



Parents' Perception of Child Weight Status, Risk Factors and Health Concern of Childhood Obesity: A Systematic Review

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Abstract: The increased prevalence of childhood obesity is becoming a public health concern as it is related to numerous health implications. Parental perception of child's weight status is an important factor for reducing childhood obesity burden. Parental perception of the risk factors and health outcomes of obesity are important in prevention and management of childhood obesity. However, previous reviews focused mainly on parental perceptions about healthy behaviors to reduce the burden of childhood obesity. Thus, this systematic review was carried out to investigate parental perceptions of their child weight status as well as risk factors and health concern of childhood obesity. A systematic review was conducted and was reported in accordance with PRISMA statement on studies between 2012 and 2017 through a variety of database like CINAHL, PubMed, Science Direct, Scopus and Cochrane Library. However, out of 2,334 articles identified, only 35 studies were included, which originate mostly from high-income countries. The results revealed that parents' misperception rate of their children's weight varies from 9.6% to 90%, while parents perceive that only genetic factors, non-vegetable-consumption or low physical activity and environmental factors are the key risk factors of childhood obesity. Hence, parents' of obese children estimate their children to be at risk at having hypertension, heart disease, depression, and diabetes. In conclusion, parents have difficulty in correctly perceiving the obesity status of their children. Health care workers should be aware of the parents' wrong perception of their children's weight status. The result of this review may be used to develop an effective intervention programs aimed at reducing the burden of childhood obesity which focus on the parental perception of the risk factors contributing to childhood obesity.

Keywords: Perception, Childhood, Parents, Obesity, Obesity risk factors, Health concerns

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I. INTRODUCTION

Childhood obesity has become a global epidemic as its prevalence has increased over the past few decades¹. Obesity is associated with numerous health conditions which can lead to morbidity and mortality such as cardiovascular diseases, type 2 diabetes, certain types of cancer as well as adverse psychosocial conditions, such as social stigmatization, depression, loss of self-confidence². Parental perception of their child's weight status is an important factor in the prevention and control of childhood obesity³. Enrolling parents in addressing childhood obesity epidemic depends on their understanding of their children's weight status. Parents are considered as motivators by influencing the dietary and lifestyle habits for the children such as reducing sedentary time and encouraging the physical activity of their children⁴. Parents who failed to recognize their child's weight status may put their children at risk of developing obesity through wrong lifestyle habits such as low physical activity, unhealthy diet in the form of low vegetable and fruit intake and profuse intake of fast food and sweet beverages⁵. Further, in order to correctly categorize children as obese, previous researches suggest the importance of regular anthropometric measurements, as parental perceptions often do not correspond with actual values. However, parents tend to underestimate weight for obese children, hence, in normal weight children, obesity is often underestimated, leading to a higher attributed weight category⁶. Previous systematic reviews regarding parents' perceptions of their child's weight status have focused on parental perceptions about healthy behavior to prevent childhood obesity⁷ and they mainly focused on school-going children⁸. Although there are other reviews that focused on parents' perceptions of their child's weight status in a particular culture, for instance, Asian culture⁹. Moreover, other systematic review focused only on maternal perception rather than both parents¹. Understanding parents' perceptions of their child's weight status and risk factors, health concern of childhood obesity are important factors for providing effective programs to reduce the burden of childhood obesity⁴. If parents cannot recognize their child as obese, they will not participate in childhood obesity programs. Additionally, parents' underestimation of risk factors and health concern of childhood obesity may be associated with low weight management behaviors and higher adverse health risks¹⁰. The first aim of this review assessed parents' child weight perception and secondly to review parent's perception of causes and health outcomes related to childhood obesity. This systematic review summarizes the findings of the available studies on various cultures, looking at preschool and school children within the age group of 0-19-year-old. This wide coverage of this systematic review enhances the reliability of the results and conclusion, making conclusion stronger and can be generalized in comparison to the previous similar systematic reviews that were limited to certain culture. The summary of the available evidence presented in this systematic review will allow identification of areas for future research.

2. METHODOLOGY

The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines are used in conducting this review¹¹. PRISMA guidelines for conducting systematic reviews and protocols have been created by a group of international experts to improve accuracy, transparency,

completeness, and frequency of documented systematic review. Generally, the study focused on the article that reported parents' perceptions of childhood obesity and the weight-related parameters of their children.

2.1 Search strategy

PubMed, CINAHL, Science Direct, Scopus, Cochrane Library and Grey literature electronic databases were used as sources of the articles that have been published in English and Arabic languages from 2012 to 2017 on parent's perception of their children's weight status. Both Medical Subject Headings (MeSH) terms and text words were included; natural languages were used as keywords in search of the stated electronic databases. MeSH is the National Library of Medicine's controlled vocabulary thesaurus which is used for indexing articles for the MEDLINE®/PubMED® database. In addition to manual search, the included studies' reference lists were checked for any relevant papers that met the inclusion criteria. The different keywords used were perception, childhood, parents, obesity, obesity risk factors, and health concerns and their synonyms. The literature survey and studies that were included in our systematic review are illustrated in Figure 1.

2.2 Stages of studies selection

First, the relevant articles were identified by searching all articles that included keywords or the synonyms in the title. Conference abstracts were excluded as the full papers are not available. There were 2,334 publications, identified from the different electronic databases. Secondly these studies were imported to the EndNote X6 software, whereby 104 studies were subsequently removed as a result of duplications. Thirdly, the articles that were not related were excluded and a balance of 424 papers remained. However, relevant articles were identified by including articles that include keywords or the synonyms in the abstract and a balance of 176 papers remained. Subsequently, abstracts of the remaining studies were independently reviewed by the authors in order to identify studies that are eligible for inclusion and 67 studies remained. Finally, the articles with study design either qualitative, a pilot study or systematic review were excluded. The 35 selected papers were then analyzed to ensure the eligibility. The selected digital libraries and stages of selection are illustrated in Table 1

2.3 Inclusion criteria

All studies on parent's perception of obesity and weight-related parameters of their children that have been published in English from 2012- 2017, that include children aged below 19 years old were considered, including cross sectional studies, case control studies, cohort studies, descriptive studies, and mixed method studies. In addition to studies which identified parents' perception regarding risk factors and health concerns of childhood obesity. There was no limit placed on the study setting.

2.4 Exclusion criteria

The articles which measured the child's own weight perception but not parents were excluded. In addition to studies where children had underlying medical problems or eating upset. Also, studies relating to participants over 19 years of age were excluded as the focus of the current systematic review is children population. Moreover, conference abstracts as well as pilot studies, and qualitative studies were excluded.

Table 1. The stages of articles selection

Libraries	CINAHL	PubMed	Science Direct	Scopus	Others (Gray literature)	Total
Stages						
Stage 1	960	245	812	257	60	2334
Stage 2	930	215	778	247	60	2230
Stage 3	123	69	52	138	42	424
Stage 4	60	51	5	32	28	176
Stage 5	15	23	5	11	13	67
Stage 6	7	11	5	7	5	35

2.5 Outcome

The primary outcome of interest is the correlation between parental perceptions of childhood obesity and childhood obesity among children aged below 19 years old. The secondary outcome, on the other hand, is the parents' perceptions regarding risk factors and health concerns of childhood obesity among children aged below 19 years old.

2.6 Quality assessment

The quality of the studies using critical appraisal tools published for different study designs were assessed. For the cross-sectional studies, a British Sociological Association (BSA) Medical Sociology¹² which contained 7 questions in which each item is answered with either yes or no and each question provided a positive answer contributed to one point and "no", with zero was used. Studies that reported a score of 1-2 were grouped as low quality, whereas those with a score of 3-5 were grouped as medium quality, and studies with a score of 5-7 were grouped as good quality. Consequently, studies of good and medium qualities were included in our systematic review. Although, for cohort study, we used New Castle Ottawa Scale (NOS)¹³. This tool is used to assess the selection, comparability, and outcome. Studies are reported as of good quality if they have 3 or 4 stars in selection domain, 1 or 2 stars in comparability

domain and 2 or 3 stars in outcome/exposure domain. Studies reported of fair quality if they have 2 stars in selection domain, 1 or 2 stars in comparability domain and 2 or 3 stars in outcome/exposure domain. Studies reported as of poor quality if they have 0 or 1 star in selection domain or 0 stars in comparability domain or 0 or 1 stars in outcome/exposure domain. Consequently, studies of good and fair qualities were included in our systematic review. National Critical Appraisal Skill Program (CASP) appraisal tool was used for mixed-method study¹⁴ that contained 10 questions and each item is answered with either yes, can't tell or no and each question that provided a positive answer contributed to one point and "no" or can't tell with zero. Studies that reported a score of 1-3 were grouped as low quality, whereas those with a score of 4-7 were grouped as medium quality, and finally, studies with a score of 8-10 were grouped as good quality. Consequently, studies of good and medium qualities were included in our systematic review. The quality assessment of the studies is illustrated in Table 2.

2.7 Data extraction

Specific data on the author(s)—year, country, study design, sample, setting, outcome measures, evaluation tools, applied theory and the major findings were extracted from the included papers.

3. RESULTS

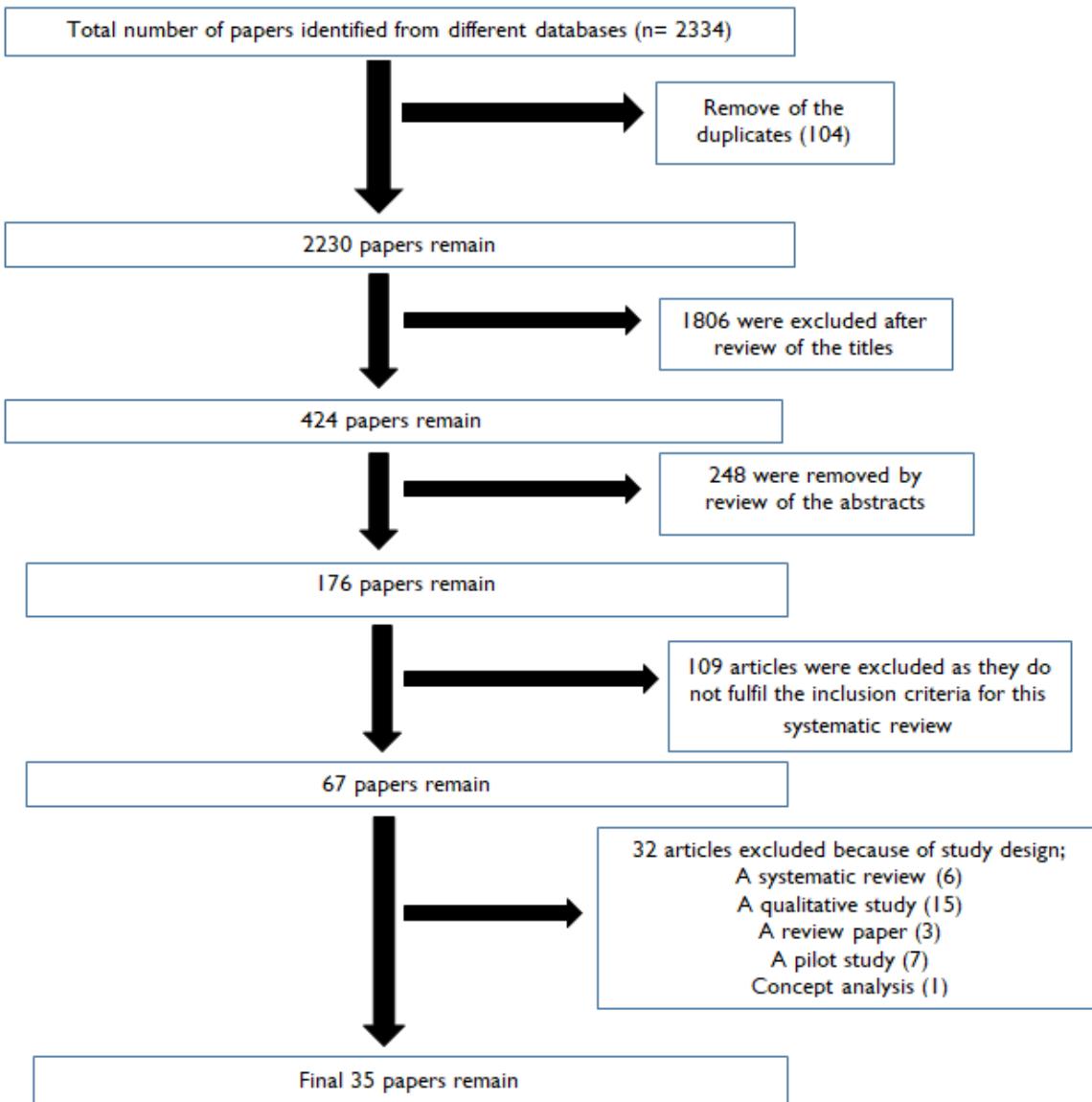


Fig 1. Flow chart showing the selection of studies.

Table 2. The data extraction and quality of the studies

No	Authors, year	Study design	Sampling and setting	Outcome measures	Evaluation tools	Applied theory	Major findings	Study quality
1	(Murang et al. 2017) ¹⁵	Cross-sectional study	A number of 358 parents of children aged 4,5,6 years from 4 primary schools in Brunei-Muara district in Brunei, no sampling method was used as all eligible parents were included.	Parental knowledge about obesity, children eating habits, physical activity and children body weight status. Descriptive statistics such as frequencies and percentages were used.	Modified validated questionnaires with themes such as demographic characteristics, parental knowledge of obesity, children eating habits and physical activity and on their children body weight status	None	<ul style="list-style-type: none"> ❖ Key risk factors to childhood obesity: <ul style="list-style-type: none"> ▪ Genetics (61.4%), ▪ Not eating vegetables (80.4%). ▪ Barriers to physical activity (68.7), with fear of crime and traffic dangers the main barriers to physical activity. ❖ 91.8% did not know how to calculate BMI but 48.1% perceived their children were at their ideal weight. 	Good
2	(Nemecek, et al. 2017) ⁶	Cross-sectional study	A total of 600 parents and their children (aged 0–14 years) conducted at a general pediatric outpatient clinic in Vienna, Austria.	Parents' perception of their child's weight status	Parents were asked to estimate children's weight status as "underweight", "normal weight" or "overweight"	None	<ul style="list-style-type: none"> ▪ Only a fair agreement between parent perception of their child weight status and the actual weight status. (κ statistics = 0.214, $p < 0.001$). ▪ Only 75 % of the children were classified in the correct weight classification by their parents. 	Good
3	(Wright et al. 2016) ¹⁶	Cross-sectional study	A total of 502 parents with a 5– 12-year-old child in United State.	Parent's perception regarding the risks of developing obesity-related chronic health conditions.	Questions from the Consumer Assessment of Healthcare Providers and Systems (CAHPS) survey were used to assess parent perceptions of their child's current health and future health prospects, and the child's frequency of healthcare utilization	None	<ul style="list-style-type: none"> ▪ The mean (SD) unadjusted parent predicted health risks were 15.4% (17.7%), 11.2% (14.7%), 12.5% (16.2%), and 12.1% (16.1%) for hypertension, heart disease, depression, and diabetes, respectively. ▪ Parents of obese children are more likely to rank their predicted risk as being in a higher category for hypertension ($OR = 1.9$, 95% CI: 0.97, 3.8), heart disease ($OR = 2.26$, 95% CI: 1.1, 4.7), and type 2 diabetes ($OR = 2.2$, 95% CI: 1.1, 4.4) relative to parents of healthy weight children. 	Medium
4	(Min et al. 2017) ¹⁷	Cohort study	Parents' of first-born children aged 6–18 years (n 2310) in families surveyed	Maternal and child perceptions of the child's weight status.	Mothers and child were asked to describe their first child's weight status, as	None	<ul style="list-style-type: none"> ▪ 9.6 % of mothers perceived their child as overweight. ▪ Mothers who thought their 	Fair

		in 2004, 2006, 2009 and 2011 in The China Health and Nutrition Survey (CHNS)	Weight-related parenting practices. Child weight and height.	normal weight, underweight or overweight. Child weight and height were measured to the nearest 0·1 kg and 0·1 cm using a weight scale and measuring tape.	children were overweight, were more likely to encourage their children to increase their physical activity (OR; 95 % CI: 1·8; 1·0, 3·3) and to diet (4·3; 2·3, 7·8)			
5	(Ashraf et al. 2017) ¹⁸	Cross-sectional study	Parents of 330 healthy children aged 5-14 years at Aga Khan University Hospital, Karachi, Pakistan	Anthropometric measurements of children, and parental perception about their child's weight	An interviewer-based pre-tested questionnaire.	None	<ul style="list-style-type: none"> 59% (179) of parents incorrectly perceived their child's weight status. 53% of normal weight children were perceived by their parents as of underweight and 1% as of little overweight. 65% of overweight children were perceived as of the right weight. 19% of obese children were perceived as of normal weight by their parents. While 62% were perceived as of little overweight and 19% as overweight. 	Medium
6	(Alexander et al. 2018) ¹⁰	Cross-sectional study	A total of 595 African Americans caregivers of children attending school are centrally located in a rural community in a Georgia county.	Parents' perceptions of risk factors of childhood obesity, perceptions of child's weight status, perceptions of barriers and benefits in the community, perceptions, and importance of prevention strategies.	Perceptions of childhood obesity survey: The survey comprised of five sections including demographic information, perceptions of risk factors of childhood obesity, perceptions of child's weight, perceptions of barriers and benefits in the community, perceptions, and importance of prevention strategies. Height and weight measurements of the children	Social Cognitive Theory Social Ecological Model	<ul style="list-style-type: none"> The Spearman's rho correlation indicated a significant relationship between caregiver's self-reported and objective body mass index ($r = 0.39$, $p < 0.001$) 	Medium
7	(Syahrul et al. 2017) ¹⁹	Cross-sectional study	A total of 886 elementary school students aged 6 to 13 years and their parents in Indonesia	Parents' perceptions of their children's weight status and the factors associated with parental misperceptions about their children's weight status.	Questionnaire about parents' perceptions of their children's weight status. The children's anthropometric parameters were measured using the standardized equipment.	None	<ul style="list-style-type: none"> Approximately 50% of the parents misperceived their children's weight status; the parent's perception of the body weight is different from the actual body weight classification according to BMI (5% overestimated; perceived the child's weight as higher than the actual 	Medium

					weight, and 45% underestimated it; perceived it as lower than the actual weight).			
8	(Reyes and Higgins 2017) ²⁰	Cross-sectional study	A consecutive sample of parents and caregivers with a child aged 2–18 (n 6000) at an urban pediatric primary care clinic in the southeastern United States.	Parental perception of the child's weight status in relation to the child's age.	Caregiver's perception of the child's weight status using verbal a, just about right, overweight, little overweight, obese) and a visual scale. The visual scale had seven drawings from the heaviest character to the lightest character.	None	<ul style="list-style-type: none"> The underestimation of weight status by parents was associated with: <ul style="list-style-type: none"> the younger children (OR: 1.5), higher parental educational level (OR: 1.54), and irregular BMI screening (OR: 1.34). 	Medium
9	(Lydecker and Grilo 2016) ²¹	Cross-sectional study	The participants were 1007 parents of children aged 5 to 15 years old from the Mechanical Turk website in the USA.	Parents' opinions about their children weight and eating. Anthropometric data for parents and their children.	Parents completed online measures of personal eating attitudes, attitudes about their children's eating and weight, and parental practices related to weight-related attitudes.	None	<ul style="list-style-type: none"> Approximately 85% of caregivers never told that their children were gaining weight too fast or they are overweight Parents frequently underestimated children's overweight/obesity, even more frequently than their own obesity ($P < 0.001$). Parents' child-focused eating attitudes/behaviors were related to actual ($P < 0.001$) and perceived child weight-status ($P < 0.001$). 	Medium
10	(Miller et al. 2016) ²²	Cross-sectional study	A number of 531 caregivers were recruited from two pediatricians' offices in Orlando	Caregivers' perceptions and their child's obesity status.	From seven drawings of girls (boys) that ranged from underweight to obese, caregivers were asked to, "circle the girl (boy) that you think looks the healthiest.	None	<ul style="list-style-type: none"> Caregivers misperceive their own child's weight. The association between misperception and obesity was (OR = 1.76, 95% CI= 1.32–2.34, $P < 0.05$). 	Medium
11	(Al-Mohameed 2016) ²³	Cross-sectional study	Parents of 601 children aged 6–10 years from the primary schools located in Al-Qassim, Saudi Arabia	Percentage of parents who misclassify the status of the child's weight.	The body mass index of the children was assessed in the school, and their parents responded to a self-administered questionnaire which contained	None	<ul style="list-style-type: none"> Misclassification— identifying an overweight or obese child as normal weight – was significantly higher among parents with overweight and obese children than parents with normal children ($p =$ 	Medium

				questions on parental perception of the children's weight/obesity status	0.001).
12	(Hernandez et al. 2017) ²⁴	Cross-sectional survey	A school-based sample of 55 elementary school-age children and their mothers from Houston, Texas	Mothers reported their perceptions of their child's current weight status. "Compared to other children the same age, do you feel your child is, underweight, slightly underweight, about the right weight, slightly overweight, overweight, obese"	▪ 90% of parents of the 81 overweight children misclassified their child's weight as of normal weight. ▪ 65% of parents of the 61 obese children, misclassified the child's weight status as of normal weight.
13	(Power et al. 2018) ²⁵	Population representative National Cohort Study	Data from 8,568 9-year-old school children and their caregivers living in the Republic of Ireland	Maternal perception of the weight status of their children categorized as very underweight, moderately underweight, slightly underweight, about the right weight, slightly overweight, moderately overweight and very overweight Height and weight of the children were objectively measured using standard measurement techniques.	▪ Over one-third of mothers misperceived their child's weight status [9% (n = 5) overestimated; 27% (n = 15) underestimated]
14	(Vangeepuram et al. 2016) ²⁶	Cross-sectional study	A number of 117 parents/guardians of children aged 3–17 years from elementary and after-school programs in the Sector of Excellence for Elimination of Disparities (SEED) from December 2009 to February 2010 in New York City.	Child dietary and physical activity behaviors. parental perception of the child's health and weight. Anthropometric measurements of the children.	▪ Only 17% of mothers of obese children correctly categorized the weight status of their child.
				Parental Perception of Weight was assessed by "Do you consider (Child's name) now to be: Underweight, About the Right Weight, Somewhat Overweight, or Very Overweight?" To assess Parental Perception of Health, they asked: "In general, would you say (Child's name)'s health is: excellent, very good, good, fair or poor?"	▪ Half (50 %) of the parents underestimated their children's weight. ▪ Reported daily hours of walking and/or running trended higher (3.6 vs. 2.6 h, p = 0.08) for children perceived to be of normal weight.

				children's height and weight were measured using a standard portable stadiometer and the Summit S4600 High Capacity BMI Platform Scale, respectively.			
15	(Cheng et al. 2016) ²⁷	Cross-sectional study	A total of 1237 mothers of 3 years old children in Singapore	Maternal perception of their child weight status. Anthropometric measurement of children.	Verbal description. Mothers were asked to select the answer to the question "What do you think of your child's weight?" -Visual description. Mothers were shown the seven sketches of the previously validated Toddler Silhouette Scale. Height was measured twice using a portable stadiometer, weight was measured twice using an electronic flat scale.	None	<ul style="list-style-type: none"> Thirty percent of the mothers were unable to describe their child's weight status accurately. <ul style="list-style-type: none"> In the verbal description, 17.9% under-estimated and 11.8% over-estimated their child's weight status. In the visual description, 10.4% under-estimated and 19.6% over-estimated their child's weight status
16	(Foster and Hale 2015) ²⁸	Cross-sectional, mixed-methods study	A number of 40 parents of children aged 2–5 years old were recruited from the waiting rooms of two pediatric clinics in Harlingen, Texas.	Parents perception of their child weight status	perception of weight was assessed using a standardized pictogram depicting children of the appropriate sex with a median weight child displayed along with a continuum with heavier and lighter children with a total of 7 child sizes	None	<ul style="list-style-type: none"> The quantitative analysis showed, most (58%) of the parents of overweight and obese children misclassified their child's weight status as normal or underweight.
17	(Merema et al. 2016) ²⁹	Cross-sectional study	A total 4,437 parents of children aged 5–15 years from 2009 to 2012 as part of the Western Australian Health and Wellbeing Surveillance System in Australia.	Parents' perceptions of their child's weight status. The child's BMI.	To measure weight perceptions, parents were asked, "Is your child underweight, normal weight, overweight or very overweight?" BMI values were also derived via parent-reported height and weight. The child's BMI category was derived from the parents' report of their child's height and weight using age and gender-specific Centers	None	<ul style="list-style-type: none"> Significantly fewer parents perceived their child as overweight (8.2%) or very overweight (0.2%) comparing to actual weight (16.3% and 5.8%, respectively)

for Disease Control and Prevention (CDC) BMI cut-offs for children.						
18 (Czajka and Kołodziej 2015) ³⁰	Cross-sectional study	Data were collected from parents of 230 children aged 6 years attending preschools in the city of Wrocław, Poland.	Parents' perception of their child weight status. Body height and weight were measured to calculate children' BMI.	The parents of the children examined were asked: How would you describe your child's body mass? (significant underweight, slight underweight, normal body mass, slightly overweight, significant overweight)	None	<ul style="list-style-type: none"> The study showed that 42.1% of underweight children and 60.9% overweight and obese children are perceived as having normal weight. 13.3% of the parents declared their normal-weight children to be underweight
19 (Alexander et al. 2015) ³¹	Mixed methods study	A convenience sample (135) of African American caregiver's in Georgia county.	Caregivers' perception of their child weight status, perception regarding risk factors and health concern of childhood obesity.	Perceptions of childhood obesity survey: (perception of risk factors of obesity, health concern and obesity status of their children)	Social Cognitive Theory Social Ecological Model	<ul style="list-style-type: none"> Caregivers perceived child's weight and height measurements by the child's appearance or a recent doctor visit. They perceived environmental barriers and insufficient physical activity are risk factors of obesity.
20 (Gauthier and Gance-Cleveland 2016) ³²	Cross-sectional study	A total of 83 Hispanic parents of children aged 2-5-years old in the USA	The accuracy of Hispanic parents' perceptions of their preschool children's weight status.	To measure word perception, parents were asked to respond to the prompt, "I feel my child is" Response options included underweight, a little underweight, about the right weight, a little overweight, or overweight. To measure visual perception used seven gender-specific silhouettes arranged in descending linear order depicting children 2-5 years of age.	None	<ul style="list-style-type: none"> Approximately half of the parents (50%) underestimated their child's weight status.
21 (Nobari et al. 2015) ³³	Cross-sectional study	A number of 2,051 randomly selected mothers of children aged 2-5 years living in Los Angeles County who were enrolled in the Special Supplemental Nutrition Program for Women Infants and Children in the USA.	Mother's perception of child's weight. Height and weight of the children.	The mothers of the children examined were asked "Right now, do you consider [child] to be overweight, underweight or about right for his/her height?"	None	<ul style="list-style-type: none"> 78% of mothers of obese children considered their child's weight to be about right.

22	(Yalçın, et al. 2016) ³⁴	Cross-sectional study	Mothers' of 367 children aged 0-6 years excluding a newborn period in Turkey.	Mothers' assessment of their child's weight status. Child body mass index-for-age z score.	Perceived child weight was assessed by verbal questions and visual tools included picture percentiles for assessment of the child's current weight. Adiposity was assessed by using z score for children.	None	<ul style="list-style-type: none"> 43.1 % of mothers correctly assessed the child body mass index-for-age Z score verbally. Maternal verbal estimation was correlated with maternal visual estimation. 	Medium
23	(McKee et al. 2016) ³⁵	Cross-sectional study	Data from multi-year surveys (2009–2012) with random samples of public school parents at Mississippi State (N = 14,808)	The accuracy of parental perceptions of their child's weight status. Child's BMI percentile.	Parents were asked: "What would you say best describes [your child's] weight?" (underweight, healthy weight, overweight, or obese)	None	<ul style="list-style-type: none"> More than 2 out of 5 parents misperceived the weight status of their child. 83.9% of parents categorized their children as "healthy", when only 28.3% actually were. Parents who misperceived their child's weight were almost 12 times more likely of having an obese child. 	Medium
24	(Tarasenko et al. 2014) ³⁶	Cross-sectional study	Guardians' of 4691 children and adolescents, ages 8 to 15 years in the United States.	The accuracy of guardians' perceptions of their child overweight and obesity.	Parents or guardians were asked if they considered their child "overweight, underweight, or about the right weight." Standing height was measured using a stadiometer, Weight was taken using a digital floor scale.	None	<ul style="list-style-type: none"> Little agreement existed between guardians perceptions and their children obesity status (Cohen's kappa = 0.28) 	Medium
25	(Kiliç Arslan-TÖRÜNER, Ayaz and Savaş Er 2014) ³⁷	Cross-sectional descriptive study	A number of 736 mothers and 712 fathers of children in grades 1 to 5 in the city of Ankara, Turkey	Compare children's actual weight status with their mothers' and fathers' perceptions.	The parents were asked; 'How concerned are you about your child's weight? The other question "How do you perceive your child's weight?"	None	<ul style="list-style-type: none"> Children's actual weight status (8% underweight and 20.1% overweight or obese) was different from mothers' and fathers' perceptions ($p < 0.05$). Parents were more likely to perceive the actual weight as being underweight than as being overweight or obese. 	Medium
26	(Aljunaibi et al. 2013) ³⁸	Cross-sectional study	A total of 1440 parents of public school children (grade 1-12) in Abu Dhabi.	Parental perception and determinants of their children weight status	The parents were asked regarding their perception of their children's weight status (underweight, normal, and overweight/obese	None	<ul style="list-style-type: none"> 11.0% of parents of normal weight children classified their children as underweight. 61.9 % of parents of overweight/obese children classified their children as of normal weight, 	Medium

						and 1.6 % of parents classified their overweight/obese child as underweight.	
27	(Ferrão et al. 2013) ³⁹	Cross-sectional study	A total of 2690 children and their parents in preschools and elementary schools in Porto	The association between parents' perceptions of their neighborhood safety and their children's weight status.	To assess perceptions of the neighborhood environment the parents completed the standard questionnaire of the International Physical Activity Prevalence Study, to assess the perceived environmental factors that prevent or limit the opportunity to walk and cycle in residential neighborhoods	None	<ul style="list-style-type: none"> The odds of children being obese were lower if their parents believed that it was safe to walk/cycle (OR = 0.65), easy and pleasant to walk (OR = 0.73) and when local sidewalks were well maintained (OR=1.18)
28	(Datar et al. 2013) ⁴⁰	Cross-sectional study	Analyzing 9 years of longitudinal data (1999–2007) on a cohort of approximately 19,000 US kindergartners from the Early Childhood Longitudinal Study.	BMI percentile and obesity status of children, neighborhood safety, physical activity time, sedentary behavior time.	Parent perception of neighborhood safety was derived from the survey question "How safe is it for children to play outside during the day in your neighborhood?" Height and weight were measured and BMI was calculated based on the 2000 BMI-for-age growth charts issued by the Centers for Disease Control and Prevention.	None	<ul style="list-style-type: none"> Parents' perception of neighborhood safety was associated with 0.13 fewer days per week of vigorous physical activity ($\beta = -0.127$; 95% CI (-0.192, -0.063) and 0.40 additional hours per week of television-watching ($\beta = 0.404$; 95% CI: 0.115, 0.694), but were not associated with significant changes in BMI percentile or obesity status of children.
29	(Nogueira et al. 2013) ⁴¹	Cross-sectional study	A total of 1885 Portuguese parents of school boys and girls in Portugal.	The association between parents' perceptions of their social and built residential environment and childhood obesity	The children's weight and height were measured, and their parents filled out the "Environmental Module" questionnaire of the International Physical Activity Prevalence Study	None	Parents perceived that poorly built environmental conditions (OR = 1.47), and unsafe, dangerous environments (OR = 1.339) had increased odds of being obese.
30	(Guevara-Cruz et al. 2012) ⁴²	Cross-sectional descriptive study	A number of 273 mothers of children between the ages of 2 and 15 years at the Children's Hospital of the Central Region of Mexico	Mothers' perceptions of their children's weight. Weight and height of the children.	Mothers' perceptions of their children's weight were assessed using a two-question questionnaire: the first question was: Your children's weight is: normal or not; and the second question was Your children's weight is: normal, overweight or obese. Weight	None	<ul style="list-style-type: none"> The perceptions of mothers about their children's weight are not associated with actual BMI category of children ($p < 0.0001$). They found 74 children who were overweight and obese (27%); 62.2% of the mothers of these children considered them to be overweight and obese and 37.8% of

31	(Petricevic et al. 2012) ⁴³	Cross-sectional study	A number of 1,084 parents and their children in the framework of mandatory health examination at school entry in 2007 in Croatia.	Perception of parents on the weight status of their offspring	and height data were registered. Seca Cuadra 808 scales were used to measure the weights of the children and height measurements were achieved using a stadiometer	these mothers felt that their sons were of normal weight when in fact they were overweight ($p = 0.038$).
32	(Yao and Hillemeier 2012) ⁴⁴	Cross-sectional study	A number of 863 mothers of children aged 6 to 18 years during the 2006 China Health and Nutrition Survey	Maternal perceptions of their child weight status.	The parent was asked; "Do you consider your child to be 'underweight', 'of normal weight', or 'overweight'?" Weight and height of their children. were achieved using a stadiometer	▪ Overall, 28.9 % of parents misclassified their child's weight status (21.5 % of parents underestimated and 7.4 % overestimated their child's weight). Medium
33	(Kaufman-Shriqui et al. 2012) ⁴⁵	Cross-sectional study	Data were obtained from 224 mothers of preschool children aged 4-7 years old in Israel.	Maternal perceptions and beliefs regarding their children weight status	The mothers were asked: "Do you think your child is underweight, normal, or overweight?" child's weight and height were measured using standardized measurement techniques	▪ 72% mothers of the overweight children ($n=143$) underestimated their child's weight status as underweight (7.9%) and normal weight (64.0%). Medium
34	(Regber et al. 2013) ⁴⁶	Cross-sectional multi-center study	Parents of 16,220 children, ages 2–9 years in eight European countries.	parental perceptions of and concern about the child's body weight	Mothers were asked to classify the child as thin, normal weight or overweight. Children's heights and weights were obtained in preschools using a standardized protocol	▪ Over 82% of mothers underestimated their child's weight status. 74 % were perceived by their mothers as having 'normal weight' and 8% were perceived as 'thin'. Medium
35	(Cochran et al. 2012) ⁴⁷	Cross-sectional descriptive study	Parents or legal guardians of all children who participated in the Coronary Artery Risk Detection In Appalachian Communities (CARDIAC)	Parental perception of their child's weight status	Parents answered a self-administrated questionnaire consisting of 70 questions, covering a broad range of variables such as behavioral factors, dietary and sedentary habits, and parental perceptions, attitudes, and values	▪ Parental weight perception corresponded overall to children's mean body mass index z-scores. ▪ About one-third of the total indicated concern about underweight, paradoxically most often parents of children in the overweight or obesity categories. Medium
					Height (cm) and weight (kg) were obtained by measuring to the tenth digit using the SECA Road Rod stadiometer	▪ A significant relationship between accurate parental perceptions of their child's weight status and the child's actual weight status ($p < 0.001$). Medium

health
screening in eight counties
between 2006 and 2009 (n
2121)

3.1 Description of the studies

Thirty-Five full texts were retrieved. Fourteen of them were from the USA, two from China, Turkey, Georgia and Australia, and one each was from the following countries: Pakistan, Indonesia, Ireland, Croatia, Mexico, Portugal, Emirates, Poland, Singapore, Israel, Saudi Arabia, and Georgia. Almost all studies represented high-income countries, based on the World Bank classification, with the exception of Indonesia and Pakistan from a lower middle-income group⁴⁸. Most of the studies included in this review were quantitative using a cross-sectional study design with the exception of five studies; two of them mixed method study, two cohort study, and one descriptive study. The sample sizes for the included studies ranged between 40 and 19,000 participants. Seven studies included mothers only, while the other studies included parents and other types of caregivers (e.g.: legal guardians).

3.2 Parents' perception of their child's weight status

Parents' misperception rate of their children's weight varies from 9.6% to 90% and the misperception rate varied according to their child's weight category. The misperception rate was high especially for parents of overweight/obese children. Some parents of obese children classified their children as underweight, while other classified their child as of normal weight³⁸. Parents of normal weight children perceived their children to be underweight^{30,37}. Some studies showed that regardless of their child's weight status, parents perceived their children were at their ideal^{15,33}. The review showed that misperception of weight status by parents was associated with the younger children (OR: 1.5), a higher parental educational level (OR: 1.54), irregular BMI screening¹⁹ and parents' child-focused eating attitudes/behaviors ($p < 0.05$)²¹. However, only six studies used visual descriptions to assess parental perception of their child's weight status while other studies have used either verbal descriptions or self-administered questionnaires. Further, the review also showed that parents' perception was categorized as underestimation, overestimation, accurate perception, misperception, and incorrect perception. Noteworthy, two studies reported fair agreement between parent perception of their child weight status and the actual weight status (kappa statistics = 0.214, 0.28 respectively)^{6,36}. Another study reported a significant association between parents' misperception and obesity status of their children (OR = 1.76, 95% CI = 1.32–2.34 $P < 0.05$)²². Furthermore, a couple of studies reported a significant relationship between accurate parental perceptions of their child's weight status and the child's actual weight status ($p < 0.01$)⁴⁷

3.3 Parents' Perception Regarding Risk Factors And Health Concerns Of Childhood Obesity

Six studies examined parents' perception regarding the risk factors of childhood obesity, parents perceived that genetic factors, less vegetable-consumption, low physical activity as key risk factors of childhood obesity¹⁵. Further, three studies revealed that parents perceived environmental factors such as poorly built environmental conditions, unsafe, dangerous environments, environmental barriers, and poorly maintained sidewalks had increased odds of being obese^{41,39,49}. Other studies showed that parents perceived that low physical activity and additional hours of watching television as risk factors of childhood obesity⁴⁰. Furthermore, another study

showed that some parents perceived walking and/or running are protective factors against childhood obesity²⁶. Finally, one study reported parents' perception regarding to health concerns of childhood obesity, thus parents of obese children are more likely to perceived the risk of hypertension (OR = 1.9), heart disease (OR = 2.26), type 2 diabetes (OR = 2.2) and depression (OR = 1.8) relative to parents of healthy weight children¹⁶.

4. DISCUSSION

This review was conducted to test the association between parental perceptions of childhood obesity and parents' perceptions regarding risk factors and health concerns of childhood obesity among children. As expected, this review affirms that parents' wrong perception regarding to their children weight status is quite common across the globe. Parents' misperception rates of their child's weight status varied from low to high and differ among parents' subgroups, ranging from 9.6% (China) to 90% (Saudi Arabia), which was consistent with the findings from preceding systematic reviews, that reveals wrong parental perception of their child's weight was more prevalent among parents with overweight/obese children when compared with parents with normal weight children⁹. Thus, only six out of 35 studies used visual descriptions. However, other studies either used verbal description or self-administered questionnaires and this can be explained by the issue of stigma. This conforms to a meta-analysis aimed at determining the proportion of parents worldwide who underestimate their children's weight and moderators of such misperceptions, which found that only eight out of 84 studies conducted worldwide used a visual assessment method⁵⁰. Although, other systematic review also revealed that only two out of eight studies used visual description to measure parental perception of their children's weight however, the other six studies used verbal description⁹. Similarly, this systematic review aimed at identifying the differences between parental perception and the actual weight status of children worldwide, this finding reveals that majority of studies used verbal descriptions⁵¹. This review shows that parents' wrong perception regarding their children weight status was higher in parents compared to only mother (90%, 30% respectively)^{23,24}, this finding is in accordance with previous findings of other study who reported a higher wrong perception in parents compared to only mother⁵², this can be explained by mothers having more concerned than fathers about their child's weight status. Noticeably, this systematic review revealed that obese children are often perceived as normal-weight children and not vice versa. This result supported the result of previous systematic review⁵¹. Parents' perception regarding risk factors of childhood obesity varies from inherited factors to dietary pattern and environmental factors¹⁵. This review showed that many parents perceived childhood obesity as "inherited" and controlled by genetics¹⁵, this finding is in consistent with previously published studies which revealed that parents felt their children were genetically predisposed to being overweight or obese^{53,52}. This review also revealed that parents perceived their children dietary pattern e.g. no vegetable intake is a key risk of childhood obesity. This is may be explained by the taste of the vegetables. This is supported by another study which found that parents felt the dietary lifestyle of children may affect their body weight status and increased risk of childhood obesity^{54,55}. The results obtained from this study suggest that when parents perceive their environment as unsafe, danger neighborhood

for their children to walk as having poor sidewalk conditions and having high traffic load that create barriers to physical activity, children are more likely to be obese^{39,41}. Moreover, some parents perceived that low physical activity time and more hours of watching television may increase the risk of being obese^{40,10}. This phenomena can be best explained by parents' belief that lack of movement and increasing sedentary time may lead to fat accumulation, thus increasing the risk of obesity. Our systematic review revealed that only one study assessed the parent-perceived risk that a child will develop obesity-related health conditions. Parents of obese children are more likely to perceive the risk of obesity-related comorbidity (e.g. hypertension, heart disease, type 2 diabetes, and depression) when compared to parents of healthy weight children¹⁶. This can be elucidated by the parents' distress of disease occurring to their children, although they are not able to do proper assessment of their children's weight status.

4.1 Limitation

Most studies used a cross-sectional design which is difficult to determine the causal relationship between parental characteristics and parental perception of their child's weight status. Most of the studies depended on the perceived and/or self-reported result of the parents regarding their children's weight status and/or parents' perception regarding risk factors of childhood obesity which can lead to under- or overestimation of the outcome, thus, there would be some recall bias. Most studies only examined the child's BMI, a measure parents may not fully understand comparing with other measures such as waist circumference, skinfold, or body fat. Most studies included either both parents or child-mother and no child-father couples, thus, could not test the differences in perception between genders of parents. This study did not include studies that were written in any other language except English, which may have omitted important findings related to the parental perception of child's weight.

4.2 Recommendation

Health care workers should be aware of the parents' wrong perception of their children's weight status due to the significant negative impact of childhood obesity at an early age as it may turn into adulthood obesity, hence, may lead to several comorbidities as mentioned above. Based on the result of this review, parental perception of the weight status

of their children is an inadequate diagnostic tool for obesity. Worthy to note is that weight status of children should therefore not be measured by asking the parents, but height and weight should be measured instead. The difference between parental visual and verbal perceptions of children weight status suggests that parents are sensitive to stigma which implies the need for educational programs which focuses on changing parents' norms on obesity and try to convince them that it is a disease that can be overcome and there is no need to feel shame or decency. Future research might include other measures such as skinfold, waist circumference which are easier to understand than BMI measures. Intervention programs aimed at reducing the burden of childhood obesity should focus on the parental perception of the risk factors contributing to childhood obesity for example, low physical activity, low vegetable intake, and environmental factors. Intervention programs that rely on parents' perceptions about the risks of childhood obesity and its health concern may be successful because it takes into account, the opinion of parents and their advice. Finally, all doctors dealing with young patients and evaluating the weight status should be aware that parents often misperceive the actual height and weight of their children.

5. AUTHORS CONTRIBUTION STATEMENT

Dr. Mawia M Beshti did the preliminary searches and extracted the listed information from all included full-texts into a data extraction template. Professor Tin Tin Suchecked the extracted information for accuracy and any discrepancies were resolved by discussion with other reviewers. Dr. Nik DalianaNik Farid contacted the authors of individual papers to obtain any missing information from the publication. All authors discussed the methodology and results and contributed to the final manuscript.

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7. CONFLICT OF INTEREST

Conflict of interest declared none.

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