The relationships between caregivers’ self-reported and visual perception of child weight and their non-responsive feeding practices: A systematic review and meta-analysis

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ABSTRACT

Background: The impacts of caregivers’ perception of child weight on their non-responsive feeding practices are inconclusive. This systematic review aimed to examine their relationships.

Methods: A systematic search of five databases was conducted from inception to March 2022, following PRISMA guidelines. Data synthesis was performed using semi-quantitative approach and meta-analysis.

Results: Twenty-two studies with 12005 respondents were included for semi-quantitative analyses. Eighteen studies examined 26 associations between caregivers’ perception of child weight and food restriction with 12 statistically significant associations being observed. A total of 22 relationships between caregivers’ perception of child weight and pressure to eat were investigated, with 13 being statistically significant. The statistically significant associations consistently reported that caregivers’ visual and self-reported perception of child weight was positively associated with their restrictive feeding and negatively associated with pressure to eat. The pooled odds ratios (ORs) indicated that caregivers who perceived their child as overweight were found to apply pressure to eat less frequently (OR = 0.61; 95%CI: 0.44, 0.84) compared with those who did not. However, caregivers’ perception of child weight was not statistically significantly associated with restrictive feeding (OR = 1.37; 95% CI: 0.74, 2.55).

Conclusion: Caregivers’ self-reported and visual perception of child weight may be important risk factors for non-responsive feeding practices, particularly food restriction and pressure to eat. Thus, interventions need to consider the role of caregivers’ perception of child weight, which may optimize feeding practices. Furthermore, longitudinal and intervention-based studies using validated measurements while controlling for potential covariates are needed to provide more evidence on their causal relationships.

1. Introduction

The rise in childhood overweight and obesity has become a major public health concern, which affected 39 million children under the age of 5 in 2020 globally (World Health Organization, 2022). Childhood overweight and obesity has been associated with physical and mental health issues and increased risk of adulthood overweight and obesity (Geng, Smith, Li, & Huang, 2018; Gordon-Larsen, Adair, Nelson, & Popkin, 2004; Körner et al., 2007).

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Strategies of child weight management include caregivers (e.g., parents, grandparents) because they play key roles in their children’s/grandchildren’s eating behaviors and nutrition (Lindsay, Sussner, Kim, & Gortmaker, 2006; Simmonds, Llewellyn, Owen, & Woolacott, 2016). Unlike adults, young children may not be capable of establishing their food environment independently. Caregivers’ feeding practices are therefore critical in shaping children’s eating habits and a key target in efforts to prevent childhood overweight and obesity (Golan & Crow, 2017; Moore, Tapper, & Murphy, 2010; Zhou, Liew, Yeh, & Perez,
Feeding practices refer to specific behaviors or strategies that caregivers employ to manage what, when and how much their children eat and shape their children’s eating patterns (Boots, Tiggemann, & Corsini, 2018; Ventura & Birch, 2008). There are two types of caregivers’ feeding practices: non-responsive and responsive feeding (Jansen, Williams, Mallan, Nicholson, & Daniels, 2018; Savage, Rollins, Kugler, Birch, & Marini, 2017; Shi et al., 2017). Responsive feeding practices (e.g., encouragement of healthy eating, modelling and monitoring) means feeding practices that encourage children to eat autonomously and in response to physiological and developmental needs, which may encourage self-regulation in eating and support cognitive, emotional, and social development (Pérez-Escamilla, Jimenez, & Dewey, 2021; Pérez-Escamilla & Segura-Pérez, 2020). This is a reciprocal relationship between children and their caregivers (Black & Aboud, 2011; Rossiter, Richard, Whitfield, Mann, & McIsaac, 2022). Non-responsive feeding practices (i.e., restrictive feeding, pressure to eat, food as a reward and emotional feeding) refer to caregivers’ self-centred feeding strategies including coercion and psychological control. They serve the caregivers’ goals and desires and may not take the children’s emotional or psychological needs into account (Vaughn et al., 2013, 2016). Non-responsive feeding practices have been widely studied and raised great concerns due to their positive associations with children’s obesity (Beckers, Karssen, Vink, Burk, & Larsen, 2021; Boucheron et al., 2020; Dev, McBride, Fiese, Jones, & Cho, 2013; Faith, Scanlon, Birch, Francis, & Sherry, 2004; Ruzicka, Darling, & Sato, 2021). For example, a meta-analysis of 51 studies, with 17431 parent-child dyads reported that the use of food restriction and pressure to eat by caregivers was associated with an increased risk of child obesity (Ruzicka et al., 2021).

Many empirical studies have identified factors related to non-responsive feeding practices, such as socioeconomic and psychological characteristics (Chang, Mendelson, Fierman, Au, & Messito, 2017; Eicher et al., 2019; Francis, Hofer, & Birch, 2001; Freitas et al., 2019; Robertson, Dempster, Doherty, & Sharpe, 2022; Ruzicka et al., 2021), of which caregivers’ perception of child weight has been a significant factor (Chang et al., 2017; Francis et al., 2001; Freitas et al., 2019; Robertson et al., 2022). For example, a cross-sectional study conducted in the United States (US) (n = 196) reported that maternal self-reported perception of 5-year-old child weight was statistically significantly associated with restrictive feeding and pressure to eat, using structural equation modelling (Francis et al., 2001). Similarly, Loth et al. (Loth, Mohamed, Trotholz, Tate, & Berge, 2021) found that parents who perceived their child as overweight were more likely to use restriction of food than those who perceived their child as underweight or normal weight. Evidence-based theories of information processing and behavioral learning, such as Gagne’s Information Processing Model, have suggested that cognitive changes (e.g., perception of child weight) may lead to specific behaviors (e.g., feeding practices). Consistently, a middle-range explanatory theory indicated that family lifestyle changes (e.g., feeding practices) may be attributed to their perception of child weight (Mareno, 2014). However, some studies reported the lack of evidence for statistically significant associations (Gebre, Gebreyesus, Habtemariam, Yirgu, & Abebe, 2021; May et al., 2007; Tylka, Eneli, Kroon Van Diet, & Lumeng, 2013). For instance, a cross-sectional study conducted in Ethiopia (n = 542) used multiple linear regression analyses and reported that caregivers’ perception of preschool child weight was not statistically associated with their restriction of food and pressure to eat (Gebre et al., 2021). Overall, despite the progressive evidence linking caregivers’ perception of child weight to their non-responsive feeding practices, the current findings of their relationships have been inconsistent.

Except for the evidence above, some studies suggested that caregivers’ visual perception of child weight was an important risk factor for their non-responsive feeding practices (Holub & Dolan, 2012; Salinas Martínez et al., 2020; Yilmaz, Ü, Ozcetin, & Karaaalan, 2013). For example, Holub et al. (Holub & Dolan, 2012) found that maternal visual perception of child overweight was associated with their restrictive feeding. On the other hand, they may apply pressure to eat if they perceived their child as underweight. In contrast, a cross-sectional study in Mexico (n = 507) showed that maternal visual perception of child overweight/obesity was not statistically significantly associated with their restrictive feeding and emotional feeding and was negatively associated with pressure to eat (Salinas Martínez et al., 2020). Additionally, Yilmaz et al. (Yilmaz et al., 2013) found that maternal visual perception of child weight had no statistically significant correlation with pressure to eat and restriction of food but had a negative correlation with their emotional feeding. Although the evidence above indicates that caregivers’ visual perception of child weight may be associated with their non-responsive feeding practices, the results of their relationships were less clear. Thus, there is a need to summarize the current evidence to identify the influence of caregivers’ self-reported and visual perception of child weight on their non-responsive feeding practices.

Notably, many studies reported that caregivers tended to misperceive their children’s weight status. As the prevalence of childhood obesity increased, they may shift their perception of child normal weight, resulting in perceiving heavy weight as normal weight (Oldham & Robinson, 2018). Consistently, the visual normalization theory (Oldham & Robinson, 2018; Robinson, 2017) indicated that caregivers evaluate their children’s weight status in reference to visual body-weight norms. That is, if they are accustomed to larger body sizes, they may be more likely to underestimate their children’s weight. In this case, they might apply some inappropriate feeding practices (e.g., pressure to eat) to enforce their children to eat more food, which may eventually make their children appear to be “normal weight” (Ruzicka et al., 2021). Moreover, many caregivers do not often perceive children’s overweight or obesity as a health issue because they may believe higher weight indicates better nutrition (Doolen, Alpert, & Miller, 2009; Rietmeijer-Mentink, Paulis, van Middelkoop, Bindels, & van der Wouden, 2013). They also tend to use food as a symbol of their love, or as an educational and emotional tool for shaping their children’s behaviors (Jiang et al., 2007). Given the consequences of non-responsive feeding practices, it is essential to identify the impacts of caregivers’ perception of child weight on their non-responsive feeding practices, which could provide caregivers with some guidance on the importance of their perception of child weight.

To sum up, the current findings about the relationships between caregivers’ perception of child weight and their non-responsive feeding practices were equivocal. This systematic review and meta-analysis aimed to summarize the existing evidence on their associations. To the best of our knowledge, this is the first systematic review and meta-analysis to summarize the relationships between caregivers’ perception of child weight (including self-reported and visual weight perception) and their non-responsive feeding practices. Findings from this review will enhance our understanding of their relationships and inform future interventions to optimize caregivers’ feeding practices. Furthermore, our review aimed to summarize the impacts of caregivers’ self-reported and visual perception of child weight on their non-responsive feeding practices. The findings will help to identify their impacts on caregivers’ non-responsive feeding practices, which may provide guidance on developing personalized interventions to improve caregivers’ feeding practices and eventually manage childhood obesity.

2. Methods

2.1. Data sources and search strategy

The systematic review and meta-analysis followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Page et al., 2021) and the Meta-analysis of Observational Studies in Epidemiology (MOOSE) (Stroup et al., 2000). This review was registered on PROSPERO (registration number: 2020).
A systematic search (from inception to March 2022) was carried out on PubMed, Embase, PsycINFO, Web of Science core collection, and CINAHL. To minimize publication bias, we also searched for additional studies in grey literature sources including Grey literature report (http://greylit.org/), and Open grey EU (http://opengrey.eu/). The search was limited to publications published in English. The free text and Medical Subject Headings (MeSH) terms used for the search included: child, preschool, school child, paediatric, youth, pre-teen, caregiver, parent, grandparent, mother, father, guardian, perception, view, recognition, weight, body size, body mass index, feeding practice, food parenting, food control, pressure to eat, restriction. The detailed search strategy was provided in Supplemental Table 1. A manual search of the bibliography of the included studies was performed to identify additional studies.

2.2. Inclusion and exclusion criteria

All studies were included if they met the following criteria:

1. Study design was cohort, case-control, or cross-sectional study.
2. Studies that examined the relationships between caregivers’ perception of child weight and their non-responsive feeding practices.
3. The exposure was caregivers’ perception of child weight, including visual and self-reported perception of child weight.
4. The outcomes were caregivers’ non-responsive feeding practices.
5. Children aged 1–11 years at baseline (from toddler to middle childhood) (Centers for Disease Control and Prevention, 2022).

Evidenced showed that it is a critical period for the development of children’s self-regulation (Montroy, Bowles, Skibbe, McClelland, & Morrison, 2016; Zimmer-Gembeck & Skinner, 2010) and is characterised by growing independence including in relation to eating (Mah & Ford-Jones, 2012). The majority of children’s transition to table food occurs between the ages of 12 and 24 months, when caregivers may gradually adopt specific feeding practices to regulate their children’s eating (Birch & Doub, 2014).

In addition, the age range of the children in our review was similar to that of the children in the tools (e.g., Child Feeding Questionnaire and Comprehensive Feeding Practices Questionnaire) measuring caregivers’ feeding practices (Birch et al., 2001; Musher-Eizenman & Holub, 2007).

Studies were excluded if they:

1. Were reviews, editorials, commentaries, letters, or methodological papers.
2. Were non-English papers.
3. Did not report the statistics for the relationships between caregivers’ perception of their child weight and their non-responsive feeding practices.
4. Focused on children with diseases that might influence their eating.

2.3. Study screening and data extraction

The PRISMA flow chart was followed during the screening stage (Page et al., 2021). One investigator (JW) screened the title and abstract for initial inclusion. We excluded the articles from initial screening if they did not report related endpoints or exposures. The articles were not retrieved for full text if they were non-human based studies, or they were reviews, editorials, commentaries, letters, and abstracts only. A second reviewer (XW) randomly verified 10% of title and abstracts. Full texts were reviewed independently by the two investigators (JW and XW) for further screening. Data extracted was compared and summarized into one final document on which analysis was conducted. The information extracted included: name of the first author, year of publication, country that the study was conducted in, study design, sample size, response rate, variables of interest and their measures, findings. Quantitative results that may represent the associations between caregivers’ perception of child weight and non-responsive feeding practices, including regression coefficients (β) or risk ratio (OR) and their 95% confidence intervals (CI) or standard errors (SE), were extracted. We contacted the corresponding authors if a study did not provide necessary numerical results. For any disagreements that occurred during the screening and data extraction stages between the two investigators, the review team was consulted (Y-SC, KW and YC).

2.4. Exposure and outcomes

**Body weight perception** represents how individuals make judgements of body weight, size, and shape (Gauthier & Gance-Cleveland, 2015; Maren, 2014; Robinson, 2017), and are categorized into visual weight perception and self-reported weight perception. Caregivers’ perception of child weight means that caregivers’ judgment of their child’s body weight (Maren, 2014) which may be formulated by caregivers’ recognition of body size, physical appearance, functional abilities, psychosocial effects and health effects related to current body weight (Gauthier & Gance-Cleveland, 2015).

Based on the conceptual analyses of caregivers’ feeding practices (Musher-Eizenman et al., 2019; Di Pasquale & Rivolta, 2018; O’Connor et al., 2017), the non-responsive feeding practices were classified into four categories including restriction, pressure to eat, use of food as a reward, and emotional feeding.

1. **Restriction** means that the caregivers enforce strict limitations on children’s access to food or opportunities to consume specific food (Vaughn et al., 2016). Typically, restrictive feeding is used to control children’s intake of unhealthy food (e.g., high-fat and high-sugar food) (Arlinghaus et al., 2019; Birch et al., 2001; Rodgers et al., 2013; Yuan et al., 2019) and children’s weight (Arlinghaus et al., 2019). These are two common types of restrictive feeding.

2. **Pressure to eat** means that caregivers insist, demand, or physically struggle with the child to have the child eat more food or specific food (Arlinghaus et al., 2019; Birch et al., 2001; Vaughn et al., 2016; Yuan et al., 2019).

3. **Using food as a reward** is also called instrumental feeding, which bribes and threatens children to eat food (Jansen, Williams, Mallan, Nicholson, & Daniels, 2016; Vaughn et al., 2016). For example, parents may attempt to shape their children’s behaviors using highly desired food as enticements (e.g., stickers).

4. **Emotional feeding** means that caregivers use food to manage or calm children when they are upset, fussy, angry, or bored (Kidwell, Tomaso, Lundahl, & Nelson, 2020; Vaughn et al., 2016). For example, using food to soothe, intrigue, and/or relieve.

2.5. Study quality assessment

The Joanna Briggs Institute (JBI) critical appraisal checklist for analytical cross-sectional studies, and the JBI critical appraisal checklist for cohort studies were used for quality appraisal (Moola et al., 2020). These tools help assess the methodological quality of a study and determine the extent to which a study has addressed the possibility of bias in its design, conduct and analysis. Two reviewers (JW and XW) independently performed the assessment. The final assessment was achieved upon discussion, and no studies were identified for exclusion by reviewers (See Supplementary Tables 2 and 3).

2.6. Statistical analysis

We used a semi-quantitative approach to summarize the findings of
all the included articles, as adopted by recent reviews (Collins, Dun-canson, & Burrows, 2014; Wang et al., 2022a; Zhu, Norman, & While, 2011) due to not all included studies had necessary numerical results for meta-analysis. The studies with necessary numerical results were included in the meta-analysis. If an association between the same exposure and outcome was multiply evaluated in one study, the results were first synthesized within the study, and the summarized data were then used for the meta-analysis. All effect sizes ($\beta$ or OR) were selected in each article and were pooled. For studies that did not report OR, crude OR was calculated using the numbers of cases with and without the use of specific non-responsive feeding practices between two groups. For the pooled results, a 95% CI that did not include 0 was considered statistically significant. The heterogeneity of the included studies was investigated using $I^2$ statistics (Higgins, Thompson, Deeks, & Altman, 2003). The random-effects model was used in case of high heterogeneity indicated by an $I^2 > 50$%; otherwise, the fixed-effects model was used (Higgins & Green, 2018; Higgins & Thompson, 2002). The possibility of publication bias was assessed by the combination of Egger’s test (Egger, Davey Smith, Schneider, & Minder, 1997). As no specific associations were evaluated in more than three studies, funnel plots were not provided. All analyses were performed in Stata 17.0 (StataCorp, College Station, TX, USA). All tests were two-sided, and the statistical significance was set as $P$-value $< 0.05$.

3. Results

3.1. Search results

A total of 35780 articles were identified. Removal of duplicates resulted in 23194 articles for initial screening. 22955 articles were excluded based on titles and abstracts and 239 articles were retrieved for full text screening. After screening the full texts of the 239 articles, 22 studies were included. The PRISMA flow chart is shown in Fig. 1.

3.2. Characteristics of the studies

Characteristics of the studies are shown in Table 1. Studies were published between 2001 and 2022, conducted in the US (n = 8) (Ayine, Selvaraju, Venkatapoorna, & Geetha, 2020; Chang et al., 2017; Francis et al., 2001; Holub & Dolan, 2012; Loth et al., 2021; May et al., 2007; Tylka et al., 2013; Wehrly, Bonilla, Perez, & Liew, 2014), Brazil (n = 3) (de Souza Rezende, Bellotto de Moraes, Mais, Warkentin, & Augusto de Aguiar Carrazedo Taddei, 2019; Freitas et al., 2019; Mais, Warkentin, Latorre, Carnell, & Taddei, 2017), Australia (n = 2) (Crouch, O’Dea, & Battisti, 2007; Tiggemann & Lowes, 2002), UK (n = 2) (Robertson et al., 2022; Webber, Hill, Cooke, Carnell, & Wardle, 2010), Sweden (n = 1) (Nowicka, Sorjonen, Pietrobelli, Flodmark, & Faith, 2014), China (n = 1) (Wang et al., 2022b), Ethiopia (n = 1) (Gebru et al., 2021), Mexico (n = 1) (Salinas Martínez et al., 2020), India (n = 1) (Jani Mehta, Mallan, Mihreshahi, Mandalika, & Daniels, 2014), Turkey (n = 1) (Yilmaz et al., 2013), and Portugal (n = 1) (Costa, Hetherington, & Oliveira, 2021). The study design was cross-sectional (n = 21) and cohort (n = 1) (Costa et al., 2021). All included studies reported cross-sectional relationships between caregivers’ perception of child weight and their feeding practices. The caregivers were typically mothers (n = 13). Only one study used random sampling method (Gebru et al., 2021). The total sample size was 12005, with individual study sample size ranging from 50 (Holub & Dolan, 2012) to 3233 (Costa et al., 2021).

3.3. Measurements for caregivers’ perception of child weight

Tools used for the assessment of caregivers’ perception of child weight are shown in Table 2. The most common tool (n = 14) was the Child Feeding Questionnaire (CFQ) (Birch et al., 2001), which was intended to assess caregivers’ self-reported perception of their child weight. Three studies used age range specific sketches to measure caregivers’ visual perception of child weight, of which two (Salinas Martínez et al., 2020; Yilmaz et al., 2013) used an array of seven figures...
and the other (Holub & Dolan, 2012) used an array of nine figures (Rand & Wright, 2000).

3.4. Measurements for caregivers’ non-responsive feeding practices

Tools used for the assessment of caregivers’ feeding practices are shown in Table 2. The most common tool (n = 14) was the Child Feeding Questionnaire (CFQ) (Birch et al., 2001), which was intended for use by caregivers of children aged 2–11 years. Others included the Comprehensive Feeding Practices Questionnaire (CFPQ) (Mushzer-Eizenman & Holub, 2007) (n = 5) (de Souza Rezende et al., 2019; Freitas et al., 2019; Holub & Dolan, 2012; Mais et al., 2017; Robertson et al., 2022), and the Parental Feeding Style Questionnaire (PFSQ) (Wardle, Sanderson, Guthrie, Rapoport, & Plomin, 2002) (n = 1) (Yilmaz et al., 2013). Two studies (Salinas Martínez et al., 2020; Tiggemann & Lowes, 2002) conducted principal component analyses (PCA) to explore the components of maternal feeding practices.

3.5. The associations between caregivers’ perception of child weight and their feeding practices

Table 3 summarizes the associations between caregivers’ perception of child weight and their non-responsive feeding practices. Fourteen studies controlled for potential covariates and eight studies used bivariate analyses which did not control for confounding variables. The included studies focused on examining the relationships between caregivers’ perception of child weight and their restriction and pressure to eat. Specifically, eighteen studies examined the relationships between caregivers’ perception of child weight and restrictive feeding practices and 12 statistically significant associations were observed. The results consistently reported that caregivers’ perception of child weight was positively associated with their restrictive feeding (Ayine et al., 2020; Francis et al., 2001; Holub & Dolan, 2012; Tiggemann & Lowes, 2002; Wehrly et al., 2014). Three studies examined four cross-sectional relationships between caregivers’ visual perception of child weight and restrictive feeding (Holub & Dolan, 2012; Salinas Martínez et al., 2020; Yilmaz et al., 2013), of which two found statistically significant associations that were positively associated with restriction for weight and health (Holub & Dolan, 2012). A detailed summary of the associations is reported in Table 2.

A total of 22 statistical estimates of the relationships between caregivers’ perception of child weight and pressure to eat were investigated in seventeen studies, with over half of the associations being statistically significant. The results consistently reported that caregivers’ perception of child weight and their non-responsive feeding practices. Fourteen studies controlled for potential covariates and eight studies used bivariate analyses which did not control for confounding variables. The included studies focused on examining the relationships between caregivers’ perception of child weight and their restriction and pressure to eat. Specifically, eighteen studies examined the relationships between caregivers’ perception of child weight and restrictive feeding practices and 12 statistically significant associations were observed. The results consistently reported that caregivers’ perception of child weight was positively associated with their restrictive feeding (Ayine et al., 2020; Francis et al., 2001; Holub & Dolan, 2012; Tiggemann & Lowes, 2002; Wehrly et al., 2014). Three studies examined four cross-sectional relationships between caregivers’ visual perception of child weight and restrictive feeding (Holub & Dolan, 2012; Salinas Martínez et al., 2020; Yilmaz et al., 2013), of which two found statistically significant associations that were positively associated with restriction for weight and health (Holub & Dolan, 2012). A detailed summary of the associations is reported in Table 2.

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Table 2  
Related measurements and the estimates of the relationships between caregivers’ perception of their child weight and their non-responsive feeding practices \((n = 22)\).

| First author, year | Exposure and measure | Outcome and measure | Estimates | Statistical Analysis and covariates in the related model |
|---------------------|----------------------|---------------------|-----------|---------------------------------------------------|
| Aynie, 2020 (Aynie et al., 2020) | CFQ Parental perception of child weight | CFQ | 1) \(\beta = 0.171, P < 0.05\), 2) \(\beta = -0.065, P > 0.05\). | Pearson’s correlation Did not control for covariates |
| Chang, 2017 (Chang et al., 2017) | NHANES One item Parental perception of child weight (Perception of non-overweight vs. Perception of overweight) | CFQ | 1) \(NR, P > 0.05\), 2) Adjusted OR = 0.57 \(95\% CI: 0.21, 0.92\) | Multiple linear regressions Covariates: child’s age and gender, maternal education level, marital status, maternal overweight status, parent respondent |
| Francis, 2001 (Francis et al., 2001) | CFQ Maternal perception of child weight (Continuous variable) | CFQ | 1) \(\beta = 0.23, P < 0.05\), 2) \(\beta = -0.28, P < 0.05\). | SEM Covariates: maternal weight concern and restraint, daughters’ adiposity, concern for daughters’ weight, family income, maternal education, maternal depression, general parenting style |
| Freitas, 2019 (Freitas et al., 2019) | CFQ Maternal perception of child weight (Perception of non-overweight vs. overweight) | CFPQ Restriction (for weight control) | OR = 4.61, \(95\% CI: 1.848, 11.524\) | Multiple logistic regression Covariates: mother’s BMI, child’s age and gender |
| Webber, 2010 (Webber et al., 2010) | One item (5-point Likert scale) Maternal perception of child weight (Perception of overweight vs. normal weight vs. underweight) | CFQ | 1) \(\beta = -0.023, P = 0.001\). | Linear regression analysis Covariates: BMI SD-score |
| Loth, 2021 (Loth et al., 2021) | One item Parental perception of child weight (Perception of overweight vs. normal weight vs. underweight vs. Don’t know) | CFQ | 1) \(P < 0.05\) 2) \(P < 0.05\) | Multiple regression model Covariates: child’s sex, age and race, parent weight and education status, household income status and receipt of public assistance. |
| Robertson, 2022 (Robertson et al., 2022) | CFQ One item Parental perception of child weight (Perception of overweight vs. normal weight vs. underweight) | CFPQ | Perception of normal weight vs. overweight 1) \(\beta = 0.20, t = 4.59, P < 0.001\). 2) \(\beta = 0.04, t = 0.85, P = 0.394\). Perception of normal weight vs. underweight 1) \(\beta = -0.08, t = -1.75, P = 0.082\). 2) \(\beta = -0.02, t = -0.36, P = 0.721\). | Hierarchical Regression Analyses Covariates: parent sex, child sex, parent age, child age, household income, parent level of education, country of residence |
| May 2007 (May et al., 2007) | CFQ Maternal perception of child weight (Perception of non-overweight vs. overweight) | CFQ | 1) Adjusted OR = 1.02 \(95\% CI: 0.99, 1.06\) 2) Pressure to eat all: Adjusted OR = 0.68 \(95\% CI: 0.32, 1.46\). | Multiple logistic regression Covariates: child’s sex, age and race/ethnicity |
| Gebru, 2021 (Gebru et al., 2021) | CFQ Caregivers’ perception of child weight (Continuous variable) | CFQ | 1) \(\beta = -0.01 \(95\% CI: -0.13, 0.15\). 2) \(\beta = -0.07 \(95\% CI: -0.08, 0.22\). | Multiple linear regression Covariates: child’s age and sex, child’s BMI z score, child’s mental health status, caregiver’s depression status, caregiver’s perceived feeding responsibility, perceived caregiver weight, concern about child overweight/overweight, caregivers’ education level and socioeconomic status |
| Crouch, 2007 (Crouch et al., 2007) | CFQ Maternal perception of child weight (Continuous variable) | CFQ | 1) \(\beta = -0.01, P > 0.05\). | Multiple linear regression Covariates: mothers’ perceived responsibility, concern, education, BMI, perceived maternal weight; child gender and BMI; family income. |
| de Souza Rezende, 2019 (de Souza Rezende et al., 2019) | CFQ Maternal perception of child weight (Perception of underweight vs. non-underweight) | CFPQ Pressure to eat | OR = 1.58 \(95\% CI: 1.09, 2.30\) | Linear regression analysis Did not control for covariates |
| Jani Mehta, 2014 (Jani Mehta et al., 2014) | NOURISH Questionnaire Maternal perception of child weight (Perception of underweight vs. non-underweight) | CFQ Pressure to eat | 1) \(\beta = 0.06 \(95\% CI: 0.2, 0.3\). 2) \(\beta = 0.04 \(95\% CI: 0.2, 0.3\). | Independent sample \(t\)-test Did not control for covariates |

(continued on next page)
Table 2 (continued)

| First author, year | Exposure and measure | Outcome and measure | Estimates | Statistical Analysis and covariates in the related model |
|---------------------|----------------------|---------------------|-----------|--------------------------------------------------------|
| Yilmaz, 2013 (Yilmaz et al., 2013) | Age range specific Sketches Parental (visual) perception of child weight (Perception of overweight vs. normal weight vs. underweight) | 1) Instrumental feeding 2) Strict control 3) Emotional feeding | 1) 9 (7.10–7.5) vs. 10 (7–11) vs. 9.5 (8.12–2.5); P = 0.154 2) 11.92 ± 3.82 vs. 12.50 ± 3.36 vs. 12.68 ± 3.61; P = 0.487 3) 11.83 ± 4.26 vs. 12.98 ± 4.15 vs. 13.91 ± 4.27; P = 0.015 | One-way ANOVA Did not control for covariates |
| Salinas Martínez, 2020 (Salinas Martínez et al., 2020) | Age range specific Sketches Maternal (visual) perception of child weight (Perception of non-overweight vs. overweight) | 1) CFQ + CFPQ: Restriction 2) PFQ + CFPQ: Regulation 3) CFQ + CFPQ: Pressure to eat | 1) Adjusted OR = 0.9 (95% CI: 0.5, 1.4) 2) Adjusted OR = 0.7 (95% CI: 0.4, 1.3) 3) Adjusted OR = 0.6 (95% CI: 0.4, 0.9) | Multivariate logistic regression analysis Covariates: child’s weight concern, sex, birth order and age; mother’s overweight/obesity and age |
| Holub, 2012 (Holub & Dolan, 2012) | An array of nine infant figures Maternal (visual) perception of child weight (Continuous variable) | 1) Pressure to eat 2) Restriction for weight 3) Restriction for health | 1) r = –0.32, P = 0.02. 2) NR, P < 0.05. 3) NR, P < 0.05. | Pearson correlations Did not control for covariates |
| Mais, 2017 (Mais et al., 2017) | CFQ Parental perception of child weight (Perception of child non-overweight vs. Perception of child overweight/obesity) | 1) Use food as a reward 2) Restriction for weight 3) Restriction for health 4) Pressure to eat | 1) NR, P > 0.05. 2) OR = 4.6, P = 0.001. 3) OR = 1.82, P = 0.040. 4) OR = 1.88, P = 0.038. | Multivariate logistic regression Covariates: child’s sex and maternal education |
| Nowicka, 2014 (Nowicka et al., 2014) | CFQ Maternal perception of child weight (Continuous variable) | Pressure to eat Principal components Analysis Control over child feeding | β = –0.31, P < 0.05. | SEM Covariates: level of education, foreign background, and mother’s and father’s BMI |
| Tiggemann, 2002 (Tiggemann & Lowen, 2002) | One item (7-point Likert scale) Maternal perception of child weight (Continuous variable) | | r = 0.33, P < 0.01 | Pearson correlations Did not control for covariates |
| Wehrly, 2014 (Wehrly et al., 2014) | CFQ Parental perception of child weight (Continuous variable) | 1) Pressure to eat 2) Restriction | | Pearson correlations Did not control for covariates |
| Tylka, 2013 (Tylka et al., 2013) | CFQ Maternal perception of child weight (Continuous variable) | 1) Pressure to eat 2) Restriction | | Pearson correlations Did not control for covariates |
| Costa, 2021 (Costa et al., 2021) | CFQ One item (5-point Likert scale) Maternal perception of child weight | 1) Pressure to eat 2) Restriction | Perception of normal weight vs. overweight at 4 y 1) β = 0.249 (95% CI: 0.149, 0.349) 2) β = 0.020 (95% CI: –0.174, 0.214) Perception of normal weight vs. overweight at 7 y 1) β = –0.188 (95% CI: –0.394, 0.019) 2) β = –0.008 (95% CI: –0.172, 0.156) Perception of normal weight vs. underweight at 4 y 1) β = 0.229 (95% CI: 0.059, 0.398) 2) β = –0.175 (95% CI: –0.310, –0.039) Perception of normal weight vs. underweight at 7 y 1) β = 0.190 (95% CI: 0.005, 0.376) 2) β = –0.121 (95% CI: –0.269, 0.026) | Multiple linear regression Covariates: maternal concern and dissatisfaction about weight, maternal education, child’s sex and zBMI |
| Wang, 2022 (Wang et al., 2022b) | CFQ Maternal perception of child overweight (Continuous variable) | C-CFQ Pressure to eat Standardized β = 0.10 (95% CI: 0.157, –0.040), P < 0.001. | | SEM Covariates: child’s age, maternal age, maternal education level and annual household income. |

Notes. CFQ: Child Feeding Questionnaire; CFPQ: Comprehensive Feeding Practices Questionnaire; PFQ: The Parental Feeding Style Questionnaire; PPQ: Preschooler Feeding Questionnaire; C-CFQ: Chinese Child Feeding Questionnaire; BMI: body mass index; SEM: Structural equation modelling; NR: not report.
3.6. The results of meta-analysis

Four cross-sectional studies were included in meta-analysis (Francis et al., 2001; Holub et al., 2012; Salinas Martínez et al., 2020; Yilmaz et al., 2013). Fig. 2 shows that caregivers who perceived their child as overweight were found to be associated with less frequent pressure to eat (OR = 0.61; 95%CI: 0.44, 0.84) compared with those who did not based on the fixed-effects model ($I^2 = 0.09$).

As shown in Fig. 3, caregivers’ perception of child overweight had no statistically significant associations with restrictive feeding (OR = 1.37; 95%CI: 0.74, 2.55) based on the random-effects model ($I^2 = 81.2\%$, $P = 0.005$).

### 4. Discussion

The systematic review and meta-analysis aimed to summarize the available evidence on the relationships between caregivers’ visual and self-reported perception of child weight and their non-responsive feeding practices. The included studies focused on exploring the associations between caregivers’ perception of child weight and their restrictive feeding and pressure to eat.

Seventeen studies tested 22 associations between caregivers’ perception of child weight and their pressure to eat with 13 associations being statistically significant in the semi-quantitative results. The statistically significant associations consistently suggested that caregivers’ perception of child weight was negatively associated with their pressure...
to eat (Francis et al., 2001; Holub & Dolan, 2012; Loth et al., 2021; Nowicka et al., 2014; Wang et al., 2022b). Simultaneously, caregivers who perceived their child as overweight showed decreased pressure to eat compared to those who did not perceive their child as overweight (Chang et al., 2017; Mais et al., 2017; Salinas Martínez et al., 2020). Consistently, the results of the meta-analysis indicated that caregivers who perceived their child as overweight were found to be associated with less frequent pressure to eat compared with those who did not perceive their child as overweight. These findings suggested the significant role of caregivers’ perception of child weight in their pressure to eat. Some studies (Costa et al., 2021) suggested that caregivers’ forced feeding might arise because of caregivers’ perception of their child as thin and the desire for a heavier child. It may be due to caregivers’ beliefs and attitudes towards child weight in different cultural contexts.

In developing countries (e.g., China) or low socioeconomic settings (Black et al., 2015), caregivers do not often perceive overweight or obesity as a health issue (Doolen et al., 2009; Rietmeijer-Mentink et al., 2013). They may be usually more concerned about child underweight than overweight because underweight represents a lack of nutrition and their negligence of their feeding (Costa et al., 2021). Thus, caregivers may be more likely to apply pressure to eat when they perceived their children as underweight. Furthermore, caregivers might consider that a lower weight could compromise their children’s healthy development and growth (Brown et al., 2016), directly using pressuring practices. In contrast, if they perceived their child overweight, they may be less likely to apply pressure to eat, which has been demonstrated to cause negative affective reactions to food and a close relationship with low weight in children (Afonso et al., 2016).
Eighteen studies examined 26 relationships between caregivers’ perception of child weight and their restrictive feeding with 12 statistically significant associations being observed in the semi-quantitative analyses. The results consistently reported that caregivers’ perception of child weight was positively associated with their restrictive feeding (Ayine et al., 2020; Francis et al., 2001; Holub & Dolan, 2012; Loth et al., 2021; Tiggemann & Lowes, 2002; Wehrly et al., 2014). It suggests that caregivers’ perception of child weight may play an important role in restrictive feeding and reflected a process by which the caregivers desire their child to be thinner. When caregivers perceived their child as overweight or obese, they may believe their children to be at risk for developing weight problems and worry about their children being stigmatised (Francis et al., 2001) as societal and media pressures the public to be slim (Puhl & Heuer, 2010). Thus, caregivers may be more likely to restrict their children’s eating if they realized their child was becoming overweight. On the other hand, caregivers may consider the consequences of childhood overweight or obesity (Geng et al., 2018; Gordon-Larsen et al., 2004; Körner et al., 2007) when they perceived their children as overweight, such as adulthood obesity and chronic disease, which may make them adopt controlled feeding practices (e.g., restriction of unhealthy food) (Xiang et al., 2021). Although restricting the availability of food is a vital aspect of healthy eating, caution is needed because when children are exposed to restricted items, they could be more likely to choose this type of food and consume them in excess (Jansen, Mulkens, & Jansen, 2007). Hence, it is important to raise awareness of the negative consequences of excessively using this feeding practice (Barlow, 2007). However, the results of the meta-analysis showed that caregivers’ perception of child weight was not statistically significantly associated with restriction. It suggests that the perception of child overweight may not be the main reason for the high frequency of caregivers’ restrictive feeding. It is noted that some important potential risk factors (e.g., concern about child weight and child sex) may be more directly associated with caregivers’ restriction of food (Costa et al., 2021; Costanzo & Woody, 1985; Francis et al., 2001). For example, Costanzo and Woody (1985) (Costanzo & Woody, 1985) proposed that caregivers may use restrictive feeding practices when they are concerned about their children’s weight. Additionally, there are different types of restrictive feeding, some of them may be adopted in response to child health (Musher-Eizenman & Holub, 2007), which may not be directly related to caregivers’ perception of child weight. However, CFQ did not distinguish between these different types of restriction; it refers to restriction in general, measuring parental attempts to restrict their child’s intake of the type and amount of food (Birch et al., 2001). As the results are mixed, further studies are warranted.

Only three studies (Holub & Dolan, 2012; Salinas Martinez et al., 2020; Yilmaz et al., 2013) reported the relationships between caregivers’ visual perception of child weight and their non-responsive feeding practices. The results in the semi-quantitative analyses showed that caregivers’ visual perception of child weight was negatively associated with pressure to eat and positively associated with restrictive feeding, which are consistent with the findings of the relationships between caregivers’ self-reported perception of child weight and their non-responsive feeding practices. That is, caregivers who rated their child as a larger body size were more likely to use restrictive feeding. In contrast, caregivers who visually perceived their children to be thin used pressure to eat more than caregivers who did not. Based on the findings above, caregivers’ visual perception of child body size was shown to be one of the determinants of caregivers’ restriction of food and pressure to eat. However, caregivers’ visual perception of child weight may not always reflect child actual body size (Oldham & Robinson, 2018; Robinson, 2017), perhaps due to the increasing weight status of the population (Binkin, Spinelli, Baglio, & Lambert, 2013; Maximova et al., 2009; Ogden et al., 2016). It made their evaluations of their children’s weight relative to visual body-weight norms, which are shaped by the size of bodies a person is frequently exposed to in his or her environment (Oldham & Robinson, 2018; Robinson, 2017). Thus, it is essential for professionals and clinicians to focus on making caregivers accurately evaluate their children’s actual weight status, especially weight problems, which may help them implement effective feeding practices to control their children’s weight. Due to the limited number of included studies, the relationships between caregivers’ visual perception of child weight and non-responsive feeding practices need to be further investigated.

To the best of our knowledge, this review was among the first that comprehensively synthesized data on the relationships between caregivers’ self-reported and visual perception of child weight and their non-responsive feeding practices. However, there are several limitations to this systematic review and meta-analysis. First, some studies did not report standard error or 95%CI, which precluded us from pooling all the extracted data and conducting a meta-analysis to distinguish the impacts of caregivers’ self-reported and visual perception of child weight on their non-responsive feeding practices by subgroup analyses. Thus, the results from the meta-analysis should be interpreted with caution. Simultaneously, we were not able to conduct subgroup analysis based on various demographic factors (e.g., child age, sex) due to the small number of articles included in the meta-analysis. Second, most studies with cross-sectional design precluded us from establishing causal inferences. Third, all included studies employed self-reported questionnaires to assess our interest variables, which may be subject to recall bias. Moreover, some included studies did not control for some important potential covariates (e.g., child sex, child temperament) (Chae & Ra, 2018), which may influence the associations between caregivers’ perception of child weight and their non-responsive feeding practices. Thus, further studies should consider these confounders when exploring their relationships. In addition, we did not include responsive feeding practices as outcomes because limited studies focused on exploring the relationships between caregivers’ perception of child weight and their responsive feeding practices. As a result, further robust empirical studies are needed to explore their relationships. Finally, the included studies were mainly conducted in western countries such as the US and Australia. Findings from this systematic review might not be extrapolated to other populations (e.g., Asian).

5. Conclusion

This systematic review synthesized the evidence and indicated that caregivers’ perception of child weight may be a significant risk factor for non-responsive feeding practices. It seems that caregivers who perceived their child as overweight or obesity may be less likely to apply pressure to eat. They might more frequently use restrictive feeding when they perceived their child as overweight. Given the consequences of non-responsive feeding practices and the potentially important effects of caregivers’ perception of child weight, further interventions are needed to consider caregivers’ visual and self-reported perception of child weight, which may optimize their feeding practices and eventually contribute to child health. Additionally, future longitudinal and intervention-based studies using validated measurements and representative sampling while controlling for potential covariates are needed to provide more evidence on the effects of caregivers’ perception of child weight over time.

Ethical approval and consent to participate

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Author contributions

Conceptualization: JW, Y-SC, KW-B, and YC; Data curation: JW, XW, and YSC; Formal analysis: JW, Y-SC, KW, and XW; Investigation: JW; Methodology: JW and Y-SC; Project administration: JW, Y-SC, KW, and YC; Supervision: Y-SC, KW, and YC; Validation: JW; Software: JW; Visualization: JW; Writing – original draft: JW; Writing – review & editing: JW, Y-SC, KW, and YC.

Availability of data and materials
All data generated or analyzed during this study are included in this published article and its supplementary information.

Ethical statement

We would like to submit the enclosed manuscript entitled “The relationships between caregivers’ self-reported and visual perception of child weight and their non-responsive feeding practices: A systematic review and meta-analysis”, which we wish to be considered for publication in “APPETITE”.

The authors declare that they have no conflict of interest. The study did not directly involve any human samples and did not contain any studies with animals performed by any of the authors; therefore, ethical approval was not required for this study. The systematic review and meta-analysis protocol is registered in the online platform “PROSPERO” with the registration number “CRD42021286933”.

Declaration of competing interest

The authors declare no conflicts of interest.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2022.106343.

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