measurements. This suggests that many adolescents do not have a good understanding of what underweight is, and may confuse healthy weight with underweight. In addition, regardless of the measurement used, overweight individuals were most likely to misperceive their weight. This suggests that a substantial proportion of adolescents do not recognise they are overweight, which could have implications for their lifestyle choices and future weight gain.

There was very little variation in accuracy of weight perception in the healthy weight category across measurements however there was marked variation within the overweight category. Further, the correlation of an anthropometric measurement with perceived weight was related to the proportion of adolescents that it classified as overweight. The more adolescents a measurement classified as overweight, the poorer correlate it was for overweight perception and for weight perception overall. Thus, body fat percentage classified the most adolescents as overweight and was the poorest correlate of weight
perception within the overweight category and overall. BMI-z classified the least participants as overweight and was the best correlate of weight perception within the overweight category and overall. It has been suggested that BMI has systematically underestimated the prevalence of obesity in Australian adolescents over the past 10 to 20 years by obscuring a reduction in muscle mass with an accumulation of fat mass (26). Similarly the prevalence of underestimation of weight status in adolescents may have been obscured by the use of BMI-z in weight perception research. The current study suggests that underestimation of weight is a significant problem among overweight adolescents and that the prevalence reported in the past may have been understated.

The main limitations of this study relate to the lack of internationally established reference values for waist circumference and body fat percentage. The reference values that were used for waist circumference in this study came from an Australian cohort; however, the reference values for body fat percentage were derived from a Caucasian British sample. The particularly low level of agreement between perception of weight and body fat percentage may indicate that the reference values did not appropriately define weight status in this sample. There is still contention concerning which are the most appropriate cut-offs to use to determine weight categories for waist circumference and body fat percentage. Until these are established we cannot be certain about the level of misperception that occurs by these two measurements. A further limiting factor to the lack of established cut-offs and percentiles, is the range of sites on the torso where waist circumference is measured. The size of an individual’s waist circumference will vary depending on whether the waist is measured at the narrowest point of the
waist or the point of the umbilicus. Another limitation is that the findings are representative of a predominately Caucasian, Australian adolescent population.

This study suggests that there is cause for concern at both ends of the weight spectrum. Regardless of the type of measurement used, there were a small percentage of adolescents, particularly girls, who overestimated their weight and may be at risk of engaging in unnecessary weight loss behaviours. However, there were also a large proportion of overweight adolescents who underestimated their weight. Despite only 1% or less of participants being classified as underweight by any measurement, a relatively high number of participants perceived themselves as underweight. Misperception of weight was particularly prevalent amongst overweight adolescents suggesting many adolescents may not be aware of the health risks associated with their excess weight. In addition, the tendency of young adults to underestimate their weight appears to be increasing over the past two decades (27). The tendency of BMI-z to underreport underestimation, particularly amongst girls, suggests potential benefits to using measures of central adiposity to determine weight misperception. However, without international reference values for waist circumference, BMI-z is still the most reliable method to use in weight perception research.

The current study examined how perceived weight correlated with weight status by three different anthropometric measurements in adolescents. Classification of weight status differed across the three anthropometric measurements. The results indicated that girls were aware of their overall size but underestimated their central adiposity. For boys, measures of central adiposity correlated well with overall size and they were equally accurate by both measures. There was a large degree of underestimation of weight status within the current
sample. Overweight adolescents and boys in particular were most likely to underestimate. The more adolescents a measurement classified as overweight, the less likely it was that the measurement would correlate well with adolescent weight perception. Thus, the alignment of BMI-z with weight perception in this sample may have been due to the tendency of overweight adolescents to underestimate their weight status.

Acknowledgements

The authors would like to thank the co investigators, staff, schools, students, parents and communities involved in the *Its Your Move!* project. The authors acknowledge the funding support of the National Health and Medical Research Council (Australia).

Abbreviations used

BMI-z – Standardised Body Mass Index
BIA - Bioelectrical Impedance Analysis
WHO - World Health Organization
ABAKQ - Adolescent Behaviour, Attitudes and Knowledge Questionnaire
References


Table 1. Participant characteristics (mean ± SD)

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<th>Boys (n=1302)</th>
<th>Girls (n=976)</th>
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<td>14.2 ± 1.0</td>
<td>14.1 ± 1.1</td>
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<td>Weight (kg)</td>
<td>58.0 ± 13.3</td>
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<td>Height (cm)</td>
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<td>160.6 ± 7.2</td>
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<td>Waist circumference</td>
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<td>77.6 ± 10.9</td>
<td>76.6 ± 9.7</td>
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<tr>
<td>Body fat percentage</td>
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<td>26.6 ± 9.3</td>
<td>31.9 ± 7.9</td>
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<td>Waist circumference</td>
<td>Body fat percentage</td>
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<td>302 (30.9)</td>
<td>439 (45)</td>
<td>589 (60.3)</td>
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Table 3. Distribution of weight status perception by standardised body mass index (BMI-z), waist circumference and body fat percentage for boys and girls

<table>
<thead>
<tr>
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<td>759 (33.3)</td>
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<td>335 (34.3)</td>
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Table 4. Comparison of weight perception by weight status category across three different measures of objective status weight for boys and girls

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<td>BMI-z</td>
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<td>Healthy weight</td>
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<td>Overweight</td>
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# AUTHORSHIP STATEMENT

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<td>Submitted for publication to Journal of Health Psychology</td>
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<th>Email or phone</th>
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<td>Julia Fredrickson</td>
<td>Psychology</td>
<td>0415 878 514</td>
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## 2. Inclusion of publication in a thesis

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## 3. HDR thesis author’s declaration

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If there are multiple authors, give a full description of HDR thesis author’s contribution to the publication (for example, how much did you contribute to the conception of the project, the design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)

Conducted the literature search, contributed to the conception of the study and the design and planning of the analysis, conducted all of the statistical analysis, contributed to data interpretation and drafted the full manuscript and incorporated the revisions of the other authors.

*I declare that the above is an accurate description of my contribution to this paper, and the contributions of other authors are as described below.*

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<tr>
<td>Marita McCabe</td>
<td>Contributed to the conception and design of the study, contributed to the analysis plan and provided feedback on analysis. Also contributed to redrafting and critical revision of the manuscript.</td>
</tr>
<tr>
<td>Peter Kremer</td>
<td>Contributed to the conception of the study and planning of analysis, provided critical feedback and guidance on analysis. Also contributed to redrafting and critical revision of the manuscript.</td>
</tr>
<tr>
<td>Boyd Swinburn</td>
<td>Contributed to the interpretation of analysis and critical revision of the manuscript.</td>
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Andrea de Silva
Contributed to interpretation of analysis and critical revision of the manuscript.

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I agree to be named as one of the authors of this work, and confirm:

xi. that I have met the authorship criteria set out in the Deakin University Research Conduct Policy,

xii. that there are no other authors according to these criteria,

xiii. that the description in Section 4 of my contribution(s) to this publication is accurate,

xiv. that the data on which these findings are based are stored as set out in Section 7 below.

If this work is to form part of an HDR thesis as described in Sections 2 and 3, I further

xv. consent to the incorporation of the publication into the candidate’s HDR thesis submitted to
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Name of author | Signature* | Date
---|---|---
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Peter Kremer | | 27/2/2014
Boyd Swinburn | | 13/3/2014
Andrea de Silva | | 5/3/2014

6. Other contributor declarations
I agree to be named as a non-author contributor to this work.

Name and affiliation of contributor | Contribution | Signature* and date
---|---|---

* If an author or contributor is unavailable or otherwise unable to sign the statement of authorship, the Head of Academic Unit may sign on their behalf, noting the reason for their unavailability, provided there is no evidence to suggest that the person would object to being named as author

7. Data storage
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Data format | Storage Location | Date lodged | Name of custodian if other than the executive author
---|---|---|---
Original electronic data is stored in de-identified SPSS and Stata data files
On password protected computers at WHO-CC Deakin Waterfront Campus
2008
Prof Boyd Swinburn

Original hard copy information
Locked filing cabinets at WHO-CC Deakin Waterfront Campus
2008
Prof Boyd Swinburn

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Chapter 8

Paper 3: Submitted for Publication to the Journal of Health Psychology

Weight perception in overweight adolescents: The association with body change intentions, diet, and physical activity

Julia Fredrickson¹, Peter Kremer², Boyd Swinburn³,⁴, Andrea de Silva⁵,⁶, Marita McCabe¹

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Abstract

Perception of overweight may be a better predictor of weight loss intentions than weight status itself. This study examined the association of weight perception and weight satisfaction with body change intentions and weight related behaviours in 928 overweight adolescents (aged 11 -18, 44% female). Accurate perception of weight and dissatisfaction with weight were associated with trying to lose weight; but were negatively associated with some healthy weight related behaviours. Awareness of overweight and body dissatisfaction may be detrimental to the adoption of healthy weight control behaviours.

Keywords: Weight, perception, intention, diet, activity, adolescent
It is estimated that between 21% and 25% of Australians aged 2 to 18 years are overweight (Olds et al., 2010). Obesity tends to track into adulthood, therefore, overweight adolescents are at increased risk of developing type 2 diabetes, heart disease and certain cancers in adulthood (Deshmukh-Taskar et al., 2005). It is of concern then, that many adolescents do not recognise that they are overweight (Edwards et al., 2010; Martin et al., 2010; Wang et al., 2009), as this lack of awareness may have implications for weight related behaviours such as diet and physical activity. Adolescents who do not recognise that they are overweight may not be motivated to make changes to their lifestyle to prevent further weight gain.

Overweight adolescents who are aware of their weight status (Edwards et al., 2010; Khambalia et al., 2012; Lenhart et al., 2011) or dissatisfied with their body (Wang et al., 2009) are more likely to report that they are trying to lose weight. This suggests that perception of overweight and body dissatisfaction engender a desire to alter weight or shape. Adolescents’ intentions to change their weight and shape are also likely to be influenced by gender-specific body ideals. For girls, the ideal body tends to be thin (Keel et al., 2007); thus for girls who are aware of their overweight status, their ideal body is much slimmer than their actual body. Accordingly, overweight girls are most likely to be dissatisfied with their body (Wang et al., 2009). In addition, girls who are dissatisfied with their body are typically trying to lose weight (Neumark-Sztainer et al., 2006).

However, amongst overweight boys there may not be a discrepancy between their ideal body and their actual body. The male ideal tends to be lean and muscular (Gray & Ginsberg, 2007) yet there is also evidence to suggest that adolescent boys feel inadequate if they are not physically large (Lubans & Cliff, 2011). Thus perception of overweight may equate to an unfavourable perception of having
excess fat tissue, or it may be consistent with a favourable perception of being ‘large’ and muscular. Previous research suggests that boys who are dissatisfied with their body will be trying to gain muscle, regardless of their weight status (McVey et al., 2005). However, it is unclear how perception of overweight is related to intention to gain muscle. It is possible that overweight boys who underestimate their weight status may be of the view that they are not large enough and consequently, will be trying to gain muscle mass.

An understanding of the relationship between perception of weight status and intentions to gain muscle or lose weight may help to understand the dietary behaviour and physical activity that overweight adolescents engage in. Currently, it is unclear whether accurate perception of overweight has an impact on actual weight related behaviours, such as physical activity and diet. Adolescents of both genders who are aware of their overweight status may be more likely to engage in physical activity to lose weight (Edwards et al., 2010; Kambalia et al., 2012; Lenhart et al., 2011). However, perception of overweight has also been found to negatively predict engagement in exercise in both healthy weight and overweight adolescents (Gillison et al., 2006). The evidence for the impact of accurate weight perception on dietary behaviour in overweight adolescents is also mixed. Accurately perceiving overweight is associated with dieting behaviour and lowered calorie intake (Edwards et al., 2010), but also with poorer dietary choices (Kambalia et al., 2012). Weight related behaviours may differ by gender, studies have found that among overweight adolescents who accurately perceive their weight status; girls are more likely than boys to diet in order to lose weight (Kurdak et al., 2010; Lenhart et al., 2011).
The equivocal evidence for the impact of weight perception on behaviour may be related to other factors, including body satisfaction and gender. As noted above, dissatisfaction with weight is associated with trying to lose weight and has the potential to influence behaviour. Some researchers have suggested that dissatisfaction with weight among overweight adolescents may actually motivate individuals to make healthy lifestyle changes (Heinberg et al., 2001). Furthermore, as boys and girls are influenced by different body ideals, the strategies that they employ may differ by gender. Girls who accurately perceive their bodies may simply diet to lose weight, whereas boys may engage in exercise to achieve a lean muscular ideal. This suggests that the impact that perception of overweight has on an individual’s intentions and behaviour may depend on the individual’s gender and whether they are dissatisfied with their body. Very few studies have taken into account body dissatisfaction and gender when examining the impact of weight perception on weight related intentions and behaviour.

The aim of the current study was to examine the relationship of accurate weight perception, gender and weight satisfaction with body change intentions and weight related behaviours among overweight and obese adolescents. It was hypothesized that intention to lose weight would be more common amongst girls and would be associated with accurate perception of overweight and dissatisfaction with weight. It was hypothesized that overweight boys who underestimated their weight status would be trying to gain muscle. Further, it was hypothesized that behaviours aimed at reducing weight, such as reduced intake of unhealthy food and increased intake of fruit and vegetables and increased physical activity, would be more prevalent amongst overweight adolescents who accurately perceived their weight status and were dissatisfied with their weight.
Method

Participants

Participants were drawn from a quasi-experimental, longitudinal intervention study called *It’s Your Move!*, which was part of the larger Pacific Obesity Prevention in Communities (OPIC) study. The original sample consisted of 3,040 adolescents aged between 11 and 18 years. For the current study, a subsample of overweight and obese ($N = 928$) adolescents were included. The analysed sample was ethnically homogenous; 93.4% of participants were European Australian, 1.9% were Indigenous Australian, and the remaining group identified with a range of other ethnicities.

Measures

Weight and height were measured by trained researchers using standardized methods (Swinburn et al., 2011). Body mass index (BMI; weight (kg) / height in (m)$^2$) was used to define weight status. BMI was converted to standardized BMI (BMI-z) and adolescents’ weight status was categorized as underweight, healthy weight or overweight/obese using World Health Organization cut-offs (de Onis et al., 2007).

Weight perception, weight satisfaction and demographic information were derived from the Adolescent Behaviour, Attitudes and Knowledge Questionnaire (ABAKQ) (Mathews et al., 2009). The ABAKQ consisted of 87 questions and was developed for the OPIC study and was pilot tested for acceptability, appropriateness, and feasibility of completion prior to implementation. The question about weight satisfaction was phrased, “How happy or unhappy are you with your body weight?”, responses were measured on a scale from 1 (*very unhappy*) to 5 (*very happy*). Intention to change weight and change muscle was
assessed by the question “Which of these statements most closely applies to you?” for intention to change weight the responses ranged from “trying to gain weight”, “trying to stay at my current weight”, “not doing anything about my weight” and “trying to lose weight”. For intention to change muscle the response options were; “trying to gain muscle”, “trying to stay at the same muscle size”, “not doing anything about my muscles”. Both of these variables were dummy coded so that responses were either equal to 1 (intention to lose weight/gain muscle) or 0 (no intention to lose weight or gain muscle; which was all other responses for that question combined).

Activity after school was assessed via the question, “In the last 5 school days, on how many days after school did you do sports, dance, cultural performances or play games in which you were active?” responses options ranged from 0 to 5 days. Current activity guidelines recommend that adolescents should engage in at least 60 minutes of moderate to vigorous physical activity each day (Australian Department of Health, 2004). Thus this variable was dichotomized into 0 (3 days or less) and 1 (4 days or more), to capture those adolescents who were most likely to be meeting the requirements. For takeaway food, the question was “In the last 5 school days, on how many days did you buy snack food from a shop or takeaway after school?” available responses ranged from 0 to 5 days. This variable was dichotomized into 0 (bought takeaway food after school on one or more days), versus, 1 (not bought takeaway food after school) to reflect dietary guidelines that recommend limiting foods that are high in saturated fat or have added salt or sugar (NHMRC, 2013) . To assess intake of fruit, participants were asked, “How many serves of fruit do you usually eat each day?”. The question assessing vegetable intake was phrased the same way. The responses were 1 serve
or less, 2 to 3 serves and 4 serves or more. These variables were dichotomized to reflect recommended daily intake of fruits and vegetables for adolescents, which is two serves and five serves respectively (NHMRC, 2013). Thus, responses were split into 1 serve or less (0) versus 2 serves or more (1) for fruit, and 3 serves or less (0) versus 4 serves or more (1) for vegetables. All variable were coded so that unhealthy behaviors were coded as 0 and the more healthy behavior were coded as 1.

To determine accuracy of weight perception, participants were also asked how they would describe their weight using a 5 point scale where 1 = very underweight, 2 = slightly underweight, 3 = about the right weight, 4 = slightly overweight, and 5 = very overweight. Participants who reported they were slightly overweight or very overweight were classified as accurate, all other participants were classified as underestimating.

**Procedure**

The *It’s Your Move!* study was designed to prevent unhealthy weight gain in adolescents in 12 schools in the Barwon-South Western Region of Victoria, Australia. The methods used have been reported previously (Millar et al., 2011; Swinburn et al., 2011). Briefly, five secondary schools participated in the intervention and the comparison sample was drawn from seven schools. The study was conducted between 2005 and 2008, students completed the ABAKQ and had their anthropometry measured at baseline and at follow up. Baseline data from both the intervention and comparison groups were used in the cross-sectional analysis. Ethics approval for the present study was provided by the University Human Research Ethics Committee.

**Analysis**
Of the original subsample of 928 overweight adolescents, 11 were excluded from the analysis because of missing data on weight satisfaction. A Chi square test was used to test for differences between boys and girls for accuracy of perception and a t-test was used to examine gender differences for weight satisfaction. Two separate bivariate logistic regression models, adjusted for age, were conducted to determine the relationship between weight misperception and body change intentions and behaviour. Model 1 examined the association of weight perception, BMI-z, weight satisfaction and gender with intention to lose weight, intention to gain muscle, physical activity after school, takeaway eaten in the past week and fruit and vegetable intake. Model 2 included the additional effect for the interaction of weight perception with gender. The outcomes of logistic regression models were reported as odds ratios and 95% confidence intervals. All analyses were performed using SPSS (V21) and statistical significance was accepted as $p < .05$.

**Results**

**Characteristics of the study sample**

Characteristics of the adolescents in this study are presented in Table 1. Just over half of all overweight adolescents correctly identified their weight status. A non-significant trend suggested boys were more likely to underestimate their weight status than girls, $\chi^2 (1, N = 917) = 3.28, p = .07$. Boys were more satisfied with their weight than girls; $t (915) = 8.84, p < .01$.

**Insert table 1 about here**

**Correlates of body change intentions**
The results of the logistic regression models for body change intentions are presented in Table 2. The factors that were associated with trying to lose weight were consistent across both model 1 and model 2. Adolescents who were aware of their overweight status were more than twice as likely to be trying to lose weight compared to those who underestimated. In addition, adolescents with higher BMI-z scores were significantly more likely to be trying to lose weight. As BMI-z increased, the odds that the adolescents would be trying to lose weight became higher. Lower weight satisfaction was also associated with increased likelihood of trying to lose weight and boys were half as likely to report that they were trying to lose weight compared with girls. The interaction of weight perception with gender was not significant, indicating that adolescents of both genders were likely to be trying to lose weight if they perceived themselves to be overweight.

In both model 1 and 2, participants who were satisfied with their weight were less likely to be trying to gain muscle, with each unit increase in satisfaction; the odds that adolescents would be trying to gain muscle were lowered. There was no association with BMI-z and trying to gain muscle. In model 1, boys were eight times more likely to report that they were trying to gain muscle. Trying to gain muscle was significantly associated with inaccurate weight perception in model 1; adolescents who misperceived their weight were more likely to report trying to gain muscle. However, in model 2, when the interaction of gender and weight perception was added to the model, the association between underestimation and trying to gain muscle was no longer statistically significant. This indicates that the association of trying to gain muscle with underestimation was relatively weak. In addition the interaction of weight perception with gender was not significant,
indicating that there was a weak association between trying to gain muscle and perception of overweight in both genders.

*Insert table 2 about here*

*Correlates of weight related behaviour*

The results of the logistic regression models for weight related behaviours are presented in Table 3. In model 1 only, boys were significantly more likely to be active after school compared to girls. In both model 1 and 2, underestimation of weight was also associated with higher levels of physical activity; adolescents who underestimated their weight were more than 1.5 times more likely to be active after school at least four days of the week. There was no association between BMI-z and level of activity in either model.

In both model 1 and 2, adolescents who were satisfied with their weight were less likely to have eaten takeaway in the past week. Weight perception, BMI-z and gender were not associated with having eaten takeaway in the past week. In both models, adolescents who were satisfied with their weight were more likely to report eating the recommended number of daily serves of fruit per day. In model one only; girls were 1.4 times more likely to meet the recommended daily intake of fruit per day compared to boys. In model 2 there was no association with gender, weight perception or BMI-z. Eating the recommended daily serves of vegetables was not associated with weight perception or any other factors in the models.

*Insert table 3 about here*

*Discussion*
This study examined the association of weight perception, gender and weight satisfaction with body change intentions and weight related behaviour. The main findings supported the prediction that accurate perception of being overweight and dissatisfaction with weight were associated with trying to lose weight. The findings, however, did not support the prediction that accurate perception of overweight would be associated with healthy dietary intake and physical activity. In addition, satisfaction with weight was associated with healthy dietary intake.

Intention to lose weight was associated with accurate perception of overweight and dissatisfaction with weight. This suggests that both awareness of overweight and dissatisfaction with weight status prompted a desire to lose weight. Adolescents with a higher BMI-z were the most likely to report trying to lose weight, perhaps because their excess weight was more obvious. In addition, girls were more likely than boys to be trying to lose weight, and were more dissatisfied with their weight. This suggests that girls were influenced by the thin ideal and the discrepancy between an idealised thin body and their actual body may have provoked dissatisfaction and a desire to lose weight. In addition, the prevalence of trying to lose weight was ten percent higher than the prevalence of accurate perception amongst girls. This suggests that some girls who underestimated their weight also wanted to lose weight. This is consistent with research that indicates girls want to lose weight despite having a perception of healthy weight (Duncan et al., 2011) and reflects a desire to obtain an ideal that is underweight rather than healthy.

Boys were more likely than girls to report they were trying to gain muscle. However, the relationship between misperception and intention to gain muscle was weak. Previous research suggests that boys with smaller bodies have less
favourable self perceptions (Lubans & Cliff, 2011), so having a perception of a smaller body might be related to dissatisfaction and a desire to increase their size through gaining muscle. However in this sample, all boys were overweight and probably were larger than their peers. Therefore, those who underestimated their weight probably viewed their bodies to be an average size, rather than smaller than average. In addition, adolescents who were dissatisfied with their weight reported trying to lose weight and gain muscle; this is consistent with trying to achieve a body ideal that is lean and muscular rather than ‘large’.

In the current study accurate perception of weight was not associated with increased consumption of fruit and vegetables or takeaway food. This suggests that awareness of overweight did not inspire healthy dietary choices nor did it inspire poor dietary choices. However, weight dissatisfaction did have an impact on dietary choices. Adolescents who were dissatisfied with their weight were more likely to report eating takeaway in the past week and not meeting the recommended daily intake of fruit. Dissatisfaction with weight may encourage overweight adolescents to restrict their intake of healthy foods and increase their intake of unhealthy foods. This pattern of eating is consistent with disordered eating patterns seen in bulimia or binge eating disorder, where body dissatisfaction leads an individual to restrict their intake of food throughout the day. In turn, the hunger caused by restriction leads them to eat energy dense foods later in the day (Murphy, Straebler, Cooper, & Fairburn, 2010). In the current study, adolescents who were dissatisfied with their weight may have bought takeaway for themselves at the end of the day in response to food restriction throughout the rest of the day. Body dissatisfaction has previously been associated with reduced consumption of fruit and vegetables (Neumark-Sztainer
et al., 2006) and perception of overweight has been associated with unhealthy weight control behaviour such as skipping meals (Felts et al., 1996), eating fewer vegetables (Nystrom, Schmitz, Perry, Lytle, & Neumark-Sztainer, 2005) or restricting food and fasting (Al Sabbah et al., 2010). Whilst in the current study, weight perception had no direct impact on dietary intake; adolescents who were dissatisfied with their weight were more likely to make poor dietary choices.

Adolescents who underestimated their weight were more active more than adolescents who were aware of their overweight status. This indicates that accurate perception of overweight may not be a motivating factor to maintain engagement in exercise. In a study by Gillison and colleagues (2006), perception of overweight was associated with perceived pressure to lose weight, exercise being an extrinsic goal, and reduced engagement in exercise. In the current study, participants who recognised that they were overweight may have answered in the affirmative when asked if they wanted to lose weight because they knew that was expected of them; but not because weight loss was an intrinsic goal for them. Therefore, their perception may have influenced their intentions but not their behaviour. Underestimating overweight seemed to be a protective factor in terms of encouraging engagement in exercise in this sample. The participants who underestimated their weight may have felt less external pressure to lose weight and so they engaged in physical activity for reasons other than weight loss.

Another possible explanation for the higher levels of physical activity among underestimating adolescents could be linked to the definition of overweight. Some participants may have had a high level of lean mass relative to their height which could cause them to be misclassified as overweight. These individuals would be more likely to both report their weight as healthy and have a
high level of participation in physical activity. However, the pattern of association with BMI-z does not support this explanation. BMI-z was associated with intention to lose weight, but it was not associated with physical activity. If the relationship of underestimation to activity was due to body composition it would be expected that BMI-z would be negatively correlated with activity – that is, the lower the BMI-z, the more likely they would be to engage in physical activity. However, as this relationship was not present, it suggests that underestimation itself is a factor in higher activity independent of body composition.

Overall, the findings demonstrate that participants’ intentions did not align with their behaviour. Factors that were positively associated with intention to lose weight often did not correlate, or correlated negatively with positive health behaviours. This suggests there is disconnect between what adolescents report they are trying to do compared to their actual behaviours. Accurate perception of overweight and dissatisfaction with weight were actually related to unhealthy weight behaviours. When examining the overall potential benefits of accurate perception versus the potential harms, it is worth considering that adolescents who accurately perceive overweight are more likely to report bullying and suicide attempts (Lenhart et al., 2011) compared to those who underestimate. In addition, perception of overweight predicts the development of depressive symptoms in adolescents (Rawana, 2013). It is possible that the harms of having a perception of overweight may outweigh any potential benefits.

Strengths of the current study include the use of a large sample of overweight adolescents, consideration of the factors that influence intention to gain muscle and examination of weight dissatisfaction in addition to weight perception. There were several limitations to this study, one being that dietary and
exercise behaviours were self reported. Lowry et al. (2002) suggested that self report of fruit and vegetable intake is acceptable as long as it is systematically underestimated. However in this sample, there may be a difference in the reporting between adolescents who were accurate and those who underestimated their weight. It is possible that the individuals who favourably self reported their weight status may also over-report their engagement in healthy dietary and exercise behaviours. This may account for the correlation between underestimation of weight and higher engagement in exercise. Additionally, the measurement used to assess physical activity was a single item measure, which lacked sensitivity. Another limitation of examining the behaviour of adolescents in terms of their intentions is that their behaviours are often influenced by external factors. Adolescent behaviours are subject to some degree to school and parental control, for example, whether they are given opportunities to be active after school or the availability of fruit and vegetables at home. These environmental factors are likely to have a large impact on their engagement in these behaviours, regardless of intentions. This may explain why some of the factors that correlate with intentions did not correlate with behaviour. The impact of weight perception on behaviour may change over time; however as this was a cross sectional study it was not possible to examine this possibility. It is possible that some relationships were missed because they take some time to develop. Future studies should use a longitudinal design to enable inferences to be made on the direction of the relationship between weight perception, intentions and behaviour.

Perception of overweight itself may not be sufficient to affect healthy lifestyle changes in overweight adolescents. Despite its impact on intentions, accurate perception of weight does not seem to have the desired effect on
behaviour. This suggests that making adolescents aware of their overweight status is not sufficient to engender behaviour change. In addition, there is potential for harm if adolescents feel dissatisfied with their bodies in terms of adopting maladaptive dieting practices. Overall, it appears that making overweight adolescents aware of their weight status is not a good strategy to promote the adoption of healthy behaviours. Health practitioners should emphasise health and body satisfaction when promoting lifestyle change rather than emphasising weight or appearance. Public health initiatives that can alter an adolescent’s environment to promote healthy eating and exercise may be more useful in encouraging appropriate behaviour change as opposed to those that promote awareness of overweight.
References


Table 1. Participant characteristics: full overweight subsample and gender subgroups

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N= 917</td>
<td>n= 514</td>
<td>n= 403</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>14.47 (1.36)</td>
<td>14.30 (1.29)</td>
<td>14.69 (1.42)</td>
</tr>
<tr>
<td>BMI (kg/m²), mean (SD)</td>
<td>25.96 (3.57)</td>
<td>25.54 (3.65)</td>
<td>26.50 (3.39)</td>
</tr>
<tr>
<td>Weight (kg), mean (SD)</td>
<td>70.86 (13.83)</td>
<td>72.06 (15.43)</td>
<td>69.33 (11.30)</td>
</tr>
<tr>
<td>Height (cm), mean (SD)</td>
<td>164.72 (9.52)</td>
<td>167.26 (10.44)</td>
<td>161.49 (6.97)</td>
</tr>
<tr>
<td>Weight satisfaction†, mean (SD)</td>
<td>2.95 (1.04)</td>
<td>3.21 (1.00)</td>
<td>2.62 (0.99)</td>
</tr>
<tr>
<td>Perception of weight, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accurate</td>
<td>551 (60.1)</td>
<td>295 (57.4)</td>
<td>256 (63.5)</td>
</tr>
<tr>
<td>Underestimate</td>
<td>366 (39.9)</td>
<td>219 (42.6)</td>
<td>147 (36.5)</td>
</tr>
<tr>
<td>Weight change intentions, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lose weight</td>
<td>576 (62.8)</td>
<td>278 (54.1)</td>
<td>298 (73.9)</td>
</tr>
<tr>
<td>Gain weight</td>
<td>13 (1.4)</td>
<td>12 (2.3)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Stay the same</td>
<td>194 (21.2)</td>
<td>134 (26.1)</td>
<td>60 (14.9)</td>
</tr>
<tr>
<td>Doing nothing</td>
<td>134 (14.6)</td>
<td>90 (17.5)</td>
<td>44 (10.9)</td>
</tr>
<tr>
<td>Muscle change intentions, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain muscle</td>
<td>459 (50.1)</td>
<td>362 (70.4)</td>
<td>97 (24.1)</td>
</tr>
<tr>
<td>Stay the same</td>
<td>194 (21.2)</td>
<td>63 (12.3)</td>
<td>175 (43.4)</td>
</tr>
<tr>
<td>Doing nothing</td>
<td>264 (28.8)</td>
<td>89 (17.3)</td>
<td>131 (32.5)</td>
</tr>
</tbody>
</table>

† Weight satisfaction was measured on a five point scale from 1 “very unhappy” to 5 “very happy”.
Table 2. Association of weight perception, weight satisfaction, weight status and gender with body change intentions for subsample of overweight adolescents (n=917)

<table>
<thead>
<tr>
<th></th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>Trying to lose weight</td>
<td></td>
</tr>
<tr>
<td>Weight perception (ref inaccurate)</td>
<td>2.35 (1.63, 3.39)**</td>
</tr>
<tr>
<td>Weight satisfaction†</td>
<td>0.43 (0.36, 0.53)**</td>
</tr>
<tr>
<td>BMI-z</td>
<td>1.88 (1.37, 2.57)**</td>
</tr>
<tr>
<td>Gender (ref female)</td>
<td>0.51 (0.36, 0.71)**</td>
</tr>
<tr>
<td>Female accurate * perception</td>
<td>1.25 (0.65, 2.39)</td>
</tr>
<tr>
<td>Trying to gain muscle</td>
<td></td>
</tr>
<tr>
<td>Weight perception (ref inaccurate)</td>
<td>0.68 (0.47, 0.98)*</td>
</tr>
<tr>
<td>Weight satisfaction†</td>
<td>0.82 (0.69, 0.97)*</td>
</tr>
<tr>
<td>BMI-z</td>
<td>1.02 (0.78, 1.34)</td>
</tr>
<tr>
<td>Gender (ref female)</td>
<td>8.54 (6.17, 11.82)**</td>
</tr>
<tr>
<td>Female accurate * perception</td>
<td>0.58 (0.31, 1.08)</td>
</tr>
</tbody>
</table>

OR = Odds ratio, CI = Confidence Interval. Regression models also adjusted for age. †Weight satisfaction was measured on a five point scale from 1 “very unhappy” to 5 “very happy”. *p < .05, **p < .01.
Table 3. Association of weight perception, weight satisfaction, weight status and gender with weight related behaviours for subsample of overweight adolescents (n=917)

<table>
<thead>
<tr>
<th></th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td><strong>Active ≥ 4 days per week</strong></td>
<td></td>
</tr>
<tr>
<td>Weight perception (ref inaccurate)</td>
<td>0.66 (0.45, 0.94)*</td>
</tr>
<tr>
<td>Weight satisfaction†</td>
<td>1.02 (0.86, 1.21)</td>
</tr>
<tr>
<td>BMI-z</td>
<td>0.96 (0.73, 1.27)</td>
</tr>
<tr>
<td>Gender (ref female)</td>
<td>1.45 (1.05, 1.99)*</td>
</tr>
<tr>
<td>Female accurate * perception</td>
<td></td>
</tr>
<tr>
<td><strong>No takeaway in past week</strong></td>
<td></td>
</tr>
<tr>
<td>Weight perception (ref inaccurate)</td>
<td>1.28 (0.92, 1.78)</td>
</tr>
<tr>
<td>Weight satisfaction†</td>
<td>1.19 (1.02, 1.38)*</td>
</tr>
<tr>
<td>BMI-z</td>
<td>1.12 (0.88, 1.43)</td>
</tr>
<tr>
<td>Gender (ref female)</td>
<td>0.94 (0.71, 1.24)</td>
</tr>
<tr>
<td>Female accurate * perception</td>
<td></td>
</tr>
<tr>
<td><strong>Fruit ≥ 2 serves per day</strong></td>
<td></td>
</tr>
<tr>
<td>Weight perception (ref inaccurate)</td>
<td>0.98 (0.71, 1.37)</td>
</tr>
<tr>
<td>Weight satisfaction†</td>
<td>1.20 (1.03, 1.40)*</td>
</tr>
<tr>
<td>BMI-z</td>
<td>1.10 (0.86, 1.40)</td>
</tr>
<tr>
<td>Gender (ref female)</td>
<td>0.71 (0.53, 0.95)*</td>
</tr>
<tr>
<td>Female accurate * perception</td>
<td></td>
</tr>
<tr>
<td><strong>Vegetable ≥ 4 serves per day</strong></td>
<td></td>
</tr>
<tr>
<td>Weight perception (ref inaccurate)</td>
<td>0.73 (0.48, 1.10)</td>
</tr>
<tr>
<td>Weight satisfaction†</td>
<td>1.01 (0.83, 1.21)</td>
</tr>
<tr>
<td>BMI-z</td>
<td>1.21 (0.90, 1.64)</td>
</tr>
<tr>
<td>Gender (ref female)</td>
<td>0.80 (0.57, 1.14)</td>
</tr>
<tr>
<td>Female accurate * perception</td>
<td></td>
</tr>
</tbody>
</table>

OR = Odds ratio, CI = Confidence Interval. Regression models also adjusted for age. †Weight satisfaction was measured on a five point scale from 1 “very unhappy” to 5 “very happy”. *p < .05, **p < .01.
Chapter 9

Discussion

The overall aims of this thesis were to examine which factors are associated with weight misperception in Australian adolescents and to investigate whether misperception has an impact on adolescents’ weight related intentions and behaviour. In order to do this, three separate studies were conducted to examine; 1) the biopsychosocial correlates of weight perception 2) how anthropometric measurements of weight status are aligned with perceived weight, and 3) the association of weight perception with weight related intentions and behaviours. This discussion provides a review the findings of the three studies included in this thesis. Specifically, it will examine how these findings contribute to the understanding of the development, maintenance and impacts of weight misperception in Australian adolescents. The related findings from the three articles will be integrated in this chapter to examine the main themes to emerge from this research. In addition, the implications for health promotion, in terms of dealing with the obesity crisis will be discussed. Finally, limitations and recommendations for future research will be explored.

Evaluation of Proposed Biopsychosocial Model

The first study of this thesis evaluated a biopsychosocial model of weight perception. Some of the biological, psychological and social factors in the proposed model were associated with adolescents’ misperception of weight. Overweight adolescents were more likely to misperceive their weight and among healthy weight adolescents, boys were more likely to underestimate their weight. The gender differences in weight perception were moderated by satisfaction with
weight. Boys were dissatisfied when they perceived that they were either overweight or underweight, that is, outside the healthy weight range, whereas girls were dissatisfied if they considered themselves overweight, but not if they considered themselves underweight. Thus, a discrepancy between a participant’s gender specific ideal body (lean and muscular for boys and thin for girls) was associated with weight dissatisfaction. There was evidence that adolescents of lower SES were more likely to consider themselves underweight, but there was no evidence for the effect of peer comparison.

**Measuring Weight Perception in Adolescents**

The second study of this thesis examined which anthropometric measure of weight was most highly correlated with adolescent’s perception of their weight. BMI-z was most closely aligned with weight perception in both boys and girls. Amongst boys, waist circumference was equally correlated with weight perception. This indicates that when adolescents report their weight perception they are reporting an estimate of their overall size and for boys, their central adiposity as well. In terms of gender differences in weight perception, there was a trend for girls to overestimate their weight and boys to underestimate, however girls were equally as likely as boys to underestimate their central adiposity.

There was a high prevalence of underestimation in the sample. A relatively high proportion of adolescents believed that they were underweight despite very few participants being classified as underweight by any measurement. Additionally, misperception was more common amongst overweight adolescents. Ultimately, as there was a tendency for adolescents to underestimate their weight status, the fewer adolescents a measure classified as overweight the more highly correlated it was with adolescents’ perception of their
weight. Thus, BMI-z aligned because it underestimated weight status, and the use of BMI-z in weight perception research may actually understate the tendency of adolescents to misperceive their weight status.

**Relationship of Weight Perception to Intentions and Behaviours**

In the third paper, the association of weight perception and body satisfaction with body change intentions and weight related behaviours was examined. Accurate perception of weight and dissatisfaction with weight were associated with trying to lose weight, but not with healthy dietary intake or increased physical activity. Overweight adolescents who were aware of their weight status and those with a higher BMI-z were most likely to be trying to lose weight. Girls were more likely to be trying to lose weight than boys, irrespective of their weight status, suggesting that they were motivated by a desire to be thin rather than healthy. Boys were more likely to be trying to gain muscle, irrespective of their weight status and were more likely than girls to underestimate their weight. Dissatisfaction with weight was associated with poorer dietary choices and underestimation of weight status was associated with higher levels of physical activity. Overall, the study represented incongruence between adolescents’ intentions and their behaviour; the factors that were associated with adolescents’ weight intentions were not associated with their weight related behaviours. Despite having a large impact on intentions accurate perception of overweight was not associated with healthy behaviours, and in some cases it was with associated with unhealthy behaviours.
Integrated Findings

The studies described above had common variables and complementary aims; and as a result there were shared findings that became evident across the three studies. When considered together, the evidence from the three studies have the potential to provide more information about adolescent weight misperception. The following section integrates the main findings from the three studies to explore the common themes that emerged. This section will also reflect on how these findings relate to contemporary theory of weight misperception and consider the practical implications for health promotion.

Adolescents have a tendency to underestimate their weight status. In the first and second study, overweight adolescents were more likely to misperceive their weight status compared to their healthy weight or underweight counterparts. In the second study, measurements that classified greater numbers of adolescents as overweight were poorer correlates of weight perception. This suggests that many overweight participants had a tendency to perceive themselves as “about the right weight” despite their actual weight status. It also notable that there were very few underweight adolescents in this sample, less than 1%, and yet 16% of adolescents thought that they were underweight. In addition, the proportion of participants who underestimated their weight status was higher when weight status was defined by waist circumference and by body fat percentage compared to when it was defined by BMI-z. This suggests that use of BMI-z to define weight status may actually obscure the prevalence of underestimation of weight. Most previous studies of weight perception have used BMI-z to define weight status, so the prevalence of underestimation of weight status may be even higher than the literature suggests. In the current sample
underestimation of weight was highly prevalent, particularly amongst overweight adolescents.

In regions where a substantial proportion of individuals are overweight, adolescents may believe that they are a healthy weight or even underweight because they assess their weight relative to their peers. This hypothesis was tested using the peer comparison variable, which was defined as the average BMI-z of an individual’s peers within their year level at school. The peer comparison variable had the potential to provide an elegant explanation as to why the proportion of people who underestimate their weight has increased over the past two decades concurrently with the prevalence of overweight (Kaltiala-Heino et al., 2003). However, in the biopsychosocial model, social comparison was not significant even though the level of underestimation of weight was high. This would suggest that some individuals assume that they are in a lighter weight category for reasons that are unrelated to social comparison. Adolescents may not understand what constitutes healthy weight or underweight. Additionally, it may be that admitting to being overweight, in a society that stigmatises overweight is distressing and that some adolescents would prefer to deny the reality. Certainly, the association of dissatisfaction with perception of overweight in this thesis suggests some degree of psychological distress occurred when adolescents were aware that they were overweight. Although the reason is not clear, it appears that overweight people are biased towards assuming that they are a healthy weight.

Differences in body composition did not explain gender differences in weight misperception. In the introductory chapters of this thesis, established gender differences in weight perception were discussed, in that girls tend to overestimate their weight and boys tend to underestimate their weight (Martin et
al., 2009). A proposed explanation for this phenomena may be related to the limitations of BMI, in that it is unable to separate lean mass from fat mass, which may lead to the misclassification of muscular males (Daniels et al., 1997). Thus, many of the boys who have been classified as underestimating in previous studies may have just been muscular and incorrectly classified as overweight by BMI. In the studies presented in this thesis, boys were found to be more likely than girls to underestimate their weight, however there was limited evidence that this was due to misclassification of boys with high muscle mass.

High levels of muscle mass can elevate an individual’s BMI without a concurrent increase in waist circumference (Visscher et al., 2010). Therefore, if a substantial proportion of boys in this sample were classified into a higher weight category by BMI because of elevated lean mass, we could expect to see a higher proportion of boys classified as healthy weight and underweight when weight status was classified by waist circumference. However, in the second study, there was no significant difference in the way that BMI and waist circumference classified boys’ weight status. In addition, both measurements were equally aligned with boys’ weight perception. This suggests that in this sample, there were not a large number of muscular boys who were misclassified by BMI.

In each weight category, those at the fringes of that category were more likely to misperceive their weight status. In the overweight category, those with a lower BMI-z had a propensity to underestimate their weight whilst those with a higher BMI-z were more likely to recognise that they were overweight. This finding was reflected in the third paper where overweight adolescents with higher BMI-z were more likely to be trying to lose weight. Taken together, these findings could indicate that some adolescents with elevated muscle mass were
classified as overweight by BMI-z. Such adolescents with a very high level of lean mass would also be expected to have a corresponding high level of participation in physical activity. However, in the third study there was no relationship between BMI-z and higher levels of activity. This provides further evidence that there were not a large number of adolescents in this sample who were misclassified as overweight due to a high proportion of muscle mass. A certain degree of misclassification is bound to occur when categorising a continuous variable such as weight into discreet categories, but misclassification did not seem to be widespread in this sample and does not explain the propensity of boys to underestimate. Overweight adolescents were probably relatively less accurate at lower levels of BMI-z because the discrepancy between their weight and a healthy weight was less obvious than for adolescents with a much higher BMI-z.

The gender differences in weight perception found in the first study and in previous literature are in part due to the characteristics of the anthropometric measurement used. This was demonstrated in the second study where many of the girls who had an accurate perception of their weight when it was defined by BMI-z were actually classified as underestimating by waist circumference. This may indicate two points, 1) that girls in this sample were equally as likely to underestimate their central adiposity as boys and 2) that BMI-z tends to classify girls into a lower weight category compared to waist circumference. However, it is worth noting that girls were more likely than boys to overestimate their weight status when weight was classified by BMI-z and waist circumference, and were more accurate by body fat percentage, which was the measurement that classified the most adolescents as overweight. This indicates that overall, there is a tendency
for girls to assume that they are heavier than they are. There were some overall
trends for girls to overestimate and boys to underestimate, but gender differences
in body composition did not fully explain those tendencies. Instead the reasons
may relate to gender specific body ideals.

**The influence of gender specific body ideals.** The evidence presented in
this thesis indicates that adolescents in this sample were aware of gender specific
body ideals and wanted to obtain these ideals. Girls were influenced by a thin
ideal; they were dissatisfied when they perceived themselves to be overweight but
were equally content with a perception of healthy weight or underweight. In the
third study, overweight girls were more likely than boys to be trying to lose
weight and some girls were trying to lose weight despite a perception of healthy
weight. Girls appear to be aware of an ideal that is below the healthy weight range
and have a drive to achieve thinness, which is a well described feature of female
body image (Thompson & Stice, 2001).

The results in thesis suggest that boys also experience dissatisfaction with
their body and feel pressure to obtain an aesthetic ideal. Boys were shown to be
dissatisfied with a perception of weight that was outside the healthy range. This
makes their body ideal distinct from girls, in that they are not simply aiming to be
thinner, instead they are aiming for a lean, healthy weight. Previous research
amongst boys who are dissatisfied with their body indicates that weight loss
intentions differ depending on their perceived weight; those who feel overweight
attempt weight loss and those who feel underweight attempt weight gain (McCall,
Williams, Schmalz, & Miller, 2010). This was supported in the third study where
perceived overweight was associated with trying to lose weight. Another
important aspect of male body image, the drive for muscularity has been proposed
to be related to body image in a way that is separate from intention to lose weight. Jones and Crawford (2005) suggested that for boys, weight concern is associated with elevated BMI and muscle concern is associated with lower BMI. However, in the third study, overweight boys were more likely than girls to be trying to gain muscle, regardless of their perceived weight. This suggests that whilst the desire to lose weight may be dependent on an accurate perception of overweight, the desire to gain muscle is present even in boys with elevated BMI and is not influenced by perceived weight status. In addition, dissatisfaction with weight was associated with both trying to lose weight and trying to gain muscle, which suggests that boys are aiming for a lean, muscular ideal. This is consistent with evidence that boys with larger BMI’s are concerned with both their weight and their muscle tone (McCabe & Ricciardelli, 2001). Overweight boy’s weight change intentions were influenced by their perception of whether they met the lean ideal; however, their intention to gain muscle was not related to their perceived weight and may be better measured by a different metric such as perceived muscularity.

Awareness of gender specific body ideals may explain some of the gender differences seen in weight perception. Previous researchers have noted that weight misperception may be related to a discrepancy between an individual’s real and ideal body image (Eisenberg et al., 2006). Body ideals may affect an individual’s perception of their weight because when they make a judgement of their weight they automatically compare themselves to an internalised ideal. Accordingly it may be expected that girls would overestimate because they compare themselves to an unrealistic thin ideal. In the second study girls were indeed more likely to view themselves to be in a heavier weight category.
compared to boys. As boys aim for healthy or ‘lean’ weight, a less than ideal perception is either underweight or overweight. It is worth noting that in study one, the only gender differences in weight perception was found in healthy weight boys who were more likely to believe that they were underweight. For girls, classification of underweight signifies achieving a thin ideal, whereas for boys it signifies failing to achieve lean and muscular ideal. Thus, that more boys believed they were underweight compared to girls indicates that both genders assumed they had failed to meet gender specific ideals. In the first study both boys and girls were dissatisfied with a perception of overweight, perhaps because it is inconsistent with both the ‘thin’ and the ‘lean and muscular’ ideal. Thus, among healthy weight and overweight adolescents, roughly equivalent numbers of boys and girls perceived themselves to be overweight. Taken together, these results suggest that gender differences in weight misperception may stem from comparisons with gender specific body ideals.

**Dissatisfaction with body impacts on weight perception and behaviour.** In the first and third study of this thesis perception of overweight was associated with body dissatisfaction in boys and girls. As these studies were cross sectional, the direction of the relationship is unclear. Awareness of overweight may lead to dissatisfaction with weight, and on the other hand, existing body dissatisfaction may cause an individual to scrutinise and judge their weight and recognise they are overweight. The relationship of weight satisfaction with healthy weight may be conceptualised the same way; perception of healthy weight may cause adolescents to be satisfied with their weight or someone who feels happy and content in their body may assume they are a healthy weight. It may be very difficult to determine exactly how weight perception and satisfaction
interacts as the relationship may be bi-directional and develop over the course of a person’s life. However, what this thesis does indicate is that dissatisfaction is associated with unhealthy weight related behaviours, even for overweight adolescents who accurately perceive their weight.

Although unhealthy weight control behaviours were not measured in this study, some of the trends seen in this thesis may have been related to unhealthy weight control behaviours. The higher consumption of takeaway food among adolescents who were dissatisfied with their weight may have been caused by these adolescents restricting their food intake during the day and as a consequence feeling hungry and consuming high energy foods at the end of the day. It is also possible that the association of dissatisfaction with weight related behaviour is bi-directional; that is, eating unhealthy foods may cause individuals to feel worse about their weight and may lead to food restriction. Such cycles of restriction and binge eating has been shown to lead to weight gain and obesity. Indeed, previous researchers (Skemp-Arlt, 2006) have argued that eating disorders and obesity are not unrelated conditions but share some commonalities in terms of their unhealthy eating practices, weight preoccupation, and diet-binge cycles. Given that overweight perception was associated with dissatisfaction in both boys and girls in the first article, this suggests a link between perceived overweight and engaging in unhealthy weight control behaviours via dissatisfaction with weight.

**Implications for Health Promotion**

*The importance of accurate weight perception.* The health belief model proposes that an important predictor of behaviour is perceived susceptibility to a condition (Abraham & Sheeran, 2005). In the context of weight, this model would
suggest that individuals are unlikely to implement necessary lifestyle changes if they do not perceive themselves as at risk of obesity. According to this model, weight perception, rather than weight itself, should have a substantial impact on weight change intentions and behaviour. The results of the third study of this thesis suggest that whilst overweight individuals who are aware that they are overweight have intentions to lose weight; awareness of overweight does not result in healthy behaviours. This suggests that encouraging accurate perception of weight may change the way adolescents feel about their bodies but will not have a large impact on the obesity crisis. In addition, BMI-z was also associated with trying to lose weight but was not associated with any weight related behaviours. This indicates that neither weight status, nor awareness of weight status has a positive impact on adolescents’ weight related behaviours, and the factors that drive behaviour may be quite different to the factors that drive intentions.

Potential harm of focusing on accurate weight perception. In addition to the lack of association with healthy weight behaviours, accurate weight perception was actually associated with lowered levels of physical activity. This suggests that participation in physical activity may be undermined by perception of overweight and is consistent with findings reported by Wang et al., (2009), who noted that boys who reported trying ‘to lose weight’ spent more time watching TV than those who were not trying to lose weight. Research in Australian adults also found that accurate perception of overweight was a barrier to engaging in physical activity (Atlantis, Barnes, & Ball, 2008). However the reasons for relationship are unclear. Gillison (2006) suggested that because exercising for weight loss is an extrinsic goal, it is not sufficiently motivating to
result in behaviour change. Other researchers have suggested that self-efficacy is an important component of engagement in physical activity (Dishman et al., 2004). Although self-efficacy was not measured in the current study, it is possible that adolescents who perceived themselves as overweight also had a more pessimistic view of their bodies’ abilities, which may have prevented them from taking part in physical activity. Perception of overweight may go hand in hand with perceived incapability to engage in exercise.

As adolescents are already focussed on aesthetic ideals, it may be counterproductive to send messages that focus on aesthetic consequences of weigh related behaviour. For girls in particular, the consequences on focusing on aesthetic outcomes may be destructive as they aspire to an unhealthy thin ideal, rather than healthy weight. Vander Wal (2012) found that considering oneself too fat was a risk factor for unhealthy weight control behaviours. The risk of encouraging disordered eating is also an important consideration. Disordered eating, including restriction, purging and binging, can lead to severe disorders such as anorexia in some adolescents, or increased weight gain and risk of obesity in others (J. M. Jones, Bennett, Olmsted, Lawson, & Rodin, 2001). Therefore, the approach to preventing eating disorders and preventing obesity are not mutually exclusive, and focusing on weight and appearance is potentially damaging for adolescents at both ends of the weight spectrum. Overall, there appears to be limited benefits associated with accurate perception of overweight which may not outweigh the potential risks.

**Future Directions for health promotion.** There is a growing movement toward encouraging “health at every size”, that is encouraging healthy lifestyle changes regardless of weight status with the aim of creating health through those
activities, rather than the weight loss itself (Robison, 2005). Health promotion programs that focus on the health and fitness benefits of healthy eating and exercise are potentially a low-risk and more effective approach to dealing with prevalence of childhood obesity. Kelly and colleagues (2005) reported on a study where girls with high body satisfaction were more likely to report receiving messages that encouraged healthy eating and exercising to be fit rather than to lose weight and had less weight-related concerns. The authors suggested that an environment that focuses on health and fitness rather than weight control will encourage body satisfaction and, accordingly, more adaptive health behaviours. The results presented in this study support that view, and suggests it may even be protective for overweight adolescents to be unaware of their weight status.

**Limitations and Future Research**

There are limitations inherent in using a secondary data set. Some potentially important factors could not be included in the model, because the information was not available. Some of the limitations of this thesis relate to being constrained by the variables that were available in the data set. The cross-sectional design presented in this thesis meant that causal pathways between variables could not be assessed. Although the study the data were derived from was longitudinal, there were not sufficient data collected at follow up to conduct longitudinal data analyses. As the data was drawn from an intervention study designed to change eating and physical activity behaviours, only data from the control group could be used to investigate behaviour change. If sufficient numbers were available, longitudinal analysis would have allowed greater examination of how current weight status perception and body change intentions may lead to lifestyle change. While weight perception and intentions had minimal
impact on behaviour in the current study, it is possible that given more time to develop, changes in behaviour may have manifested over time.

Adolescents who had a BMI-z close to the cut off of a given weight category were more likely to misperceive their weight status. This suggests that for many adolescents who misperceived their weight status, the magnitude of the misperception was not large. It is possible that there are differences between people who marginally misperceive their weight status and those who have a larger discrepancy between their perceived and measured weight. In this thesis, both objective weight and perceived weight was classified into three categorical variables; underweight, healthy weight or overweight. This was done to obtain sufficient numbers to run analyses for each weight category, however as a consequence some detail about the magnitude of misperception was lost. For example, excess fat was described in terms of overweight only, meaning that overweight individuals who thought that they were healthy weight were categorised into the same category as obese adolescents who perceived themselves to be healthy weight. As a result some of the detail of the magnitude of an individual’s misperception was lost. Additionally, obese individuals who reported that they were overweight were classified as accurate, when arguably they may have underestimated their weight.

This issue reflects the problem of not having used a standardised or validated measure of self-reported weight status – it was not possible to confidently state that a perception of ‘very overweight’ was equivalent to obese BMI. Furthermore, the differences between the points on the perceived weight scale may not have been equal to the distances between the BMI categories; therefore producing a continuous measure from those five points would not
necessarily create a valid continuous variable. For these reasons it would be preferable method to use a validated measure of body perception such as the Stunkard Body rating scale used by Maximova et al. (2008). In that study the researchers assigned a z score (from -3 to 3) to each item on the seven point rating scale, and calculated misperception of weight as the difference between BMI-z and the perceived weight z score. This resulted in measurement of misperception that was detailed and continuous. This method would be useful for future research because it allows for the use of more sophisticated statistical methods using a continuous variable for weight perception. In addition, it can provide more detail about the magnitude of the misperception which may reveal associations that are hidden by more crude, categorical measurements.

It is possible that peer comparison was a factor in adolescent weight misperception, but that the measure used in the first study was not sensitive enough to demonstrate an effect of peer comparison. Given that all the participants in this study came from the same regional area, it is reasonable to expect that they would not just be influenced by the people within their class at school, but also by other people in their school, their families and the wider communities. To investigate this effect more comprehensively it would be optimal to sample adolescents from different geographical locations and obtain an estimate of the body adiposity of the people within their schools, families and communities.

Another limitation of this study was the lack information on maladaptive dieting and weight control practices for this sample. Previous studies suggest that perception of overweight can be related to unhealthy weight control practises (Cheung, Ip, Lam, & Bibby, 2007). Although this study found that accurate
perception of overweight was not associated with healthy weight control practises, it would have been useful to also examine whether it was directly related to unhealthy behaviours. Some of the behaviour measured was consistent with maladaptive dieting practices, but it was not possible to state whether extreme restriction, bingeing or purging was occurring in this sample. Further research in overweight adolescents could examine the impact of weight perception and dissatisfaction on maladaptive weight control practices.

A limitation of the third study is that the eating and physical activity behaviour could not be verified in the same way that weight status was verified. It is possible that some of the associations with weight perception were caused by correlation in unreliable self-report rather than correlation with actual behaviour. The association between underestimation and physical activity may simply indicate that people who self-report their weight favourably also inflate the amount of physical activity that they take part in. Ideally, future studies should use methods that independently verify behaviour. However, food intake, in particular, is difficult to verify unless participants are followed very closely for a considerable period of time. A metric that is more amenable to measurement is weight change, which could act as a proxy for dietary and physical activity. Examining how weight perception relates to weight change over time may be a good way of determining whether weight perception does alter behaviour.

It is important to consider weight perception, body dissatisfaction and weight change behaviours from the male perspective. Many previous studies have suggested that boys are less concerned about their weight, because they underestimate their weight. However the findings outlined in this thesis and in previous research (McCall et al., 2010) suggests that many boys who
underestimate their weight may be dissatisfied with their weight and have a
distorted perception of their bodies. Researchers are used to framing
dissatisfaction from the female point of view, that is, perception of overweight
results in dissatisfaction; however it is important to remember that for boys,
perception of underweight can also result in dissatisfaction and potentially
maladaptive behaviour. Weight perception research may have been
underestimating boy’s body concerns, because it was using a female paradigm to
interpret the results. Also, examining the effect of perceived muscularity on
intentions and behaviours may also help researchers to better understand the
drivers of male dietary and exercise behaviours.

Conclusion

Underestimation of weight status was highly prevalent within the
examined sample of adolescents. Through testing a biopsychosocial model of
perception this thesis revealed that gender, weight status, dissatisfaction with
weight and SES are associated with adolescent misperception of weight.
Additionally, by examining accuracy in terms of three anthropometric
measurements it was revealed that BMI-z is most closely aligned with perceived
weight, potentially because both methods tend to underestimate individuals
weight.

Reversing the rising rate of obesity is a high health priority for many
developed countries. However, there is dispute amongst policy makers and health
professionals about the best way to tackle the obesity crisis. Making sure that
adolescents are aware of their weight seems like a logical first step to addressing
this crisis. However the evidence presented in this thesis suggests that this not the
optimal way to address the rising rates of obesity. Perceived weight is related to
unrealistic, gender specific body ideals and dissatisfaction with weight.

Awareness of overweight had a negative impact on physical activity and it may also have a negative impact on dietary choices via dissatisfaction with weight. This suggests that encouraging awareness of overweight may have unintended consequences in the form of maladaptive weight loss practices. An alternative approach to focusing on awareness of overweight is to emphasise making lifestyle change for health reasons. This may lead to more realistic and sustainable changes in lifestyle which are more likely to result in long term benefits to health.
References


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doi: 10.1111/1467-8721.00144


Appendix A

Human Research Ethics Approval

Memorandum

To: Prof Manita McCabe
School of Psychology

B

cc: Ms Julia Fredrickson

From: Deakin University Human Research Ethics Committee (DUHREC)

Date: 16 December, 2011

Subject: 2011-258

Perception of weight status in Australian adolescents

Please quote this project number in all future communications

Exemption from Ethics Review was granted for this project on 16/12/2011.
Authorisation has been given for Ms Julia Fredrickson, under the supervision of Prof Manita McCabe, School of Psychology, to undertake this project for the life of the project from 16/12/2011.

This Exemption from Ethics Review is given only for the project as stated in this memo. It is your responsibility to contact the Human Research Ethics Unit immediately regarding any of the following:

- Any adverse events or events which might affect the continuing ethical acceptability of the project
- All modifications to the research relating to the data or records must be submitted to the Human Research Ethics Unit for review prior to being implemented

In addition, you will be required to report on the progress of your project at least once every year and at the conclusion of the project. You are furthermore required to retain auditable records of the project demonstrating compliance with the National Statement on Ethical Conduct in Human Research (2007) (paragraph 5.2.9) and to produce these if required.

Human Research Ethics Unit
research-ethics@deakin.edu.au
Telephone: 03 9251 7123
Appendix B

Adolescent Behaviour, Attitudes and Knowledge Questionnaire

Instructions:
Is this today's date? ______/_____/_______

What is the name of your school? ____________________

1. What year are you in? Year 9, 10, 11, 12, 13

2. Which ethnic group do you most associate with?
   European Australian
   Indian
   Chinese
   Indigenous Australian
   Other

3. Were you born in Australia? Yes, No

4. I am Male, Female

5. What is your date of birth? Day, Month, Year

6. Do you live with your parents/step-parents during the school week? Yes with two parents, Yes with one parent, Don’t live with my parents

7. Do you live with other ADULT relatives during the school week? (e.g. grandparents, uncle, aunt, cousin) Yes, No

12. How many people usually live at your home including yourself during the school week? 1-15 _____

13. On school days, where do you usually get your breakfast from? Home, School canteen or tuck shop, Shop (outside school), From friends, I don’t eat breakfast

14. In the last 5 school days, on how many days did you have something to eat for
breakfast before school started?  
0 days  
1 day  
2 days  
3 days  
4 days  
5 days

15. Where do you usually get your morning tea for recess from?  
- Home  
- School canteen or tuckshop  
- Shop (outside school)  
- From friends  
- I don’t eat morning tea

16. In the last 5 school days, on how many days did you eat at morning recess/interval?  
0 days  
1 day  
2 days  
3 days  
4 days  
5 days

17. Where do you usually get your lunch from?  
- Home  
- School canteen or tuckshop  
- Shop (outside school)  
- From friends  
- I don’t eat lunch

18. In the last 5 school days, on how many days did you eat lunch at lunchtime?  
0 days  
1 day  
2 days  
3 days  
4 days  
5 days

19. How many serves of fruit do you usually eat each day? (a serve = 1 apple, 1 banana, 1 mandarin or 1 cup of diced fruit)  
- 1 serve or less  
- 2 to 3 serves  
- 4 serves or more

20. How many serves of vegetables do you usually eat each day? (1 serve = ½ cup cooked vegetables or 1 cup of raw vegetables/salad)  
- 1 serve or less  
- 2 to 3 serves  
- 4 serves or more

21. In the last 5 school days (including time spent at home), on how many days did you have regular (non diet) soft drinks? (Soft drinks = drinks like Coke, Sprite, Fanta)  
0 days  
1 day  
2 days  
3 days  
4 days  
5 days

22. On the last school day, how many glasses or cans of non-diet soft drinks did you
have?  
0-More than 2 litres

23. In the last 5 school days, on how many days did you have fruit drinks or cordial?  
(Such as Ribena and Cottees)

<table>
<thead>
<tr>
<th>Days</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24. On the last school day, how many glasses of fruit drinks or cordial did you have?  
0-9 glasses  

25. How often do you usually eat food from a takeaway? (e.g. McDonalds, KFC, Subway, fried chicken, fish and chips, hamburgers, Chinese takeaway)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

26. In the last 5 school days, on how many days did you buy snack food from a shop or takeaway after school?

<table>
<thead>
<tr>
<th>Days</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
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<tr>
<td>Days</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

27. How often do you usually eat fruit after school?  
Everyday or almost everyday
Most days
Some days
Hardly ever or never

28. How often do you usually eat bread, toast, buns or sandwiches after school?  
Everyday or almost everyday
Most days
Some days
Hardly ever or never

29. How often do you usually eat biscuits, potato chips or snacks such as instant noodles after school?  
Everyday or almost everyday
Most days
Some days
Hardly ever or never

30. How often do you usually eat pies, takeaways or fried foods such as French fries after school?  
Everyday or almost everyday
Most days
Some days
Hardly ever or never

31. How often do you usually eat chocolates, lollies, sweets or ice cream after school?
32. In the last 5 school days, how many times did you walk or bike to or from school? (walking from home to school and back on 1 day is 2 times: walking to school and taking the bus home is 1 time)

- Everyday or almost everyday
- Most days
- Some days
- Hardly ever or never
- 0-more than 10 times

33. How long does it take you to walk from home to your school?

- Less than 15 minutes
- 15-30 minutes
- More than 30 minutes

34. Over the last 5 school days, what did you do most of the time at morning recess/interval (apart from eating)?

- Mostly just sat down
- Mostly stood or walked around
- Mostly played active games

35. In the last 5 school days, what did you do most of the time at lunchtime (apart from eating)?

- Mostly just sat down
- Mostly stood or walked around
- Mostly played active games

36. In the last 5 school days, on how many days after school did you do sports, dance, cultural performances or play games in which you were active?

- 0 days
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days

37. In the last 5 school days, how many days did you watch TV, videos or DVDs in your free time?

- 0 days
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days

38. On the last school day that you watched TV, videos or DVDs, how long did you watch for?

- Less than 1 hour – More than 4 hours

39. Last Saturday, how many hours did you spend watching TV, videos or DVDs?

- 0-more than 10 hours

40. Last Sunday, how many hours did you spend watching TV, videos or DVDs?

- 0-more than 10 hours

41. During the school week, do your parents (or caregivers) limit the amount of TV you are allowed to watch? (including videos and DVDs)

- No limits, I can watch anything
- Yes, but not very strict limits
- Yes, strict limits
42. In the last 5 school days, how many times did you watch TV while eating your evening meal?
   - 0 days
   - 1 day
   - 2 days
   - 3 days
   - 4 days
   - 5 days

43. Do you have a TV in your home?
   - Yes
   - No

44. Do you have a TV in your bedroom?
   - Yes
   - No

45. In the last 5 school days, how many days did you play video games, electronic games or use the computer (not for homework)?
   - 0 days
   - 1 day
   - 2 days
   - 3 days
   - 4 days
   - 5 days

46. On the last school day that you spent time playing video games or using the computer (not for homework), how long did you play for?
   - Have not played for ages
   - Less than 1 hour
   - 1 hour
   - 2 hours
   - 3 hours
   - 4 hours
   - More than 4 hours

47. Last Saturday, how many hours did you spend playing video games or using the computer (not for homework)?
   - 0 – More than 5 hours

48. Last Sunday, how many hours did you spend playing video games or using the computer (not for homework)?
   - 0 – More than 5 hours

49. Do you have video games, electronic games or a computer in your home?
   - Yes
   - No

50. How would you describe your weight?
   - Very underweight
   - Slightly underweight
   - About the right weight
   - Slightly overweight
   - Very overweight

51. How happy or unhappy are you with your BODY WEIGHT?
   - Very happy
   - Happy
   - In between / OK
   - Unhappy
   - Very unhappy
   - Never thought about my body weight
52. How happy or unhappy are you with your BODY SHAPE?
   Very happy
   Happy
   In between / OK
   Unhappy
   Very unhappy
   Never thought about my shape

53. Which of these statements most closely applies to you?
   I am…
   Trying to lose weight
   Trying to gain weight
   Trying to stay at my current weight
   Not doing anything about my weight

54. Which of the following statements most closely applies to you?
   I am…
   Trying to gain muscle size
   Trying to stay at the same muscle size
   Not doing anything about my muscles

55. How much does your mother (or female caregiver) encourage you to eat healthy foods?
   A lot
   Some
   A little
   Not at all
   Don’t live with my mother

56. How much does your father (or male caregiver) encourage you to eat healthy foods?
   A lot
   Some
   A little
   Not at all
   Don’t live with my father

57. How often do you have food from a takeaway shop for dinner?
   More than once a week
   About once a week
   2-3 times a month
   Once a month or less

58. How often is fruit available at home for you to eat?
   Everyday or almost everyday
   Most days
   Some days
   Hardly ever or never

59. How often are potato chips or similar snacks available at home for you to eat?
   Everyday or almost everyday
   Most days
   Some days
   Hardly ever or never

60. How often are chocolates or sweets available at home for you to eat?
   Everyday or almost everyday
   Most days
   Some days
   Hardly ever or never
61. How often are non-diet soft drinks available at home for you to drink? (soft drinks = drinks like Coke, Sprite, Fanta)
   - Everyday or almost everyday
   - Most days
   - Some days
   - Hardly ever or never

62. In the last 5 school days, how much money did you spend in total on food or drinks for yourself at takeaway shops or milkbars (not at the school canteens)?
   - 0 – 20 Dollars

63. How much does your mother (or female caregiver) encourage you to be physically active or play sports?
   - A lot
   - Some
   - A little
   - Not at all
   - Don’t live with my mother

64. How much does your father (or male caregiver) encourage you to be physically active or play sports?
   - A lot
   - Some
   - A little
   - Not at all
   - Don’t live with my father

65. How much do your older brothers or male cousins encourage you to be physically active or play sports?
   - A lot
   - Some
   - A little
   - Not at all
   - Don’t have older Brother/cousin

66. How much does your older sister or female cousins encourage you to be physically active or play sports?
   - A lot
   - Some
   - A little
   - Not at all
   - Don’t have older sister/cousin

67. How much do your best friends encourage you to be physically active or play sports?
   - A lot
   - Some
   - A little
   - Not at all

68. In the last 5 school days, how many times did all or most of your family living in your house eat an evening meal together?
   - 0 days
   - 1 day
   - 2 days
   - 3 days
   - 4 days
   - 5 days

69. How much does your school encourage ALL students play organised sport?
70. How much does your school encourage ALL students to be physically active at lunchtime?

A lot
Some
A little
Not at all

71. How do you rate the teachers at your school as role models for being physically active?

Excellent
Good
OK
Not very good
Poor

72. How do you rate the teachers at your school as role models for healthy eating?

Excellent
Good
OK
Not very good
Poor

73. How do you rate the food and drink choices available at your school canteen?

Mostly healthy
Half healthy/half unhealthy
Mostly unhealthy

74. How much does your school encourage students to make healthy food choices?

A lot
Some
A little
Not at all

75. How safe do you feel being out alone in your neighbourhood at night?

Very safe
Safe
Unsafe
Very unsafe

76. How safe do your parents (or caregivers) think it is for you to be out alone in your neighbourhood at night?

Very safe
Safe
Unsafe
Very unsafe
Don’t know

77. How much do dogs bother you when you are walking in your neighbourhood?

A lot
Somewhat
A little
Not at all

78. How much does traffic bother you when you are walking in your neighbourhood?
79. How much do other people bother you when you are walking in your neighbourhood?
A lot
Somewhat
A little
Not at all

How strongly do you agree or disagree with the following statements

80. Skipping breakfast or lunch is a good way to lose weight
Strongly agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

81. Fruit drinks and cordials have less sugar than non-diet soft drinks like Coke and Sprite
Strongly agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

82. Watching a lot of TV does not lead to weight gain
Strongly agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

83. Eating a lot of fruit and vegetables is bad for your weight
Strongly agree
Agree
Neither agree nor disagree
Disagree
Strongly disagree

This completes the questionnaire!!
Thank you for your participation!!…well done!