

# Maternal perception of child overweight status and its association with weight-related parenting practices, their children's health behaviours and weight change in China

Jungwon Min<sup>1,\*</sup>, Vivian HC Wang<sup>2</sup>, Hong Xue<sup>1</sup>, Jie Mi<sup>3</sup> and Youfa Wang<sup>1,4,\*</sup>

<sup>1</sup>Systems-oriented Global Childhood Obesity Intervention Program, Fisher Institute of Health and Well-Being, College of Health, Ball State University, HP 302C, Muncie, IN 47306, USA: <sup>2</sup>Wagner School of Public Service, New York University, New York, NY, USA: <sup>3</sup>Department of Epidemiology, Capital Institute of Pediatrics, Graduate School of Peking Union Medical College, Beijing, People's Republic of China: <sup>4</sup>Department of Nutrition and Health Sciences, College of Health, Ball State University, HP 302E, Muncie, IN 47306, USA

Submitted 11 October 2016: Final revision received 24 March 2017: Accepted 21 April 2017: First published online 6 June 2017

## Abstract

**Objective:** Childhood obesity has increased rapidly in China, but understanding is limited on how parents perceive their child's weight status and how this perception affects weight-related parenting practices. We examined maternal perception of her child's weight status and its association with demographics, subsequent weight-related parenting practices, the child's health behaviours and weight change.

**Design/Setting/Subjects:** Maternal perception of child's weight status and health behaviours from the China Health and Nutrition Surveys were assessed at baseline and in follow-up surveys for 816 children aged 6–18 years during 2004–2011. Associations were tested using mixed models.

**Results:** Overall, maternal and child perceptions of the child's weight status were fairly consistent ( $\kappa_w = 0.56$ ), 63.8% of mothers had correct perception. While 9.6% of mothers perceived their child as overweight, 10.9% of children did so, and 13.6% of children were indeed overweight. Compared with mothers who viewed their children as normal weight, mothers who thought their 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). Children perceived as overweight by their mothers were more likely to have insufficient physical activity (2.8; 1.6, 4.7) and gain more weight during follow-up (BMI Z-score,  $\beta$  (SE): 1.0 (0.1);  $P < 0.01$ ) than children perceived by their mothers as normal weight.

**Conclusions:** In China, mothers who perceive their child as overweight are more likely to encourage their child to exercise and modify their diet for weight management, but this encouragement does not seem to improve the child's health behaviours and weight status.

**Keywords**  
Maternal perception  
Child weight status  
Obesity  
Parenting  
Health-related behaviour

In relation to the significant influence of parenting practices on children's eating behaviours, which has been well established<sup>(1,2)</sup>, several studies suggest parental perception of their child's overweight status is a protective factor against future weight gain during childhood<sup>(3)</sup>. When parents correctly assessed their children's weight status, they were more likely to perceive their overweight children as being less active and to overeat more often than other children<sup>(4)</sup>. In addition, overweight children with correct weight perceptions increased attempts to lose weight<sup>(5,6)</sup>.

However, worldwide, about half of parents underestimate their children's overweight status as reported by a recent systematic review with mean ages between 2 and

16 years<sup>(7)</sup>. The National Health and Nutrition Examination Survey in the USA showed that parental underestimation of pre-school children's overweight status has increased by 30% in the last 20 years<sup>(8)</sup>. Due to their cross-sectional designs, these studies have not shown a causal relationship between overweight perception and later weight loss. In contrast, a few longitudinal studies have found that children who are labelled fat by parents, family or peers have a higher risk of subsequent weight gain<sup>(9)</sup> or obesity<sup>(10)</sup>, but the underlying reasons are unknown. To our knowledge, children's age<sup>(7)</sup>, BMI<sup>(4,7,11,12)</sup>, parental education level<sup>(4,12)</sup>, maternal weight status<sup>(7)</sup>, maternal concern about their child's weight gain<sup>(13)</sup> and cultural

influence<sup>(12)</sup> significantly contribute to parental perception of child's weight status, although the effect of child sex<sup>(7,11)</sup> is not significant in all of these studies.

Interestingly, parents in China had higher misperception of their children's weight status compared with parents in some other countries<sup>(7)</sup>. It is reported that 56.0% of parents<sup>(14)</sup> and 65.4% of children<sup>(15)</sup> had inaccurate assessment of children's weight status. Although these perceptions seem to be associated with children's adverse health behaviours<sup>(14)</sup>, the cross-sectional study design did not allow testing how the perception may have affected weight-related parenting practices (e.g. parents might encourage their children to change their physical activity (PA) and eating behaviours to change their weight), while childhood obesity rates have been increasing over the last three decades in China<sup>(16,17)</sup>.

Using nationwide longitudinal survey data, the present study examined: (i) the prevalence of maternal and child perceptions of the child's weight status; (ii) the differences in perceptions by child sex, age, measured weight status, maternal weight status, parental education level and residence area; and (iii) their associations with subsequent weight-related parenting practices, child health behaviours and weight gain during follow-up.

## Methods and materials

### *Study design and study sample*

The China Health and Nutrition Survey (CHNS), which began in 1989, is conducted by the University of North Carolina at Chapel Hill and the Chinese Center for Disease Prevention and Control. It is a long-term, prospective, open-cohort study that applies a multistage random clustering sampling design and obtained information from about 4400 households with a total of 26 000 individuals in nine Chinese provinces at its inception. Later, more provinces and municipal cities were added. Thus far, CHNS has collected data in fifteen provinces and municipal cities. CHNS was not designed to be nationally representative, but it covers areas that account for approximately 45% of China's total population varying substantially in geography, economic development, public resources and health indicators to examine various socio-economic factors affecting people's health and nutritional status.

In CHNS, various measures on individuals (e.g. health, diet and PA), their family (e.g. residence, structure and income) and community have been collected. Data on individuals were collected by in-home visit interviews and survey questionnaires. Selected adults and children from the same household were enrolled. During in-home visit interviews, the data collectors asked the primary care provider's help if needed for the child response to survey questionnaires for children younger than 12 years old. Detailed information about the CHNS is provided elsewhere<sup>(18)</sup>. Informed consent was obtained from all study

participants for data collection. The present study was approved by the State University of New York at Buffalo Institutional Review Board.

The present study included only those first-born children aged 6–18 years ( $n$  2310) in families surveyed in 2004, 2006, 2009 and 2011, because data on maternal perception of child's weight status were collected from the mothers only for their first child in CHNS.

Children without information for age, sex, at least two weight and height measurements, and maternal and child perceptions of the child's weight status were excluded from our analysis, resulting in a final analytic sample of 816 children. For stratified analysis, two age groups were created: 6–11 and 12–18 years old.

## **Assessment and measures**

### *Child weight status*

Child weight and height were measured to the nearest 0.1 kg and 0.1 cm in light, indoor clothing without shoes using a weight scale (Floor Weight Scale No. 877; SECA, UK) and measuring tape (Mechanical Measuring Tape No. 206; SECA) by trained and certified staff during a detailed physical examination. All staff followed standard protocols of the National Center for Health Statistics in the USA and had to take inter-observer reliability tests as part of their training<sup>(18)</sup>. Child BMI ( $\text{kg}/\text{m}^2$ ) was calculated and transformed to a BMI Z-score according to the sex- and age-specific WHO reference growth charts<sup>(19)</sup>. Change in BMI Z-score was used to show weight gain during follow-up. Child weight status was classified as underweight, normal weight or overweight and obese, based on the International Obesity Task Force BMI cut-offs<sup>(20)</sup>.

### *Maternal and child perceptions of the child's weight status*

Mothers were asked to describe their first child's weight status, and children were asked to describe themselves as normal weight, underweight or overweight. Maternal and child perceptions of the child's weight status were categorized as correct/under-/over-perception by comparing their perceptions with the child's actual weight status based on the measured and calculated BMI and the International Obesity Task Force BMI cut-offs<sup>(20)</sup>.

### *Weight-related parenting practices*

Mothers were asked whether they encouraged their child to engage in more PA and to lose or gain weight through dieting, which meant modifying their usual eating habits to change weight.

### *Child health behaviours*

Children's responses on their PA level, diet, attempts to diet and screen time in the CHNS child survey were used in our analysis. Children's self-reports were classified by whether they were on a diet and whether their PA was too little, just the right amount or too much. PA was defined as

sports or activities that increased the heart rate or made them sweat.

Daily recreational screen time was defined as the average number of hours spent watching television, videos, DVD and (online) movies, playing video/computer games, surfing the Internet, and chatting online before or after school and over the weekend.

Children's food consumption data were collected using a 24 h recall and same-day interview conducted by trained nutritionists over three consecutive days. Total energy intake (kcal/d) and fat consumption (g/d) were calculated from the food consumption data<sup>(18)</sup>. Percentage of energy from fat was calculated as follows: % energy from fat = [(fat (g) × 9 kcal/g) / total energy (kcal)].

#### *Parental and household characteristics*

To consider the associations between family and household socio-economic status and maternal and child perceptions of child's weight status, we used parental weight status (overweight or obese, not overweight or obese), highest parental education (less than middle school, middle and high school, advanced degree(s)), household income per capita (tertiles) and residence (rural, urban). Parental weight status was classified using the Chinese BMI cut-points for overweight ( $24.0 \leq \text{BMI} < 28.0 \text{ kg/m}^2$ ) and obese ( $\text{BMI} \geq 28.0 \text{ kg/m}^2$ ) with measured anthropometrics.

#### **Statistical analysis**

First, we described the distributions of maternal and child perceptions of the child's weight status and examined differences in both perceptions and the mother-child matched perceptions with the child's actual weight status by demographic characteristics of the child, their families and households using the  $\chi^2$  test. Second, we tested agreement between maternal and child perceptions of the child's weight status using weighted kappa ( $\kappa_w$ ) and the total percentage of agreement in the overall sample and within subgroups.

To examine the longitudinal associations between maternal/child perceptions of the child's weight status and subsequent maternal behaviours and child's health, we used baseline perceptions from pooled data of the CHNS 2004, 2006 and 2009 and measurements of weight-related parenting practices, child's health behaviours and anthropometrics at least 2 years post-baseline. The interaction term between maternal/child weight perceptions and BMI Z-score at baseline was included in the mixed models to test whether the effect of perceived weight status on weight gain was moderated by the child's actual weight at baseline.

Mixed models were used, considering the CHNS sampling methods and hierarchical data structure. Our models included fixed and random effects (allowing individuals to have their own intercepts and slopes of their age) and adjusted for sex, age, BMI Z-score at baseline, survey wave, the interaction between maternal/child perceptions and BMI Z-score at baseline, urban/rural

residence and income level. In addition, parental education level and maternal weight status were included in the analyses to adjust for the influence of parental characteristics on parental perceptions.

Analyses were conducted using the statistical software packages SAS version 9.3 and Stata version 14. Effect size was presented as  $\beta$  coefficient with SE or OR with 95% CI, and significance was set as  $P < 0.05$  for all analyses.

#### **Results**

At baseline, half of the 816 children aged 6–18 years were boys (51.5%) and 34.3% lived in urban areas. Less than 10% of their parents had advanced degree(s) (Table 1).

#### **Maternal and child perceptions of child's weight status at baseline**

Among 816 children, 13.6% of children were overweight (Table 1). Table 2 describes the distributions of maternal and child perceptions of child weight status in all and stratified groups by demographics. Overall about 10% of mothers and children perceived the child as being overweight (mother: 9.6%, child: 10.9%; Table 2). More than half of mothers (63.8%) correctly perceived their child's weight status, while 22.2% of mothers under-perceived and 14.0% of mothers over-perceived compared with the child's actual weight status (see online supplementary material, Supplemental Table 1). Compared with normal- and underweight children, overweight children were less likely to be perceived correctly by mothers (40.5%) and by the children themselves (37.8% of 111; Table 2).

Overweight mothers and their children and urban children tended to perceive the child as being overweight more than their counterparts, which was not surprising because children with overweight mothers and living in urban areas had higher rates of overweight (Table 2). Mothers and children tended to under-perceive younger children's weight status compared with the weight status of older children ( $P < 0.05$ ; online supplementary material, Supplemental Table 1). However, mothers' and children's weight perceptions of the child did not differ by child sex.

Overall mothers' and children's weight perceptions of the child were fairly consistent with each other ( $\kappa_w = 0.56$ ,  $P < 0.001$ ), especially for boys, overweight children, urban children and children with overweight mothers compared with their counterparts (Table 2). Comparing the mother-child matched perceptions with the child's actual weight status, 52.8% of children and their mothers correctly assessed the child's weight status, but 24.3% of children and their mothers had the same wrong perception (both under- and over-perceptions) of child's weight status (online supplementary material, Supplemental Fig. 1). This misperception by both children and their mothers was greater for younger children (26.6% of 552) than older children (19.3% of 264,  $P < 0.001$ ).

**Table 1** Characteristics of Chinese children aged 6–18 years and their parents and families from baseline data collected in the China Health and Nutrition Survey (CHNS) of 2004, 2006 and 2009 (*n* 816)\*

	% or mean, SD
<b>Children</b>	
Year of data collection (%)	
2004	53.1
2006	18.5
2009	28.4
Age (years), mean	10.5
SD	2.7
Sex (%)	
Boy	51.5
Girl	48.5
BMI (kg/m <sup>2</sup> ), mean	17.2
SD	3.2
BMI Z-score†, mean	-0.17
SD	1.33
Weight status‡ (%)	
Underweight	20.0
Normal weight	66.4
Overweight	13.6
<b>Parents and households</b>	
Highest parental education§ (%; <i>n</i> 656)	
<Middle school	12.7
Middle & high school	79.7
Advanced degree(s)	7.6
Household income per capita (Yuan inflated to 2011; <i>n</i> 808), mean	7766.0
SD	7619.5
Residence (%)	
Rural	65.7
Urban	34.3
Maternal weight status   (%; <i>n</i> 631)	
Overweight	26.8
Obese	5.9
Non-overweight/obese	67.3
Paternal weight status   (%; <i>n</i> 524)	
Overweight	32.2
Obese	8.8
Non-overweight/obese	59.0

\*Although CHNS started in 1989, in the present study 'baseline data' refers to the first observation of subjects from pooled data of CHNS rounds of 2004, 2006 and 2009. Subjects having (i) both maternal and child perceptions of child weight status and (ii) at least 2 years' time gap between perceptions and the subsequent BMI Z-score were included in data analysis. The sample size was 816 unless indicated otherwise.

†BMI Z-score was calculated based on the sex- and age-specific WHO reference growth charts<sup>(19)</sup>.

‡Child weight status was classified by the extended International Obesity Task Force BMI cut-offs<sup>(20)</sup>.

§Highest parental education was defined by the higher achieved degree of either parent.

|| Parental weight status was classified using the Chinese BMI cut-off points for overweight ( $24 \leq \text{BMI} < 28.0 \text{ kg/m}^2$ ) and obese ( $\geq 28.0 \text{ kg/m}^2$ ).

### **Associations between maternal and child perceptions of child's weight status and follow-up weight-related parenting practices, child health-related behaviours and child weight gain**

Weight-related parenting practices, child health behaviours and child weight gain were significantly affected by prior maternal perception of the child's weight status in longitudinal analysis after adjusting for individual, parental and household demographic characteristics. Mothers who considered their children overweight were more likely to

encourage their children to engage in more PA (OR = 1.8; 95% CI 1.0, 3.3) and to change his/her weight through dieting (OR = 4.3; 95% CI 2.3, 7.8) than mothers who viewed their children as normal weight (Table 3).

Children who were perceived as overweight either correctly or incorrectly by mothers believed they had insufficient PA (OR = 2.8; 95% CI 1.6, 4.7) compared with children with normal weight perception by mothers (Table 3); however, there were no significant differences in children's attempts to diet and their levels of daily energy intake, percentage of energy from fat in total energy intake and screen time by maternal perception of the child's weight status (data not shown).

Also, children who were perceived as overweight by their mothers had a higher BMI Z-score increase ( $\beta = 0.95$  (SE 0.12),  $P < 0.001$ ) and a higher likelihood of becoming overweight at follow-up (OR = 21.7; 95% CI 8.9, 52.7) than those perceived as normal weight (Table 3). There were no significant interactions between child BMI Z-score and maternal weight perception of the child for every outcome variable. These results suggest that the association between identifying a child's weight status and the child's weight gain, as well as child health behaviours and weight-related parenting practices, are not dependent on the actual BMI of the child at baseline.

Children previously perceived as underweight by their mothers also were more likely to be encouraged to change their weight through dieting (OR = 2.5; 95% CI 1.6, 4.1) than those perceived as normal weight. These children also had a lower BMI Z-score increase ( $\beta = -0.54$  (SE 0.12),  $P < 0.001$ ) and a lower likelihood of becoming overweight (OR = 0.2; 95% CI 0.1, 0.7) at follow-up. Children's own weight perceptions had the same associations with follow-up weight-related parenting practices, child health behaviours and weight gain as mothers' perceptions of their child's weight status (Table 3).

## **Discussion**

Using nationwide longitudinal survey data collected during 2004–2011 in China, we examined maternal and child perceptions of the child's weight status, mother–child agreement, and how these perceptions affected follow-up weight-related parenting practices, the child's health-related behaviours and weight gain. Only 10% of Chinese mothers and children perceived the child as being overweight or obese, while 59.5% of mothers perceived their overweight child as being not overweight, compared with 50.7% of mothers in other countries as reported by a recent systematic review<sup>(7)</sup>. In particular, overweight children and younger children were less likely to be perceived correctly regarding their weight status by their mothers and themselves, compared with their counterparts.

Maternal perception of her child's overweight status appears to be a protective factor for weight-related

**Table 2** Maternal and child perceptions of the child's weight status and their agreement from baseline data collected in the China Health and Nutrition Survey (CHNS) of 2004, 2006 and 2009 (n 816)\*

	Maternal perception of their child's weight status				Child's own weight perception				Agreement between mother and child†	
	Underweight (n 195)	Normal weight (n 543)	Overweight (n 78)	P	Underweight (n 172)	Normal weight (n 555)	Overweight (n 89)	P	Total agreement (%)	$\kappa_w$
For all children (%)	23.9	66.5	9.6		21.1	68.0	10.9		77.1	0.56
By child weight status classified based on BMI calculated using measured weight and height (%)										
Underweight	44.8	49.7	5.5	<0.001	40.5	54.0	5.5	<0.001	76.1	0.60
Normal weight	21.2	74.4	4.4		18.3	74.7	7.0		76.8	0.44
Overweight	6.3	53.2	40.5		6.3	55.9	37.8		80.2	0.65
By child sex (%)										
Boys	24.5	63.8	11.7	0.07	21.7	66.7	11.6	0.65	79.0	0.62
Girls	23.2	69.4	7.3		20.5	69.4	10.1		75.0	0.49
By child age group (%)										
Young (<12 years)	26.6	64.0	9.4	0.02	22.3	67.4	10.3	0.40	76.6	0.57
Old (≥12 years)	18.2	72.0	9.8		18.6	69.3	12.1		78.0	0.54
By residence (%)										
Urban	22.9	66.4	10.7	0.67	20.7	64.3	15.0	0.02	78.9	0.61
Rural	24.4	66.6	9.0		21.3	69.9	8.8		76.1	0.53
By maternal weight status based on BMI calculated using measured weight and height‡ (%; n 631)										
Overweight	16.0	70.4	13.6	0.01	13.1	72.8	14.1	0.005	81.6	0.61
Non-overweight	25.4	65.4	9.2		24.0	65.2	10.8		76.9	0.57
By highest parental education§ (%)										
<Middle school	28.9	65.1	6.0	0.27	25.3	68.7	6.0	0.03	80.7	0.60
Middle & high school	22.0	67.3	10.7		20.1	68.3	11.6		78.2	0.59
Advanced degree(s)	18.0	66.0	16.0		16.0	60.0	24.0		78.0	0.57

$\kappa_w$ , weighted kappa.

\*Although CHNS started in 1989, in the present study 'baseline data' refers to the first observation of subjects from pooled data of CHNS rounds of 2004, 2006 and 2009. The final sample size in the analysis was 816 unless indicated otherwise.

†Agreement between maternal and child perceptions was described by sociodemographic characteristics. For example, overweight children had 80.2% agreement between maternal and child perceptions of the child's weight status, and their  $\kappa_w = 0.65$  ( $P < 0.001$ ). All  $\kappa_w$  statistics were statistically significant ( $P < 0.001$ ).

‡Maternal weight status was classified using the Chinese BMI cut-points for overweight ( $24 \leq \text{BMI} < 28.0 \text{ kg/m}^2$ ) and obese ( $\text{BMI} \geq 28.0 \text{ kg/m}^2$ ).

§Highest parental education was defined as the higher achieved education degree of either parent.

**Table 3** Longitudinal associations of baseline maternal and child perceptions of the child's weight status with subsequent (during follow-up) weight-related parenting practices and child's health-related behaviours and weight gain: the China Health and Nutrition Survey (CHNS) 2004–2011 (n 816)\*

Outcome	Baseline maternal perception on child weight status (reference = normal weight)						Baseline child's perception on own weight status (reference = normal weight)					
	Overweight			Underweight			Overweight			Underweight		
	$\beta$ OR	SE	95% CI	$\beta$ OR	SE	95% CI	$\beta$ OR	SE	95% CI	$\beta$ OR	SE	95% CI
Child BMI Z-score†	<b>0.95</b>	<b>0.12</b>		<b>-0.54</b>	<b>0.12</b>		<b>0.78</b>	<b>0.10</b>		<b>-0.44</b>	<b>0.08</b>	
Child being overweight	<b>21.68</b>	<b>8.92</b>	<b>52.70</b>	<b>0.18</b>	<b>0.05</b>	<b>0.69</b>	<b>11.80</b>	<b>5.48</b>	<b>25.41</b>	<b>0.23</b>	<b>0.08</b>	<b>0.69</b>
Child did too little PA‡	<b>2.75</b>	<b>1.60</b>	<b>4.72</b>	1.53	0.97	2.42	1.53	0.96	2.42	0.77	0.52	1.15
Parents asked child to engage in more PA	<b>1.84</b>	<b>1.02</b>	<b>3.32</b>	0.85	0.55	1.32	<b>1.65</b>	<b>1.03</b>	<b>2.63</b>	<b>0.62</b>	<b>0.42</b>	<b>0.91</b>
Parents encouraged child to change his/her weight through dieting	<b>4.25</b>	<b>2.31</b>	<b>7.82</b>	<b>2.53</b>	<b>1.56</b>	<b>4.11</b>	<b>2.75</b>	<b>1.60</b>	<b>4.72</b>	1.53	0.97	2.42

PA, physical activity.

\*In total 816 children aged 6–18 years old and having (i) both maternal and child perceptions of child weight status and (ii) at least 2 years' later follow-up BMI Z-score were included in data analysis from CHNS 2004–2011 (number of data points = 1089). Separate mixed models were fit for each perception (maternal v. child's) and for each outcome, respectively. The models adjusted for child sex, age, BMI Z-score at baseline, survey wave, interaction between maternal perception and BMI Z-score at baseline, urban/rural residence, family income level, parental education (only included in the analysis of maternal perception effect) and maternal weight status (only included in the analysis of maternal perception effect). Significant results ( $P < 0.05$ ) are shown in bold font.

†All associations between maternal and child's perception of the child's weight status and BMI Z-score were statistically significant ( $P \leq 0.001$ ).

‡Children's self-reported data were used in the analysis.

parenting practices. Mothers would encourage their child to pursue weight management through PA and diet if they perceived their child as overweight. However, such

maternal perception and encouragement were not linked to the child's healthy eating and self-rated PA level, despite being associated with increased childhood weight gain

during the follow-up. Other factors of the household environment may impede the effect of maternal perception and encouragement on preventing childhood obesity.

Maternal perception of the child's weight status has been considered a key factor in obesity prevention and management<sup>(3)</sup>. First, parents are not good at accurately classifying their child's weight status<sup>(21)</sup>. In a worldwide meta-analysis<sup>(7)</sup>, about 50.7% parents underestimated their children's overweight status. Second, when parents underestimate their children's weight, they are more likely to report that their overweight children 'overeat less often' and are 'moderately active' compared with parents with correct classifications<sup>(4)</sup>. Third, parents do not allow their children to participate in an obesity prevention intervention if they believe their overweight/obese child does not have a weight problem<sup>(22)</sup>. These findings from cross-sectional studies support the popular belief that being perceived overweight by parents is a protective factor against children's future weight gain through better weight-related parenting practices<sup>(3)</sup>.

We found moderate agreement between maternal and child perceptions of the child's weight status (total agreement = 77.1%;  $\kappa_w = 0.56$ ,  $P < 0.001$ ), which may be partially due to parental impact on children's self-weight perception. As expected, we also found weight-related parenting practices were significantly different by maternal perception of the child's weight status. Mothers who perceived their child as overweight were more likely to encourage the child to increase PA and to change his/her weight through dieting. This pattern is similar to previous findings: correct weight perception is helpful for better control over lifestyles such as attempts to do more PA and eat less<sup>(5,6)</sup>.

Yet, as indicated in the present study, maternal concerns about their children's weight status were not sufficient to change child health behaviours or to reduce the risk of overweight during the follow-up years. Children whose mothers had perceived them as overweight thought they still had insufficient PA and they did not try to diet, modify their energy intake or reduce sedentary time more than children perceived as normal weight. Subsequently, children perceived as overweight gained more weight and had a higher risk of being overweight across childhood than did their counterparts. Also, several recent studies have found neither self-perception of overweight status among adults nor parental perception of child's overweight status is a protective factor for subsequent weight gain, even though they were associated with an increased risk of future weight gain in longitudinal analysis<sup>(9,23,24)</sup>. The underlying mechanisms remain to be determined.

We speculate these results could be due to the possible struggle between self-motivation from recognizing undesirable weight status (i.e. being overweight) and low self-esteem from weight stigma<sup>(25)</sup>. Tomiyama described the cyclic obesity/weight-based stigma model as a positive

feedback loop wherein weight stigma begets weight gain through increased eating behaviour and increased cortisol secretion governed by behavioural, emotional and physiological mechanisms, which are theorized to ultimately result in weight gain and difficulty of weight loss. Indeed, one study found that children who were labelled as fat by a family member or peer in early childhood were more likely to gain more weight into adolescence<sup>(26)</sup>. As indicated by weight management programmes, promoting children's self-motivation through self-esteem is a key factor for successful obesity interventions<sup>(27)</sup>. Encouraging overweight children's self-esteem may further enhance the moderate effects of the combined obesity interventions delivered in schools and home<sup>(28)</sup>.

Our study indicates that the rate of Chinese mothers with correct overweight perception of their children is lower than that of other countries, based on a worldwide meta-analysis<sup>(7)</sup>. However, those mothers who were overweight or who had overweight children or urban children recognized the child as being overweight more than their counterparts, as these children had a higher risk of becoming overweight. To help these groups at risk, obesity intervention programmes in China should promote children's self-motivation and improve their health behaviours. This will help reduce the growing epidemic of obesity and chronic diseases in China<sup>(16,29-32)</sup>.

The current study had some limitations. Since data on the maternal perception of child's weight status were collected only for the mother's first child in CHNS, second and later children may have somewhat different effect size in the association. The level or intensity of children's PA was not available to analyse as a function of maternal weight perception due to high rates of missing data. Due to data limitations, we could not account for the effects of breast-feeding history, birth weight and infancy growth characteristics. However, the study used a nationwide sample and longitudinal data, and studied the impact of maternal perceptions of children's overweight status on children's health behaviours and longitudinal risk of weight gain. Fifteen provinces and municipal cities that vary substantially in geography, economic development and public resources across China were included CHNS. Thus, findings based on the CHNS data could be generalized for the total Chinese population. The results provide some insight for future family-based interventions to fight the rising child obesity epidemic in China and other countries.

## Conclusion

In conclusion, maternal perceptions of their children being overweight status led to weight-related parenting practices for child weight management, such as encouraging their child to increase exercise and modify their diet, but this did not improve children's health behaviours or weight

status. In China, obesity intervention programmes need to empower parents on accurate perception of their children's weight status and healthy parenting practices and to motivate overweight children to maintain a healthy body weight.

### Acknowledgements

**Acknowledgements:** The authors thank Dr Paula Vincent for her assistance in helping improve the manuscript. **Financial support:** The study was supported by the US National Institutes of Health (NIH; grant number U54HD070725). The U54 project (U54 HD070725) is co-funded by the NIH Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) and the Office of the Director, National Institutes of Health (OD). Y.W. is the principal investigator. The content of the paper is solely the responsibility of the authors and does not necessarily represent the official views of the funders. **Conflict of interest:** None. **Authorship:** J. Min, V.H.C.W. and Y.W. formulated the research. J. Min, V.H.C.W. and Y.W. analysed the data and drafted the article. H.X., J. Mi and Y.W. revised the manuscript with critical comments. **Ethics of human subject participation:** Informed consent was obtained from all study participants for data collection in the CHNS. The present study was approved by the State University of New York at Buffalo Institutional Review Board.

### Supplementary material

To view supplementary material for this article, please visit <http://doi.org/10.1017/S1368980017001033>

### References

- Wang Y, Beydoun MA, Li J *et al.* (2011) Do children and their parents eat a similar diet? Resemblance in child and parental dietary intake: systematic review and meta-analysis. *J Epidemiol Community Health* **65**, 177–189.
- Reicks M, Banna J, Cluskey M *et al.* (2015) Influence of parenting practices on eating behaviors of early adolescents during independent eating occasions: implications for obesity prevention. *Nutrients* **7**, 8783–8801.
- Duncan DT (2011) Parental misperception of their child's weight status: clinical implications for obesity prevention and control. *Obesity (Silver Spring)* **19**, 2293.
- Mathieu ME, Drapeau V & Tremblay A (2010) Parental misperception of their child's body weight status impedes the assessment of the child's lifestyle behaviors. *Int J Pediatr* **2010**, 306703.
- Yost J, Krainovich-Miller B, Budin W *et al.* (2010) Assessing weight perception accuracy to promote weight loss among US female adolescents: a secondary analysis. *BMC Public Health* **10**, 465.
- Edwards NM, Pettingell S & Borowsky IW (2010) Where perception meets reality: self-perception of weight in overweight adolescents. *Pediatrics* **125**, e452–e458.
- Lundahl A, Kidwell KM & Nelson TD (2014) Parental underestimates of child weight: a meta-analysis. *Pediatrics* **133**, e689–e703.
- Duncan DT, Hansen AR, Wang W *et al.* (2015) Change in misperception of child's body weight among parents of American preschool children. *Child Obes* **11**, 384–393.
- Robinson E & Sutin AR (2016) Parental perception of weight status and weight gain across childhood. *Pediatrics* **137**, e20153957.
- Sutin AR & Terracciano A (2015) Body weight misperception in adolescence and incident obesity in young adulthood. *Psychol Sci* **26**, 507–511.
- Yao NL & Hillemeier MM (2012) Weight status in Chinese children: maternal perceptions and child self-assessments. *World J Pediatr* **8**, 129–135.
- Remmers T, van Grieken A, Renders CM *et al.* (2014) Correlates of parental misperception of their child's weight status: the 'Be Active, Eat Right' study. *PLoS One* **9**, e88931.
- Hernandez DC, Reesor L, Machuca I *et al.* (2016) Low-income immigrant Hispanic mothers' concerns and perceptions of their young child's weight. *Public Health Nurs* **33**, 412–420.
- Wen X & Hui SS (2011) Chinese parents' perceptions of their children's weights and their relationship to parenting behaviours. *Child Care Health Dev* **37**, 343–351.
- Zhao M, Zhang M, Zhou X *et al.* (2012) Weight misperception and its barriers to keep health weight in Chinese children. *Acta Paediatr* **101**, e550–e556.
- Wang Y, Mi J, Shan XY *et al.* (2007) Is China facing an obesity epidemic and the consequences? The trends in obesity and chronic disease in China. *Int J Obes (Lond)* **31**, 177–188.
- Sun H, Ma Y, Han D *et al.* (2014) Prevalence and trends in obesity among China's children and adolescents, 1985–2010. *PLoS One* **9**, e105469.
- China Health and Nutrition Survey (2016) Data collection. <http://www.cpc.unc.edu/projects/china/about/design/datacoll> (accessed January 2016).
- World Health Organization (2006) WHO Child Growth Standards: Methods and Development: Length-/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age. [http://www.who.int/childgrowth/standards/technical\\_report/en/](http://www.who.int/childgrowth/standards/technical_report/en/) (accessed January 2016).
- Cole TJ, Bellizzi MC, Flegal KM *et al.* (2000) Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* **320**, 1240–1243.
- Towns N & D'Auria J (2009) Parental perceptions of their child's overweight: an integrative review of the literature. *J Pediatr Nurs* **24**, 115–130.
- Taveras EM, Hohman KH, Price SN *et al.* (2011) Correlates of participation in a pediatric primary care-based obesity prevention intervention. *Obesity (Silver Spring)* **19**, 449–452.
- Robinson E, Hunger JM & Daly M (2015) Perceived weight status and risk of weight gain across life in US and UK adults. *Int J Obes (Lond)* **39**, 1721–1726.
- Liechty JM & Lee MJ (2015) Body size estimation and other psychosocial risk factors for obesity onset among US adolescents: findings from a longitudinal population level study. *Int J Obes (Lond)* **39**, 601–607.
- Tomiyama AJ (2014) Weight stigma is stressful. A review of evidence for the cyclic obesity/weight-based stigma model. *Appetite* **82**, 8–15.
- Hunger JM & Tomiyama AJ (2014) Weight labeling and obesity: a longitudinal study of girls aged 10 to 19 years. *JAMA Pediatr* **168**, 579–580.

27. Lowry KW, Sallinen BJ & Janicke DM (2007) The effects of weight management programs on self-esteem in pediatric overweight populations. *J Pediatr Psychol* **32**, 1179–1195.
28. Wang Y, Cai L, Wu Y *et al.* (2015) What childhood obesity prevention programmes work? A systematic review and meta-analysis. *Obes Rev* **16**, 547–565.
29. Wang Y, Wang L & Qu W (2017) New national data show alarming increase in obesity and noncommunicable chronic diseases in China. *Eur J Clin Nutr* **71**, 149–150.
30. Jia P, Li M, Xue H *et al.* (2017) School environment and policies, child eating behavior and overweight/obesity in urban China: the childhood obesity study in China megacities. *Int J Obes (Lond)* **41**, 813–819.
31. Xu F, Ware RS, Tse LA *et al.* (2012) A school-based comprehensive lifestyle intervention among Chinese kids against obesity (CLICK-Obesity): rationale, design and methodology of a randomized controlled trial in Nanjing city, China. *BMC Public Health* **12**, 316.
32. Xu F, Ware RS, Leslie E *et al.* (2015) Effectiveness of a randomized controlled lifestyle intervention to prevent obesity among Chinese primary school students: CLICK-Obesity Study. *PLoS One* **10**, e0141421.