

Review Article

Difference between parental perception and actual weight status of children: a systematic review

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Abstract

An increasing number of children worldwide are overweight, and the first step in treating obesity is to identify overweight. However, do parents recognise overweight in their child and which factors influence parental perception? The aim of the present review is to systematically study differences between parental perception and the actual weight status of children. Medline, EMBASE, CINAHL and PsychINFO were searched. After screening 2497 abstracts and 106 full texts, two reviewers independently scored the methodological quality of 51 articles (covering 35 103 children), which fulfilled the inclusion criteria. The primary outcome parameters were sensitivity and specificity of parental perception for actual weight status of their child. The methodological quality of the studies ranged from poor to excellent. Pooled results showed that according to objective criteria 11 530 children were overweight; of these, 7191 (62.4%) were incorrectly perceived as having normal weight by their parents. The misperception of overweight children is higher in parents with children aged 2–6 years compared with parents of older children. Sensitivity (correct perception of overweight) of the studies ranged from 0.04 to 0.89, while specificity (correct perception of normal weight) ranged from 0.86 to 1.00. There were no significant differences in sensitivity or specificity for different cut-off points for overweight, or between newer and older studies. Therefore we can conclude that parents are likely to misperceive the weight status of their overweight child, especially in children aged 2–6 years. Because appropriate treatment starts with the correct perception of overweight, health care professionals should be aware of the frequent parental misperception of the overweight status of their children.

Keywords: child, overweight, parent, perception.

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Introduction

Worldwide, an increasing number of children are overweight. (Haug *et al.* 2009) For example, in pre-school children, the worldwide prevalence of overweight increased from 4.2% in 1990 to 6.7% in 2010. (de Onis *et al.* 2010).

Obesity in adults is related to metabolic disorders such as impaired glucose tolerance, diabetes, dyslipidaemia, cardiovascular diseases and certain types of

cancer. (WHO 2006, 2012) Overweight and obesity in childhood can lead to diabetes and cardiovascular diseases at a younger age. (Freedman *et al.* 2009; Yeste & Carrascosa 2011; WHO 2012) Overweight that begins before 8 years of age and persists into adulthood is associated with a mean body mass index (BMI) of 41 in adulthood, as compared with 35 for adult-onset obesity. (Freedman *et al.* 2001; Dietz & Robinson 2005) Therefore, the high proportion of overweight in children is alarming.

Although prevention of childhood overweight is the most desirable scenario (WHO 2012), because prevention of childhood obesity has not yet been very successful (Waters *et al.* 2011), the treatment of obesity remains an important item. The first step in treating obesity is to identify overweight. (Wofford 2008; Young *et al.* 2010) This applies to health care professionals and to parents, who often initiate treatment. Parents' concerns about their child's health depend on their awareness of their child's overweight and, consequently, whether they are willing to take action against overweight. (Wake *et al.* 2002; Soto & White 2010; Moore *et al.* 2012) Therefore, the perception of overweight of parents is an important initial step. However, previous reviews show that $\geq 50\%$ of parents fail to accurately perceive the overweight of their child. (Parry *et al.* 2008; Doolen *et al.* 2009; Towns & D'Auria 2009). These reviews included studies published up to August 2007. Since then, in the wake of considerable focus on the prevention and treatment of overweight in children, it is unclear whether there has been an improvement in parental perception.

However, because studies often use different BMI cut-off criteria to define overweight, this can influence the data and might contribute to the parental misperception that was that is found in other studies. Also, societal factors (e.g. child's age and gender of parent that filled out questionnaires) might influence parents' perception of overweight. It is therefore important to study factors that might influence differences between parental perception and actual weight status of children. This might reveal possible subgroups that need more attention by health care professionals to help them become aware about their

child's weight status. Therefore, this systematic review investigates differences between parental perception and the actual weight status of children and explores possible determinants for these differences.

Materials and Methods

Study selection

The inclusion criteria for this review were the study investigated the perception of parents/caregivers, the children were aged 2–18 years and the outcome was the difference between measured weight status (classified by BMI) and weight status as observed by parents on the child level. Exclusion criteria were Diagnostic and Statistical Manual of Mental Disorders (DSM) classified eating disorders, medical conditions affecting the weight (e.g. Down syndrome, Prader Willi syndrome) and qualitative studies.

Data sources and search strategy

The PubMed, EMBASE, CINAHL and PsychINFO databases were searched up to January 2011. Search terms were combined into four groups: child, body weight, parent and perception. Articles identified by the search strategy contained at least one term from each group. The search terms were adapted to the different databases to facilitate a comprehensive search (for details on search strings, see Appendix 1). In addition, the reference lists of the retrieved articles were reviewed for promising titles, in order to recover articles not included in the major databases. There were no restrictions regarding date of publication (prior to January 2011) or language. Two reviewers

Key messages

- 63.4% of the parents of overweight children fail to recognise overweight of their child.
- 86% of the parents of children aged 2–6 years fail to recognise overweight of their child.
- Although different studies used different cut-off points for the definition of overweight, the misperception of overweight seems to be universal.
- There are no significant differences in sensitivity of parental perception between the studies included in earlier reviews and the more recent studies.
- Health care professionals should be aware of the frequent parental misperception of the overweight status of their children.

(MR, WP) independently selected citations based on titles and abstracts, or on retrieved articles. Full articles were obtained for those citations thought to fulfill the inclusion criteria. Eligibility was independently assessed by the same two reviewers. Any discrepancies were resolved through discussion.

Quality assessment

Because there was no existing quality assessment tool for the observational and cross-sectional studies, a quality assessment tool for diagnostic studies based on the Cochrane criteria (Reitsma *et al.* 2009) was selected and adapted for our purpose (Table 1). The methodological quality of articles using a verbal description of the perception of the weight status was based on six items and categorised into poor quality (0–2 items scored positive), moderate quality (3–4 items positive), good quality (5 items positive) and excellent quality (6 items positive). The quality of articles using image scales was based on seven items (good quality = 5–6 items positive; excellent quality = 7 items positive).

Data extraction

Study characteristics were extracted by the same two reviewers and included country; setting; number of children included; male-to-female ratio; age of children; type of caregiver (mother, father, other) who provided the data; and details on which classification for overweight was used (Table 2).

Data extracted included true positives (actual overweight, perceived overweight); false positives (actual normal weight, perceived overweight); true negatives (actual normal weight, perceived normal weight); and false negatives (actual overweight, perceived normal weight). In some studies, not all participants were suitable for analyses. For example, at two different moments (T1 and T2) parents were asked to give their perception about their child's weight status, but only at T2 were the child's weight and height measured. In this case, only data of T2 were extracted. In most studies ($n = 47$), parents were asked to choose the best verbal description for their child's weight status (e.g. underweight, normal weight, overweight). In some studies

($n = 6$), from a series of images, parents had to choose the one that best represented their child.

Authors were contacted when insufficient data were provided.

Definition of overweight

A variety of definitions are applied to identify overweight in children (Table 2; Appendix 2). The cut-off points for BMI used to classify overweight by the International Obesity Task Force (IOTF) are adopted from Cole *et al.* (2000). These centile curves for children and adolescents aged 2–17 years are similar to the widely used cut-off points of a BMI of 25 kg m^{-2} (overweight) and 30 kg m^{-2} (obesity) for adults from age 18 years onwards.

The cut-off points that the World Health Organisation (WHO) applies are BMI $>85\%$ on their centiles for overweight and BMI $>95\%$ for obesity. On their centiles, until 2010, the Centre for Disease Control and Prevention (CDC) defined BMI $>85\%$ as at risk of overweight and BMI $>95\%$ as overweight. After 2010, they changed the definition to BMI $>85\%$ as overweight and BMI $>95\%$ as obesity. (Ogden & Flegal 2010) From studies that referred to CDC centiles, measured BMI $>85\%$ are included as actual overweight. When articles used definitions other than those described above, this is indicated in the tables.

Definition of sensitivity and specificity

Sensitivity was defined as the correct perception of overweight (true positives/all overweight children). Specificity was defined as correct perception of normal weight (true negatives/ all normal weight children).

Subgroup analyses

Three subgroup analyses were defined to further explore differences in perception and actual weight status. The first analysis compared studies that included only young children (≤ 6 years) vs. studies that included older children, or a broader age range. The second subgroup analysis compared studies with different cut-off points used for the definition of over-

Table 1. Results of the quality assessment

	Selection bias		Blinding	Method and data collection			Non-responders	
	Inclusion did not take place based on weight	Characteristics were described, representative sample		Type of equipment mentioned, all children same equipment	In case of image scale a validated scale was used	Description of weight status classification was mentioned	Non-responders were mentioned	
Verbal description								
Abbott <i>et al.</i> 2010	+	+	+	+	n.a.	+	+	+
Al-Qaoud <i>et al.</i> 2010	-	-	-	+	n.a.	+	+	+
Anderson <i>et al.</i> 2005	+	+	+	-	n.a.	+	+	+
Baugheum <i>et al.</i> 2000	+	?	?	+	n.a.	+	+	+
Boa-Sorte <i>et al.</i> 2007	+	+	+	+	n.a.	+	+	+
Boutelle <i>et al.</i> 2004	+	+	?	-	n.a.	+	+	+
Bracho & Ramos 2007	+	+	?	?	n.a.	+	+	+
Carnell <i>et al.</i> 2005	+	?	?	-	n.a.	+	+	+
Crawford <i>et al.</i> 2006	+	+	?	-	n.a.	+	+	+
De La <i>et al.</i> 2009	+	+	?	+	n.a.	+	+	+
Eckstein <i>et al.</i> 2006	+	+	?	-	-	+	+	+
Flowers 2008	+	?	?	-	n.a.	+	+	+
Garret 2009	+	+	?	-	n.a.	+	+	+
Goodman <i>et al.</i> 2000	+	?	?	-	n.a.	+	+	+
Gray <i>et al.</i> 2007	+	-	?	+	n.a.	+	+	+
Hackie & Bowles 2007	-	-	?	-	n.a.	+	+	+
Harnack <i>et al.</i> 2009	+	+	?	+	n.a.	+	+	+
Hearst <i>et al.</i> 2011	+	+	?	+	n.a.	+	+	+
Hernandez <i>et al.</i> 2010	+	+	?	-	-	+	+	+
Hirschler <i>et al.</i> 2006	+	+	?	-	n.a.	+	+	+
Hirschler <i>et al.</i> 2008	+	+	?	-	n.a.	+	+	+
Huang <i>et al.</i> 2007	+	+	?	+	n.a.	+	+	+
Hudson <i>et al.</i> 2009	+	+	?	+	n.a.	+	+	+
Jackson <i>et al.</i> 1990	+	+	+	+	n.a.	+	+	+
Jansen & Brug 2006	+	+	?	+	n.a.	+	+	+
Jeffery <i>et al.</i> 2005	+	+	+	-	n.a.	+	+	+
Juliusson <i>et al.</i> 2011	+	+	?	+	n.a.	+	+	+
Kasensup & Reicks 2006	+	?	?	-	n.a.	+	+	+
Kroke <i>et al.</i> 2006	+	+	?	-	n.a.	+	+	+
Lampard <i>et al.</i> 2008	-	-	-	+	n.a.	+	+	+
Lazzeri <i>et al.</i> 2006	+	+	?	-	n.a.	+	+	+
Mamum <i>et al.</i> 2008	+	+	?	-	n.a.	+	+	+

Table 1. Continued

	Selection bias		Blinding		Method and data collection			Non-responders	
	Inclusion did not take place based on weight	Characteristics were described, representative sample	Parent did not know weight status before answering	Type of equipment mentioned, all children same equipment	In case of image scale a validated scale was used	Description of weight status classification was mentioned	Non-responders were mentioned		
Manios <i>et al.</i> 2009	+	+	?	+	n.a.	+	+		
Mathieu <i>et al.</i> 2010	+	+	?	-	n.a.	+	+		
May <i>et al.</i> 2007	+	+	?	?	n.a.	+	+		
Maynard <i>et al.</i> 2003	+	+	?	-	n.a.	+	+		
Molina Mdel <i>et al.</i> 2009	+	+	?	-	n.a.	+	+		
Myers & Vargas 2000	-	-	?	-	n.a.	+	+		
Neumark <i>et al.</i> 2008	-	-	?	-	n.a.	+	+		
Perrin <i>et al.</i> 2010	+	+	?	+	n.a.	+	+		
Rudolph <i>et al.</i> 2010	-	-	-	-	n.a.	+	?		
Skelton <i>et al.</i> 2006	+	?	?	-	n.a.	+	?		
Tschamler <i>et al.</i> 2010	+	+	?	-	n.a.	+	+		
Valdes <i>et al.</i> 2009	+	+	?	-	n.a.	+	+		
Vuorela <i>et al.</i> 2010	+	+	?	-	n.a.	+	+		
Wald <i>et al.</i> 2007	+	+	?	-	n.a.	+	?		
Young <i>et al.</i> 2010	-	-	?	-	n.a.	+	+		
Ratio +/-? (%)	85/15/0	70/17/13	11/6/83	32/64/4	n.a.	100/0/0	94/0/6		
Image scales									
Beatty 2009	+	+	?	-	?	-	+		
Eckstein <i>et al.</i> 2006	+	+	?	-	-	+	+		
Hernandez <i>et al.</i> 2010	+	+	?	-	-	+	+		
Reifsnider <i>et al.</i> 2006	+	+	+	+	-	+	+		
Warschburger & Kroll 2009	-	-	?	+	+	+	-		
Zonana-Nacach & Conde-Gaxiola 2010	+	+	+	-	-	+	+		
Ratio +/-? (%)	87/13/0	87/13/0	25/0/75	38/62/0	25/62/13	87/13/0	87/13/0		

+ = yes; - = no; ? = unclear; n.a., not applicable.

Table 2. Characteristics of the included studies

Author, year of publication	Country	Setting	No. of participants suitable for this analysis (n)	Male (%)	Range of age, or mean (years)	Caregiver	Definition of weight status
Verbal descriptions*							
Abbott <i>et al.</i> 2010 [§]	Australia	school ^{§§}	2148	49	5–12	n.a.	IOTF Cole ¹⁹
Al-Qaoud <i>et al.</i> 2010 [§]	Kuwait	sample Kuwait Nutrition Surveillance System study	482	45	3–6	mother	WHO ^{†††}
Anderson <i>et al.</i> 2005	USA	sample Head Start program	82	45	3–5	55% female, 45% male	CDC ^{‡‡‡}
Baughcum <i>et al.</i> 2000 [§]	USA	health care facility ^{¶¶}	304	n.a.	2–5	mother	BMI >90 th overweight
Boa-Sorte <i>et al.</i> 2007 [§]	Brazil	school	827	46	6–19	mother	CDC
Boutelle <i>et al.</i> 2004 [§]	USA	school	742	53	Mean 14.6	91% mother	CDC
Bracho & Ramos 2007 [§]	Chili	school + health care facility	270	51	2–6	mother	WHO
Carnell <i>et al.</i> 2005 [†]	UK	school	564	n.a.	3–5	94.5% mother; 5.5% other	IOTF Cole
Crawford <i>et al.</i> 2006 [‡]	Australia	school	1116	48***	5–6 and 10–12	84.4% female, 15.6% male	IOTF Cole
De La <i>et al.</i> 2009**	USA	school	576	49	5–12	n.a.	WHO
Eckstein <i>et al.</i> 2006 [§]	USA	health care facility	223	42	2–17	n.a.	CDC
Flowers 2008 [¶]	USA	health care facility	57	49	8–12	n.a.	WHO
Garret 2009 [§]	USA	health care facility	120	53	2–5	92% mothers, 8% fathers	BMI >95 th overweight
Goodman <i>et al.</i> 2000 [§]	USA	sample National Longitudinal Study of Adolescent Health	564	51	Teens	n.a.	BMI >95 th obese
Gray <i>et al.</i> 2007 [†]	USA	school	169	n.a.	Second-grade students	90% mothers, 6.5% father, 2.5% grandmother, 1% other	CDC
Hackie & Bowles 2007 [‡]	USA	health care facility	38	53	2–5	mother	BMI >95 th overweight
Harnack <i>et al.</i> 2009**	USA	school	593	54	2–5	90.5% mother, 9.5% father	CDC
Hearst <i>et al.</i> 2011 [‡]	USA	sample Aetiology Childhood Obesity study	358	48	Mean 14	80% female	WHO
Hernandez <i>et al.</i> 2010 [§]	USA	health care facility	49	57***	2–5	n.a.	WHO
Hirschler <i>et al.</i> 2006 [‡]	Argentina	School	321	50	2–6	mother	CDC
Hirschler <i>et al.</i> 2008 [†]	Argentina	School	620	48	5–13	mother	WHO
Huang <i>et al.</i> 2007 [‡]	USA	health care facility	429	45***	0–18	87% female, 13% male	CDC
Hudson <i>et al.</i> 2009 [†]	USA	sample Head Start program	96	45	3–5	75% mother, 25% father or mother	CDC
Jackson <i>et al.</i> 1990 [§]	USA	School	107	51	3–6	mother	BMI >90 th overweight

Table 2. Continued

Author, year of publication	Country	Setting	No. of participants suitable for this analysis (n)	Male (%)	Range of age, or mean (years)	Caregiver	Definition of weight status
Jansen & Brug 2006 [‡]	The Netherlands	sample Rotterdam Youth Health Monitor study	524	50	9–11	75% mothers, 15% fathers, 10% other	IOTF Cole
Jeffery <i>et al.</i> 2005 [‡]	UK	sample Early Bird Study	272	56	Mean 7.4	can be mother or father	BMI >91 th overweight, BMI >98 th obese
Juliusson <i>et al.</i> 2011 ^{††}	Norway	Sample Bergen Growth study	3770	51	2–19	n.a.	IOTF Cole
Kasemsup & Reicks 2006 [‡]	USA	School	80	n.a.	3–5	mother	BMI >95 th overweight
Kroke <i>et al.</i> 2006 [‡]	Germany	sample Dortmund Nutritional and Anthropometric Longitudinally Designed study	253	49	6 Months to 4 years	mother	CDC
Lampard <i>et al.</i> 2008 [†]	Australia	health care facility + school	329	n.a.	6–13	n.a.	IOTF Cole
Lazzeri <i>et al.</i> 2006 [‡]	Italy	School	2835	51****	8–9	mother	IOTF Cole
Mamun <i>et al.</i> 2008 [§]	Australia	sample Mater-University Study of Pregnancy	2650	52	14	mother	IOTF Cole
Manios <i>et al.</i> 2009 ^{**}	Greece	sample Growth, Exercise and Nutrition Epidemiological Study in preschoolers	1759	54	2–5	mother	CDC
Mathieu <i>et al.</i> 2010 [§]	Canada	birth cohort follow-up	1128	48	Mean 6.2	can be mother or father	WHO
May <i>et al.</i> 2007 [‡]	USA	previous research	228	49****	2–5	mother	CDC
Maynard <i>et al.</i> 2003 [§]	USA	sample Third National Health and Nutrition Examination Survey	5500	50	2–11	mother	CDC
Molina Mdél <i>et al.</i> 2009 ^{**}	Brazil	School	1272	42	7–10	mother	Must <i>et al.</i> 23,24
Myers & Vargas 2000 [‡]	USA	health care facility	200	n.a.	2–5	can be mother or father	BMI >90 th overweight
Neumark <i>et al.</i> 2008 [†]	USA	school + sample Project EAT study	307	48	Mean 14.4	92% mother	WHO
Perrin <i>et al.</i> 2010 [‡]	USA	health care facility	96	50****	4–12	92.2% female	WHO

Table 2. Continued

Author, year of publication	Country	Setting	No. of participants suitable for this analysis (n)	Male (%)	Range of age, or mean (years)	Caregiver	Definition of weight status
Rudolph <i>et al.</i> 2010 [§]	Germany	health care facility	150	54***	7–17	can be mother or father	WHO
Skelton <i>et al.</i> 2006 [§]	USA	fair	37	n.a.	4–20	can be mother or father	CDC
Tschamler <i>et al.</i> 2010 [§]	USA	health care facility	193	50	1–9	89% mother, 11% father	CDC
Valdes <i>et al.</i> 2009 [§]	USA	health care facility	141	50***	2–18	can be mother or father	BMI >75 th (at risk for) overweight, BMI >95 th obese
Vuorela <i>et al.</i> 2010 [§]	Finland	school	606	50	5 and 11	can be mother or father	IOTF Cole
Wald <i>et al.</i> 2007 [§]	USA	health care facility	612	55	3–12	can be mother or father	CDC
Young <i>et al.</i> 2010 [§]	USA	health care facility	111	43	5–11	n.a.	BMI >95 th overweight
Image scales ^{**}							
Beatty 2009 ^{**}	USA	health care facility	130	45	8–11	mother	unknown
Eckstein <i>et al.</i> 2006 ^{§¶}	USA	health care facility	223	42	3–17	78% mother	CDC
Hernandez <i>et al.</i> 2010 [§]	USA	health care facility	150	57	2–5	n.a.	WHO
Reifsnider <i>et al.</i> 2006 [§]	USA	health care facility	25	64	3	mother	WHO
Warschburger & Kroll 2009	Germany	health care facility + child care	141	58***	3–6	mother	IOTF Cole
Zonana-Nacach & Conde-Gaxiola 2010	Mexico	health care facility	525	48	2–13	mother	WHO

*Parents were asked to describe their child with words like 'very underweight, underweight, about right, overweight, very overweight'. [†]Did parents recognise overweight? [‡]Did parents recognise normal weight and overweight? [§]Did parents recognise underweight, normal weight and overweight? [¶]Did parents recognise very underweight, a little overweight and very overweight? ^{**}Did parents recognise underweight, normal weight, a little overweight and very overweight? ^{††}Did parents recognise very underweight, a little underweight, normal weight, a little overweight and very overweight? ^{‡‡}Parents were asked to compare their child with different images and say which most resembles their child. ^{§§}Selection of participants took place at school. ^{¶¶}Selection of participants took place at well child visits or outpatient clinics. ^{***}percentage male in original sample. ^{†††}weight status by WHO: BMI >85th overweight, BMI >95th obese. ^{§§§}weight status by CDC: >85th overweight, BMI >95th obese. BMI, body mass index; CDC, Centre for Disease Control and Prevention; IOTF, International Obesity Task Force; n.a., not available.

weight (IOTF, WHO BMI >85% and CDC BMI >85%). The third subgroup analysis compared relatively older studies (included in the reviews published up to 2007) with more recent studies.

Statistical analysis

For studies using verbal descriptions for recognition of both normal weight and overweight, plots for sensitivity and specificity (including 95% confidence intervals and a summary ROC curve) were constructed using REVMAN software version 5.1, (Rigshospitalet, Copenhagen, Denmark). (Cochrane 2011) Sensitivity plots were constructed for all studies addressing recognition of overweight. For subgroup analyses, sensitivity and specificity of the different studies were pooled using STATA 12 (StataCorp, College Station, TX, USA) weighing for study size.

Results

Study selection and characteristics

The electronic search resulted in 2497 hits. Screening the titles and abstracts resulted in 106 articles for which the full text was assessed. Finally, 51 articles were included in this systematic review (Fig. 1). (Jackson *et al.* 1990; Baughcum *et al.* 2000; Goodman *et al.* 2000; Myers & Vargas 2000; Young-Hyman *et al.* 2000; Maynard *et al.* 2003; Boutelle *et al.* 2004; Anderson *et al.* 2005; Carnell *et al.* 2005; Jeffery *et al.* 2005; Crawford *et al.* 2006; Eckstein *et al.* 2006; Hirschler *et al.* 2006; Jansen & Brug 2006; Kasemsup & Reicks 2006; Kroke *et al.* 2006; Lazzeri *et al.* 2006; Reifsnider *et al.* 2006; Skelton *et al.* 2006; Boa-Sorte *et al.* 2007; Bracho & Ramos 2007; Gray *et al.* 2007; Hackie & Bowles 2007; Huang *et al.* 2007; May *et al.* 2007; Wald *et al.* 2007; Flowers 2008; Hirschler *et al.* 2008; Lampard *et al.* 2008; Mamum *et al.* 2008; Neumark-Sztainer *et al.* 2008; Beatty 2009; De La *et al.* 2009; Garret 2009; Harnack *et al.* 2009; Hudson *et al.* 2009; Manios *et al.* 2009; Molina Mdel *et al.* 2009; Valdes *et al.* 2009; Warschburger & Kroller 2009; Abbott *et al.* 2010; Al-Qaoud *et al.* 2010; Hernandez *et al.* 2010; Mathieu *et al.* 2010; Perrin *et al.* 2010; Rudolph *et al.* 2010; Tschamler *et al.* 2010; Vuorela *et al.* 2010;

Zonana-Nacach & Conde-Gaxiola 2010; Hearst *et al.* 2011; Juliusson *et al.* 2011). These 51 studies were conducted in 18 different countries (Table 2). In two studies, parents had to give both a verbal description of their child's actual weight status and choose the image that best represented their child (Eckstein *et al.* 2006; Hernandez *et al.* 2010); therefore, these two articles are reported twice in the study characteristics and results.

Studies were published between 1990 and 2011. In total, the studies included over 35 000 child-parent couples; of these, by far the most were child-mother couples. The age of the children ranged from 2 to 18 years, with the largest group aged 2–6 years. Most families were recruited from schools or health care facilities.

Methodological quality

Studies using verbal descriptions had poor (6 articles), moderate (30 articles), good (8 articles) or excellent (3 articles) methodological quality. The quality of studies using image scales ranged from moderate (4 articles) to good (2 articles) (Table 1).

Combining all types of studies showed that it was unclear in most studies whether parents were unaware of the results of the weight measurement of their children before answering the question (this item scored unclear in 81% of the studies). The classification used for weight status and the number of non-responders were mentioned in most articles. The item that was not mentioned in most articles was related to which equipment was used and whether that same equipment was used for all children (64% unknown).

Perception of weight status

Of the 35 103 children enrolled (i.e. the total number of children in studies using verbal descriptions and image scales), according to objective criteria 11 530 were overweight (32.9%). Of these overweight children, 4339 (37.6%) were correctly perceived as overweight by their parents, and the remaining 7191 (62.4%) were incorrectly perceived as normal weight.

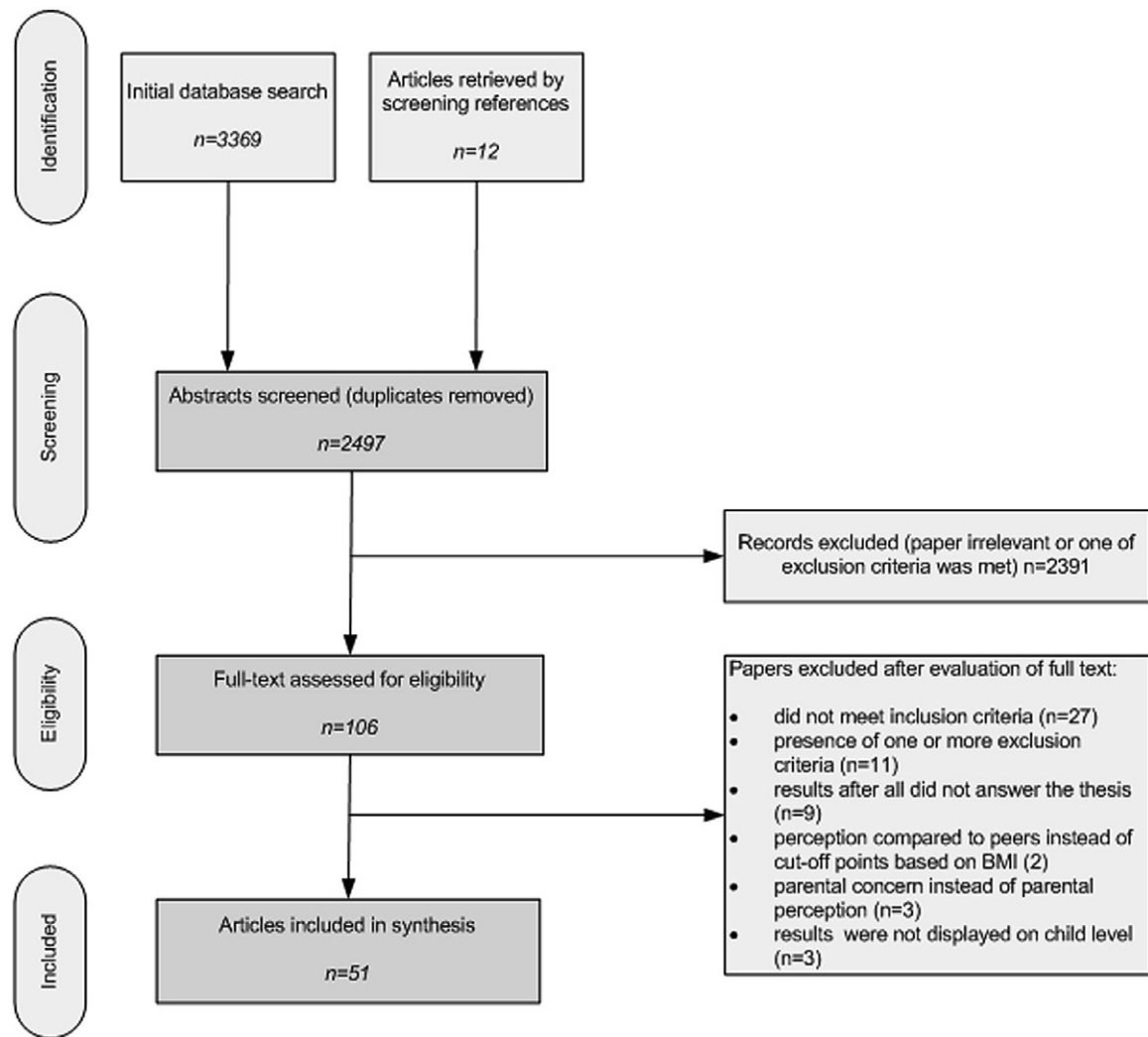


Fig. 1. Flowchart of the screening and selection process of the study articles.

According to objective criteria 23 573 (67.1%) children had a normal weight. For 21 410 of these children, information was available on the percentage perceived to be correct or incorrect: Of these normal-weight children, 664 (3.1%) were incorrectly perceived as overweight by their parents.

The six studies using image scales enrolled 1195 children. According to objective criteria, 392 of them were overweight (32.8%). Of these 392 overweight children, 52.3% were indeed perceived as overweight by their parents, and 47.7% were incorrectly perceived as normal weight by their parents. According

to objective criteria, 803 (67.2%) children had a normal weight. Parental perception was recorded for 688 of them, and 40 (5.8%) of these children were incorrectly perceived as overweight.

A total of 32 studies using verbal descriptions quantitatively reported on both overweight and normal-weight perception. Table 3 shows a forest plot of these studies reporting the percentages of parents who correctly assigned the overweight or normal-weight status to their children. Specificity (correct perception of normal weight) ranged from 0.86 to 1.00. Figure 2 shows the ROC curves of these 32 studies.

Table 3. Forest plot of studies using verbal descriptions ($n=32$) reporting sensitivity and specificity of parental perception

Study	TP	FP	FN	TN	Cut-off	Sensitivity	Specificity	Sensitivity	Specificity
Bracho & Ramos 2007	28	4	89	149	BMI > 85%	0.24 [0.17, 0.33]	0.97 [0.93, 0.99]	■	■
De La <i>et al.</i> 2009	41	5	50	481	BMI > 85%	0.45 [0.35, 0.56]	0.99 [0.98, 1.00]	■	■
Flowers 2008	17	2	10	28	BMI > 85%	0.63 [0.42, 0.81]	0.93 [0.78, 0.99]	■	■
Hearst <i>et al.</i> 2011	51	0	65	242	BMI > 85%	0.44 [0.35, 0.53]	1.00 [0.98, 1.00]	■	■
Hirschler <i>et al.</i> 2008	97	9	106	409	BMI > 85%	0.48 [0.41, 0.55]	0.98 [0.96, 0.99]	■	■
Mathieu <i>et al.</i> 2010	46	135	156	791	BMI > 85%	0.23 [0.17, 0.29]	0.85 [0.83, 0.88]	■	■
Molina Mdel <i>et al.</i> 2009	149	16	148	959	BMI > 85%	0.50 [0.44, 0.56]	0.98 [0.97, 0.99]	■	■
Perrin <i>et al.</i> 2010	25	0	20	51	BMI > 85%	0.56 [0.40, 0.70]	1.00 [0.93, 1.00]	■	■
Rudolph <i>et al.</i> 2010	48	7	6	88	BMI > 85%	0.89 [0.77, 0.96]	0.93 [0.85, 0.97]	■	■
Baughcum <i>et al.</i> 2000	21	3	78	202	BMI > 90%	0.21 [0.14, 0.31]	0.99 [0.96, 1.00]	■	■
Jackson <i>et al.</i> 1990	1	0	16	90	BMI > 90%	0.06 [0.00, 0.29]	1.00 [0.96, 1.00]	■	■
Jeffery <i>et al.</i> 2005	25	31	27	189	BMI > 91%	0.48 [0.34, 0.62]	0.86 [0.81, 0.90]	■	■
Boa-Sorte 2007	83	41	69	634	CDC BMI > 85%	0.55 [0.46, 0.63]	0.94 [0.92, 0.96]	■	■
Boutelle <i>et al.</i> 2004	61	30	209	442	CDC BMI > 85%	0.23 [0.18, 0.28]	0.94 [0.91, 0.96]	■	■
Eckstein <i>et al.</i> 2006	32	3	56	132	CDC BMI > 85%	0.36 [0.26, 0.47]	0.98 [0.94, 1.00]	■	■
Garret 2009	6	1	40	73	CDC BMI > 85%	0.13 [0.05, 0.26]	0.99 [0.93, 1.00]	■	■
Harnack <i>et al.</i> 2009	9	1	217	366	CDC BMI > 85%	0.04 [0.02, 0.07]	1.00 [0.98, 1.00]	■	■
Hudson <i>et al.</i> 2009	11	2	22	61	CDC BMI > 85%	0.33 [0.18, 0.52]	0.97 [0.89, 1.00]	■	■
Kasemsup & Reicks 2006	8	5	27	40	CDC BMI > 85%	0.23 [0.10, 0.40]	0.89 [0.76, 0.96]	■	■
Kroke <i>et al.</i> 2006	24	0	9	220	CDC BMI > 85%	0.73 [0.54, 0.87]	1.00 [0.98, 1.00]	■	■
Manios <i>et al.</i> 2009	165	22	472	1100	CDC BMI > 85%	0.26 [0.23, 0.29]	0.98 [0.97, 0.99]	■	■
Maynard <i>et al.</i> 2003	527	75	725	4173	CDC BMI > 85%	0.42 [0.39, 0.45]	0.98 [0.98, 0.99]	■	■
Tschamler <i>et al.</i> 2010	32	3	27	131	CDC BMI > 85%	0.54 [0.41, 0.67]	0.98 [0.94, 1.00]	■	■
Wald <i>et al.</i> 2007	123	2	128	359	CDC BMI > 85%	0.49 [0.43, 0.55]	0.99 [0.98, 1.00]	■	■
Young <i>et al.</i> 2010	79	1	21	10	CDC BMI > 85%	0.79 [0.70, 0.87]	0.91 [0.59, 1.00]	■	■
Abbott <i>et al.</i> 2010	111	6	330	1701	IOTF Cole	0.25 [0.21, 0.29]	1.00 [0.99, 1.00]	■	■
Carnell <i>et al.</i> 2005	9	3	136	416	IOTF Cole	0.06 [0.03, 0.11]	0.99 [0.98, 1.00]	■	■
Crawford <i>et al.</i> 2006	97	35	209	778	IOTF Cole	0.32 [0.27, 0.37]	0.96 [0.94, 0.97]	■	■
Juliusson <i>et al.</i> 2011	139	71	343	3217	IOTF Cole	0.29 [0.25, 0.33]	0.98 [0.97, 0.98]	■	■
Lampard <i>et al.</i> 2008	88	10	40	191	IOTF Cole	0.69 [0.60, 0.77]	0.95 [0.91, 0.98]	■	■
Mamun <i>et al.</i> 2008	343	98	319	1890	IOTF Cole	0.52 [0.48, 0.56]	0.95 [0.94, 0.96]	■	■
Vuorela <i>et al.</i> 2010	39	3	79	485	IOTF Cole	0.33 [0.25, 0.42]	0.99 [0.98, 1.00]	■	■

BMI, body mass index; CDC, Centre for Disease Control and Prevention; IOTF, International Obesity Task Force; TP, true positive; FP, false positive; FN, false negative; TN, true negative.

In total, 15 studies using verbal descriptions quantitatively reported on perception of only overweight children. Therefore, sensitivity (correct perception of overweight) was calculated for 47 (32 + 15) studies and ranged from 0.04 to 0.89. Figure 3 shows a forest plot of these studies. Again, it is shown that about 37% of the overweight children were perceived correctly by their parents.

Subgroup analyses

The pooled sensitivity and specificity for each subgroup are shown in Table 4. Based on the 95% confi-

dence intervals, there is a significant difference in sensitivity between the different age groups. The percentage of parents who misperceive the overweight of their children is higher in parents of children aged 2–6 years compared with parents of older children. However, there was no significant difference in specificity between the subgroups.

No significant difference in sensitivity or specificity was found between the different cut-off points used to define overweight, or between the more recent and older studies. However, there is a positive trend towards a higher sensitivity in the later studies.

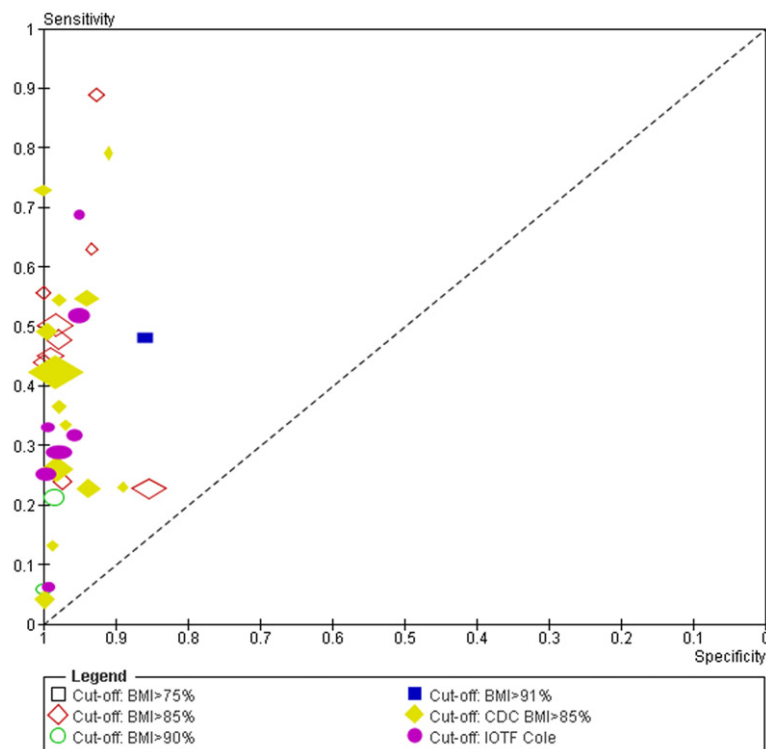


Fig. 2. ROC curve based on the 32 studies using verbal descriptions reporting sensitivity and specificity of parental perception.

Discussion

The purpose of the present systematic review was to identify differences between parental perception and the actual weight status of children. Of the 35 103 children enrolled, 11 530 were overweight (32.9%). Of these, 4339 (37.6%) children were correctly perceived as overweight by their parents, while 7191 (62.4%) were misperceived as normal weight. This implies that there is a large proportion of parents that fail to recognise the overweight weight status of their child. This is especially true for parents of young children. Subgroup analysis revealed that 86% of the parents of children aged 2–6 years fail to recognise overweight of their child.

Figure 3 shows that especially the larger studies (using verbal descriptions) lay close to the pooled result, with the exception of two studies (Goodman *et al.* 2000; Al-Qaoud *et al.* 2010). In terms of results, the smaller studies are often both positive and negative outliers. Of the nine relatively large studies with results close to the pooled results, the metho-

dological quality is relatively high (moderate: 5 articles; good: 3 articles; excellent: 1 article) (Fig. 3, Table 1). Therefore, the pooled results seem to give a reliable estimate of the available data on this subject.

Studies using image scales for the perception of parents show a higher percentage of overweight children perceived correctly by parents compared with studies using verbal descriptions (52.3% vs. 37.6%). This suggests that parents do acknowledge the weight status of their overweight child but do not verbally label it as overweight. The reason for this reluctance might be a negative association with the word overweight because of stigmatisation of obese people in our society, as previously proposed by Neumark-Sztainer *et al.* (2008). However, there are too few studies using image scales in the present review to draw firm conclusions about this.

It is noteworthy that children with a normal weight status are almost never seen as being overweight, while children with overweight are often perceived as normal-weight children. This indicates that parents

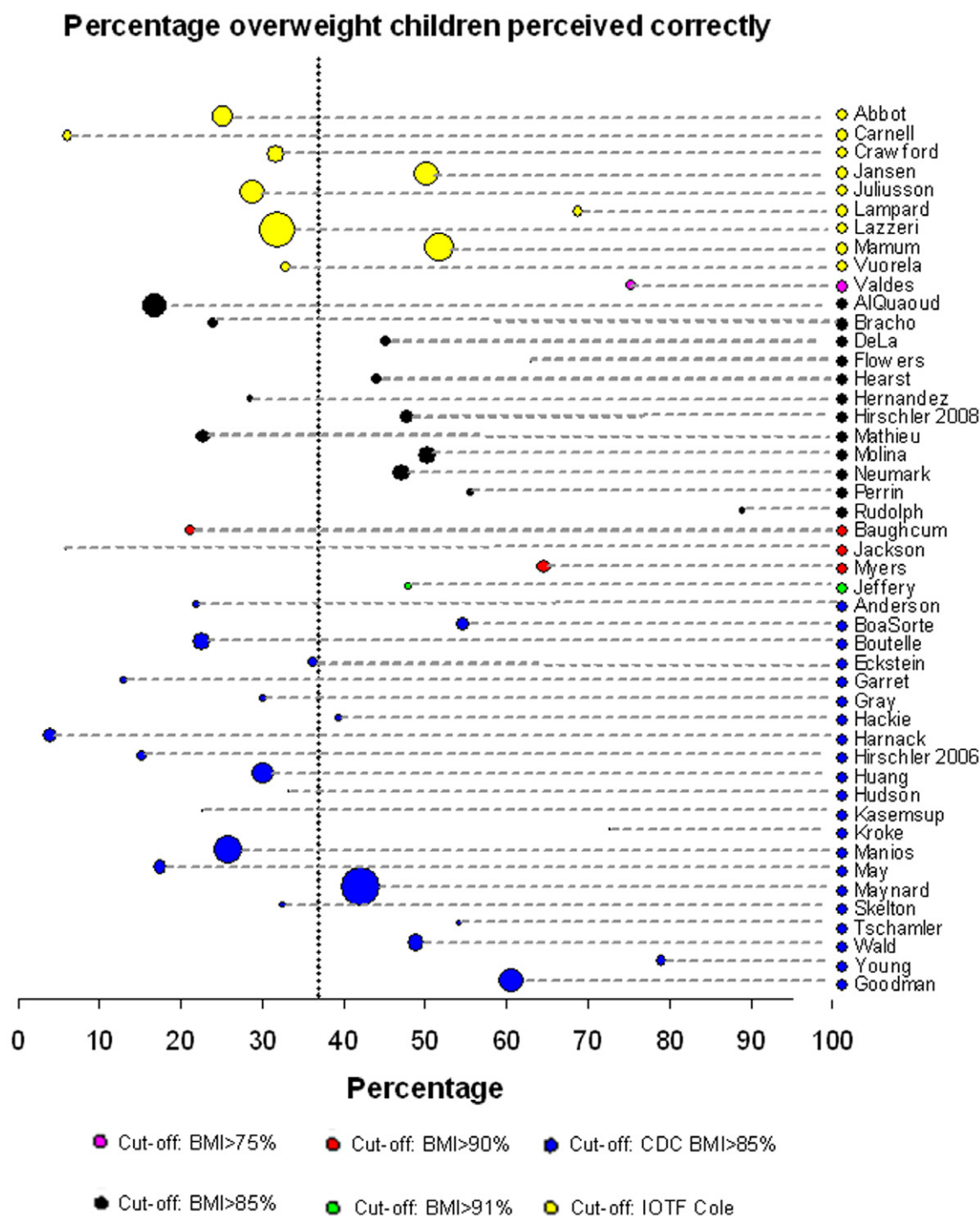


Fig. 3. Forest plot of studies using verbal descriptions reporting the percentage of parents who perceived their overweight children correctly (47 studies). The balls are proportional to study size; the dotted line is the pooled result adjusted for study size.

Table 4. Pooled sensitivity and specificity for different subgroups (*n* = number of studies)

Subgroup	Sensitivity	Specificity
Based on child's age		
Young children (2–6 years), <i>n</i> = 8	0.14 (95% CI: 0.08–0.23)	0.99 (95% CI: 0.97–0.99)
Older children, <i>n</i> = 24	0.47 (95% CI: 0.40–0.55)	0.98 (95% CI: 0.96–0.99)
Based on cut-off for overweight		
BMI > 85% (WHO), <i>n</i> = 9	0.49 (95% CI: 0.35–0.63)	0.98 (95% CI: 0.95–0.99)
BMI > 95% (CDC), <i>n</i> = 13	0.36 (95% CI: 0.23–0.51)	0.98 (95% CI: 0.96–0.99)
IOTF Cole ¹⁹ , <i>n</i> = 7	0.32 (95% CI: 0.19–0.49)	0.98 (95% CI: 0.96–0.99)
Based on year of publication		
Older studies (<2007), <i>n</i> = 10	0.29 (95% CI: 0.16–0.45)	0.97 (95% CI: 0.93–0.98)
Newer studies, <i>n</i> = 22	0.41 (95% CI: 0.31–0.52)	0.98 (95% CI: 0.97–0.99)

CDC, Centre for Disease Control and Prevention; 95% CI, 95% confidence interval; IOTF, International Obesity Task Force; WHO, World Health Organization.

often label their children as normal weight, irrespective of the child's actual weight status. This implies that parental perception of the weight status of a child is an inadequate diagnostic tool for overweight. Weight status of children should therefore not be asked to parents, but height and weight should be measured instead.

Besides stigmatisation, another possible explanation for the poor sensitivity (misperception of overweight status by parent) could be the change in reference frame. Given the current high percentage of overweight children (and parents), the overweight status may be seen as being average and therefore perceived as 'normal' (Binkin *et al.* 2011). However, one might expect a difference between sensitivity in the older and newer studies, and this was not found.

Although different studies used different cut-off points for the definition of overweight, the misperception of overweight seems to be universal. This is shown by our pooled results, where no significant differences were found between sensitivity and specificity scores of the different cut-off points used by IOTF, CDC or WHO.

Strengths and limitations

The most recent reviews (Parry *et al.* 2008; Doolen *et al.* 2009; Towns & D'Auria 2009) searched electronic databases up to August 2007. The present review included 51 studies, of which 32 were not included in the previous reviews and were published

after August 2007. This illustrates the topicality of the subject. Our review revealed no significant differences in sensitivity between the studies included in the earlier reviews and the more recent studies.

Our subgroup analyses revealed that misperception of overweight is even worse for parents of young children. Furthermore, the use of different definitions of actual overweight in terms of accurate perception of overweight did not affect the sensitivity and specificity.

Because by far most studies included child–mother and no child–father couples, no differences in misperception between genders of parents could be tested. It seems obvious to assume that overweight parents are less likely to perceive their child as being overweight. (Chaparro *et al.* 2011) Taking the weight status of the parents into account may help to elucidate whether there is a difference in perception between overweight and normal-weight parents; however, because too few studies reported parents' weight status, no subgroup analyses could be performed on this.

Finally, cultural differences in terms of a healthy weight perception are likely to affect the perception of parents. In the present review, because most studies were conducted in western countries, no comparison could be made with non-western countries.

Implications

Health care professionals should be aware of the frequent misperception of the overweight status of a

child, especially in young children. This is particularly important in view of the consequences of overweight at early age, i.e. a rapid increase in bodyweight during the first year of life is significantly associated with overweight at age 12 years. (Vogels *et al.* 2006) Moreover, childhood-onset overweight accounts for 25% of adult obesity and persists into a higher BMI in adulthood, as compared with adult-onset obesity. (Freedman *et al.* 2001; Dietz & Robinson 2005).

Also, parental awareness of their child's overweight implies concern about the child's health and willingness to take appropriate action. (Wake *et al.* 2002; Soto & White 2010; Moore *et al.* 2012) Therefore, as a first step to counteract overweight, health care professionals should aim to make parents recognise the overweight of their child. For example, physicians could measure height and weight, calculate and interpret BMI and discuss the weight status of a child during a consultation, irrespective of the reason for consultation.

Conclusion

The 51 studies (covering 35 103 children) show that parents are likely to misperceive the weight status of their overweight child, especially in young children. Despite the recent focus on the prevention and treatment of overweight in children, only 37.6% of the overweight children were perceived as being overweight by their parents. The most important implication of these results is that health care professionals should be aware of this frequent misperception and help make parents aware of the overweight of their child so that treatment options can be discussed.

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Conflicts of interest

The authors declare that they have no conflicts interest.

Contributions

MR-M participated in the design of the study, selected the articles, extracted the data and drafted the manuscript. WDP participated in the design of the study, selected the articles, extracted the data, performed analyses and helped to draft the manuscript. MvM helped to analyse the data and draft the manuscript. PJEB revised the manuscript critically for important intellectual content. JCvdW participated in its design of the manuscript and has been involved in drafting the manuscript. All co-authors participated in manuscript preparation and critically reviewed all sections of the text for important intellectual content.

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Appendix I

Search string and hits

Publication date to 2011/01/17

PubMed: 1958

(Child*[tw] OR (adolescent[MeSH] NOT adult-[mesh]))

AND

(Parent*[tw] OR father*[tw] OR mother*[tw] OR matern*[tw] OR patern*[tw])

AND

(body mass index*[tw] OR overweight[tw] OR obes*[tw] OR BMI [tw] OR Quetelet*[tw] OR weight status*[tw] OR weight gain[tw] OR weight concern*[tw] OR weight control*[tw])

AND

(percepti*[tw] OR view*[tw] OR perceiv*[tw] OR aware*[tw] OR recogni*[tw] OR notion[tw] OR judg*[tw] OR classif*[tw] OR concern*[tw] OR reported weight[tw])

Appendix 2

Study results

	Definition of weight status	Number of participants suitable for this analysis (n)	True negative*	False positive†	False negative‡	True positive§
Verbal description						
Weight status IOTF based on Cole <i>et al.</i>						
Abbott <i>et al.</i> 2010	IOTF Cole	2148	1701	6	330	111
Carnell <i>et al.</i> 2005	IOTF Cole	564	416	3	136	9
Crawford <i>et al.</i> 2006	IOTF Cole	1116	778	35	209	97
Jansen & Brug 2006	IOTF Cole	524	n.a.	n.a.	261	263
Juliusson <i>et al.</i> 2011	IOTF Cole	3770	3217	71	343	139
Lampard <i>et al.</i> 2008	IOTF Cole	329	191	10	40	88
Lazzeri <i>et al.</i> 2006	IOTF Cole	2835	n.a.	n.a.	656	306
Mamum <i>et al.</i> 2008	IOTF Cole	2650	1890	98	319	343
Vuorela <i>et al.</i> 2010	IOTF Cole	606	485	3	79	39
Weight status by WHO						
Al-Qaoud <i>et al.</i> 2010	BMI>85 th overweight	482	n.a.	n.a.	401	81
Bracho & Ramos 2007	BMI>85 th overweight	270	149	4	89	28
De La <i>et al.</i> 2009	BMI>85 th overweight	576	481	5	50	41
Flowers 2008	BMI>85 th overweight	57	28	2	10	17
Hearst <i>et al.</i> 2011	BMI>85 th overweight	358	242	0	217	9
Hernandez <i>et al.</i> 2010	BMI>85 th overweight	49	n.a.	n.a.	35	14
Hirschler <i>et al.</i> 2008	BMI>85 th overweight	620	409	9	106	97
Mathieu <i>et al.</i> 2010	BMI>85 th overweight	1128	791	135	156	46
Neumark <i>et al.</i> 2008	BMI>85 th overweight	307	n.a.	n.a.	162	145
Perrin <i>et al.</i> 2010	BMI>85 th overweight	96	51	0	20	25
Rudolph <i>et al.</i> 2010	BMI>85 th overweight	150	88	7	6	48
Weight status by CDC						
Anderson <i>et al.</i> 2005	BMI>85 th overweight	82	n.a.	n.a.	64	18
Boa-Sorte <i>et al.</i> 2007	BMI>85 th overweight	827	634	41	69	83
Boutelle <i>et al.</i> 2004	BMI>85 th overweight	742	442	30	209	61
Eckstein <i>et al.</i> 2006	BMI>85 th overweight	223	132	3	56	32
Gray <i>et al.</i> 2007	BMI>85 th overweight	169	n.a.	n.a.	49	21
Harnack <i>et al.</i> 2009	BMI>85 th overweight	593	366	1	217	9
Hirschler <i>et al.</i> 2006	BMI>85 th overweight	321	n.a.	n.a.	111	20
Huang <i>et al.</i> 2007	BMI>85 th overweight	429	n.a.	n.a.	300	129
Hudson <i>et al.</i> 2009	BMI>85 th overweight	96	61	2	22	11
Kroke <i>et al.</i> 2006	BMI>85 th overweight	253	220	0	9	24
Manios <i>et al.</i> 2009	BMI>85 th overweight	1759	1100	22	472	165
May <i>et al.</i> 2007	BMI>85 th overweight	228	n.a.	n.a.	188	40
Maynard <i>et al.</i> 2003	BMI>85 th overweight	5500	4173	75	725	527
Skelton <i>et al.</i> 2006	BMI>85 th overweight	37	n.a.	n.a.	25	12
Tschamler <i>et al.</i> 2010	BMI>85 th overweight	193	131	3	27	32
Wald <i>et al.</i> 2007	BMI>85 th overweight	612	359	2	128	123
Weight status other						
Baughcum <i>et al.</i> 2000	BMI>90 th overweight	304	202	3	78	21
Garret 2009	BMI>95 th overweight	120	73	1	40	6
Goodman <i>et al.</i> 2000	BMI>95 th obese	564	n.a.	n.a.	222	342
Hackie & Bowles 2007	BMI>95 th overweight	38	n.a.	n.a.	23	15
Jackson <i>et al.</i> 1990	BMI>90 th overweight	107	90	0	16	1
Jeffery <i>et al.</i> 2005	BMI>91 th overweight, BMI>98 th obese	272	189	31	27	25

Appendix 2 Continued

	Definition of weight status	Number of participants suitable for this analysis (n)	True negative*	False positive†	False negative‡	True positive§
Kasemsup & Reicks 2006	BMI>95 th overweight	80	40	5	27	8
Molina Mdel <i>et al.</i> 2009	Must <i>et al.</i> ^{19,20}	1272	959	16	148	149
Myers & Vargas 2000	BMI>90 th overweight	200	n.a.	n.a.	71	129
Valdes <i>et al.</i> 2009	BMI>75 th (at risk for) overweight, BMI>95 th obese	141	n.a.	n.a.	35	106
Young <i>et al.</i> 2010	BMI>95 th overweight	111	10	1	21	79
Images scales						
Weight status IOTF based on Cole <i>et al.</i>						
Warschburger & Kroller 2009	IOTF Cole	142	n.a.	n.a.	10	17
Weight status by WHO						
Hernandez <i>et al.</i> 2010	BMI>85 th overweight	150	90	11	33	16
Reifsnider <i>et al.</i> 2006	BMI>85 th overweight	25	4	9	7	5
Zonana-Nacach & Conde-Gaxiola 2010	BMI>85 th overweight	525	351	12	64	98
Weight status by CDC						
Eckstein <i>et al.</i> 2006	BMI>85 th overweight	223	127	8	52	36
Weight status other						
Beatty 2009	Unknown	130	76	0	21	33

*Actual weight status normal weight, perception normal weight. †Actual weight status normal weight, perception overweight. ‡Actual weight status overweight, perception normal weight. §Actual weight status overweight, perception overweight. BMI, body mass index; CDC, Centre for Disease Control and Prevention; IOTF, International Obesity Task Force; n.a., not available; WHO, World Health Organization.