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Sex-Based Differences in Weight Misperception and its Related Factors among Korean Children and Adolescents

The Korea National Health and Nutrition Examination Survey, 2009-2013

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Department of Public Health
The Graduate School
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Sex-Based Differences in Weight Misperception and its Related Factors among Korean Children and Adolescents

The Korea National Health and Nutrition Examination Survey, 2009-2013

A Doctoral Dissertation
submitted to the Department of Public Health,
the Graduate School, Yonsei University
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Anna Shin

February 2016

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ABSTRACT

Sex-Based Differences in Weight Misperception and its Related Factors among Korean Children and Adolescents

The purpose of this study was to quantify the extent of parental misperception of their child's weight, and to explore sex-based differences in socio-demographic factors associated with parental misperception among Korean children. Data on 3,228 children aged 6-11 years were collected from the Korea Health and Nutrition Examination Survey (KNHANES) datasets (2009–2013). The generalized logit model was used to explore sex-based differences in socio-demographic factors associated with parental misperception.

Overall, 27.4% of parents of boys and 23.7% of parents of girls misclassified their child's weight status. Parents of both boys and girls were more likely to underestimate rather than overestimate their child's weight. Parental misperception was associated with socio-demographic factors such as age, BMI, place of residence, maternal perception of their own weight, and parental obesity. Particularly, parental obesity was a significant variable only among girls. Understanding parental misperception patterns depending on sex might be the initial step towards desirable interventions for weight control.

Another purpose was to quantify the extent of weight misperception, to explore sex-based differences in socio-demographic factors associated with weight misperception, and to examine sex-based differences in the relationship between weight misperception and health-related factors among Korean adolescents. We selected data on 3,385 adolescents aged 12–18 years from the KNHANES datasets (2009–2013). The generalized logit model was used to explore the relationship between weight misperception and socio-demographic factors, and separate logistic regression models were fitted to examine the association between weight misperception and health-related factors.

Overall, 26.2% of boys and 27.9% of girls misclassified their weight status. Both boys and girls were more likely to overestimate rather than underestimate their weight. Particularly, girls were more than four-times more likely to overestimate rather than underestimate their weight. Weight misperception was associated with socio-demographic factors, such as gender, age, BMI, household income, maternal education level, place of residence, and number of family members. Household income was linked to weight overestimation and underestimation among boys. Maternal education level, place of residence, and number of family members were significant variables among girls. Weight overestimation was related to inappropriate weight control practice among girls.

However, among boys, both weight underestimation and overestimation were associated with inappropriate weight control practice. Vigorous exercise was negatively associated with weight overestimation only among boys. Drinking experience was also positively associated with weight overestimation among girls. Based on understanding the characteristics of sex-based differences in weight misperception patterns and their association with health-related factors, individualized intervention programs according to sex could be devised for adolescents and their parents.

Keywords: weight misperception, overweight, underweight, weight control practice, body weight

Ⅰ. Introduction

1) Parental misperception of their child's weight and its association with socio-demographic factors among Korean children

Childhood obesity has been increased over the past three decades and emerged as risk factors for health problems [1, 2]. In the United States, the prevalence of obesity among 6-11 year olds increased from 11% in 1988-1994 to 18% in 2009-2010 [2]. Meanwhile, the situation in South Korea is quite different. The prevalence of obesity among primary school-aged children had more than doubled from 4.2% in 1997 to 8.6% in 2005 [3], but had decreased to 7.1% in 2012 [4].

According to previous studies, a considerable number of parents cannot estimate their child's weight correctly [5-8]. In particular, a study examining a representative sample of preschoolers revealed that more than one-third of mothers misclassified their child's weight status as being lower than the actual status [9]. Some of these studies have focused on factors influencing the maternal or parental misperception, and their findings suggest that parental perceptions are influenced by children's characteristics such as age, gender, measured weight status, and parental education level [5, 6, 10]. Parental weight perception might be an important determinant of child's body weight development in later life [9], as

the eating and physical activity patterns of children are mainly influenced and controlled by parents [11, 12]. If parents cannot perceive their child's weight status accurately, then childhood obesity prevention or weight control programs are unlikely to be successful [6].

Despite the importance of parental perception of their child's weight, data on paternal/maternal measured weight status and parental self-perception of their own weight status have been included in few studies. Therefore, further studies that focus on the association of parental perception of their child's weight and of their own weight would be meaningful to explore the factors associated with parental misperception of their child's weight according to sex. In addition, as most of the previous studies in this field have been carried out in the Western countries, similar studies in other populations with different social and cultural backgrounds are needed to understand if the results can be generalized.

2) Weight misperception and its association with socio-demographic and health-related factors among Korean Adolescents

Adolescence is a time of rapid growth with dramatic changes in physical appearance. Both boys and girls move through puberty and become accustomed (or not) to their new body shape and size [13]. The body image established at this time could affect their physical and mental health throughout their entire life. A

previous study indicates that adolescents are often split between those who desire to lose weight versus those who desire to gain weight [14]. This means that adolescents sometimes perceive themselves as underweight or overweight irrespective of actual weight status. Weight misperception is the discordance between an individual's actual weight status and the perception of his/her weight [15]. According to a recent study, body size misperception was a strong predictor of body dissatisfaction regardless of actual weight status [16]. Thus, along with body dissatisfaction, weight misperception is a meaningful variable in obesity prevention and treatment programs for adolescents.

Weight misperception is a prevalent concern among adolescents in both Western and Eastern countries [17-20]. According to a US study featuring data from the nationally representative Youth Risk Behavior Surveillance System collected every 2 years from 1999 through 2007, 29-33% of overweight adolescents misperceived their weight [21]. A Korean study using the 2011 Korea Youth Risk Behavior Web-based Survey-VII data revealed that the prevalence of weight misperception was 49.3% (overestimation, 23.7%; underestimation, 25.6%) [22].

Meanwhile, significant sex-specific differences in weight perception and weight control practices have been reported. Girls tend to overestimate their weight, while boys tend to underestimate their weight [23-27]. Girls also have

more interest in body weight and control their weight more aggressively than boys [28, 29]. A thin body (e.g. low waist-hip ratio, low volume-height index) is associated with female bodily attractiveness [30], whereas a v-shaped upper body (e.g. low waist-chest ratio), which is related to muscularity, is associated with male bodily attractiveness [30]. Thus, boys and girls may be striving for a sex-specific ideal of bodily attractiveness, and perceive themselves to be falling short of the ideal.

Weight misperception among adolescents is affected by various factors, including socio-demographic and environmental factors [18, 23, 31-34]. Weight misperception patterns in different populations also vary depending on age, gender, BMI, ethnicity, and socioeconomic status (SES) [23, 30, 34, 35]. A study using US representative data revealed that there was no significant association between weight misperception and family poverty-income ratio as an indicator of adolescents' SES [27]. However, according to recent Korean studies, gender, BMI, and SES were significantly associated with weight misperception [22, 25]. Therefore, further studies are needed to establish evidence for an association between weight misperception and socio-demographic factors.

Weight perception is also related to health-related factors, such as weight control practices and psychosocial impairment [25, 36-39]. Previous studies suggested that body weight/shape concerns were potential mediators of the

association between obesity and psychosocial impairment [40-43]. These findings indicate the need to target weight perception in the clinical management of obesity, that is, in addition to body weight, in order to improve both physical health and psychosocial outcomes [41]. Weight perception may affect physical activity or weight control behaviors, but the relationship between accurate weight perception and healthy physical activity remains uncertain. According to a previous study, obesity was associated with lower prevalence of sufficient physical activity for health benefits, but the relationship could be weakened by weight perception status [44]. This means that weight misperception could be another barrier to physical activity participation among obese men and women [44].

Much of the existing research has been confined to studies focusing on weight misperception and its association with socio-demographic factors among adolescents recruited from Western population. Previous Korean studies mostly investigated weight misperception patterns using BMI calculated from self-reported height and weight. Besides, limited studies have been performed to explore health-related factors associated with weight misperception, and the relationships between weight misperception and health-related factors still remains uncertain. Therefore, further studies are needed to examine sex-based differences in the relationships between weight misperception and health-related factors, using a representative dataset from the South Korean population.

Ⅱ. **Chapter One** – Parental misperception of their child's weight and its association with socio-demographic factors among Korean children

1. Objectives

The purpose of this study was to quantify the extent of parental misperception of their child's weight, using a nationally representative dataset from the general South Korean population, and to explore sex-based differences in socio-demographic factors associated with parental misperception of their child's weight.

2. Methods

1) Database and study population

This study used data obtained from the Korea National Health and Nutrition Examination Survey (KNHANES) conducted from 2009 through 2013, which was a cross-sectional and nationally representative survey examining the health and nutrition status of South Koreans. The target population of KNHANES comprises non-institutionalized Korean citizens residing in Korea. The sampling plan follows a multi-stage clustered probability design. For example, in the 2011 survey, 92 primary sampling units (PSUs) were drawn from approximately

200,000 geographically defined PSUs for the whole country [45]. A PSU consisted of an average of 60 households, and 20 final target households were sampled for each PSU using systematic sampling; in the selected households, all individuals aged 1 year and over were targeted [45]. The surveys included the Health Interview Survey, Health Examination Survey, and Nutrition Survey. The health interview and health examination are performed by trained medical staff and interviewers at the mobile examination centre, and dieticians' visits to the homes of the study participants are followed up. According to standardized protocols, all health examination procedures are performed by trained medical personnel and all equipment is calibrated periodically [45]. The response rates for the Health Interview Survey and Health Examination Survey were 79.2% (2009), 77.5% (2010), 76.1% (2011), 75.9% (2012), and 75.0% (2013). More details regarding the survey design and methods have been provided elsewhere [46].

From the five-year KNHANES datasets (2009-2013), we selected data on 3,643 children aged 6-11 years, including their information on demographic characteristics, household environment, socioeconomic status, their health status, and their parents' health status. However, data obtained from 196 respondents were excluded because there was no information on their parents at all. Additionally, owing to missing information for major variables such as body mass index and parental perception of their child's weight status, we excluded data on

219 respondents. Finally, we selected 3,228 children aged 6-11years for the present study. Approval was obtained from the Institutional Review Board of Yonsei University's Graduate School of Public Health.

2) Measurements

Classification of objective weight status Objective weight status of children was determined according to a respondent's body mass index (BMI, the weight in kilograms divided by the square of the height in meters) which was based on anthropometric measurements from the Health Examination Survey. The cut-points for weight classification by clinical standards are as follows: underweight (BMI < 5th percentile), normal (5th ≤ BMI < 85th percentile), overweight (85th ≤ BMI < 95th percentile), and obese (BMI ≥ 95th percentile for age and gender, using the 2007 Korean Pediatric Growth Charts [47]). Objective weight status of parents was also based on a parent's BMI from the Health Examination Survey. The cut-points for parents' weight classification are as follows: underweight (BMI < 18.5 kg/m^2), normal (18.5 ≤BMI < 23 kg/m^2), overweight (23 ≤BMI < 25kg/m^2), and obese (BMI ≥25 kg/m^2) using the World Health Organization guidelines for Asian populations which were applied to obesity classification in the KNHANES [48].

Classification of parental perception of their child's weight Parental perception of their child's weight was assessed through the question: "How do you describe your child's weight status?" The answer options for the question were "very underweight", "slightly underweight", "about the right weight", "slightly overweight", and "very overweight". One parent who knew best about their child's health status answered to the question. So, the information on parental perception might be mainly derived from the mother. The answer was reclassified into 4 categories: very underweight, slightly underweight or about the right weight, slightly overweight, and very overweight. 'Very underweight' and 'very overweight' of subjective standards correspond to 'underweight' and 'obese' of objective standards, respectively. 'Slightly underweight or about the right weight' of subjective standards corresponds to 'normal' of objective standards. Parent-perceived weight status was compared to classification by objective standards mentioned above. Participants were then placed into one of three categories: correct perception (parental perception is concordant with objective weight status), underestimate (parental perception is in a lighter category than objective weight status), overestimate (parental perception is in a heavier category than objective weight status). Classification of parental perception of their own weight status was also implemented in the same way.

Socio-demographic factors Household equivalent income was calculated by dividing total family income by the square root of the number of family members, and then was categorized as quartiles (lowest, middle-low, middle-high and highest). Place of residence was classified, according to the national administration system, as living in an urban area or not (e.g., living in a town or in the countryside). In consideration of the distribution in family size, the number of family members was classified into 3 categories: ≤3, 4, and ≥5 members. Parental obesity was defined as a BMI at or above 25 for a child's parents. The survey results of parental obesity status were reclassified into 4 categories: 1) both parents; 2) only father; 3) only mother; 4) neither parent was obese. Parental education level was classified as less than or achievement of graduation of middle school, graduation from high school and more than or achievement of graduation of college. The survey results of parental education level also were reclassified into 4 categories: 1) both parents graduated from 2- or 4-year college or above; 2) only father; 3) only mother; 4) neither parent.

3) Statistical analysis

The five-year KNHANES datasets (2009–2013) were merged. Data in all statistical analyses for our study were weighted to account for the complex sampling design of the KNHANES. Based on a review of the literature, we first

selected socio-demographic variables related to parental perception of their child's weight status, including age, gender, BMI, household equivalence income, place of residence, number of family members, maternal/paternal education level, maternal/paternal obesity, and maternal/paternal perception of their own weight status from the 5-year dataset. To review the relationships between those variables and parental perception of their child's weight (correct, underestimate, overestimate groups), chi-square tests (PROC SURVEYFREQ in SAS) were used. As a result, the factors showing a statistically significant difference ($p < 0.05$) were chosen for a multivariate logistic regression, provided that age, BMI, and household equivalence income were included irrespective of its P-value.

The general characteristics of study population were displayed as percents weighted using survey sample weights for categorical variables, and as mean and standard error of means for continuous variables. Parent-perceived child's weight status was compared with objective weight status based on BMI by cross-tabulation. To measure agreement between objective weight status and parent-perceived weight status, kappa statistics based on the survey weighted cell percentages were calculated. The generalized logit model was used to explore sex-based differences in socio-demographic factors associated with parental misperception of their child's weight status, after accounting for primary sample units, stratification, and sample weights from the KNHANES. 'Correct weight

perception' served as reference for comparison. Statistical analyses were performed using the software SAS version 9.2 (SAS Institute, Cary, NC, USA) and a p-value < 0.05 was considered statistically significant.

3. Results

1) Agreement between objective weight status and parent-perceived weight status

Table 1 presents the socio-demographic characteristics of the overall sample. Comparisons of parental perception of their child's weight with the measured objective weight status of the child are shown in Table 2.

Overall, 27.4% of parents of boys and 23.7% of parents of girls misclassified their child's weight status, according to the objective standards. Among these misclassification cases, 14.7% of parents of boys and 13.0% of parents of girls underestimated their child's weight, although 12.7% of parents of boys and 10.7% of parents of girls overestimated their child's weight status. In the obese group (according to objective standards), 49.5% of parents of obese boys and 73.1% of parents of obese girls believed that their children were slightly overweight. In addition, 38.9% of parents of underweight boys and 40.6% of parents of underweight girls considered their children to be approximately the right weight. However, 99.1% of the misclassification cases in boys and 98.1% of the

misclassification cases in girls only exhibited a difference between parent-perceived and objective weight status of one position on the scale. Based on survey-weighted cell percentages, the Kappa statistic *(k)* is 0.46 for boys and 0.46 for girls, suggesting a moderate agreement between objective and parent-perceived weight status.

Table 3 shows that 16.8% of mothers of boys and 15.5% of mothers of girls underestimated their own weight, and 16.6% of mothers of boys and 17.5% of mothers of girls overestimated their own weight. In the underweight group, 66.2% of underweight mothers of boys and 71.3% of underweight mothers of girls considered their weight to be approximately the right weight. In the obese group, 57.2% of obese mothers of boys and 50.5% of obese mothers of girls believed that they were slightly overweight, and 2.8% of obese mothers of boys and 2.0% of obese mothers of girls considered their weight to be about the right weight. The Kappa statistic *(k)* is 0.48 for mothers of boys and 0.49 for mothers of girls, suggesting a moderate agreement between objective and self-perceived weight status.

Table 1. Socio-demographic characteristics among Korean children[a, b]

Variable	Boys (n=1,699)	Girls (n=1,529)	All (n=3,228)
Age (years)	8.64(0.05)	8.62(0.05)	8.63(0.03)
Body mass index (BMI, kg/m²)	18.20(0.10)	17.25(0.08)	17.75(0.07)
Household equivalent income quartile			
Lowest	24.13	24.04	24.09
Middle-low	26.02	27.47	26.71
Middle-high	26.68	25.25	26.00
Highest	23.18	23.24	23.21
Residence			
Urban area	83.22	84.24	83.70
Rural area	16.78	15.76	16.30
Number of family members			
≤3 members	14.90	12.05	13.55
4 members	55.06	54.83	54.95
≥5 members	30.03	33.11	31.50
Maternal weight status			
Underweight	5.77	5.28	5.54
Normal	71.78	72.16	71.96
Obese	22.45	22.56	22.50
Paternal weight status			
Underweight	0.59	0.52	0.56
Normal	55.04	60.63	57.67
Obese	44.37	38.84	41.77
Maternal education level			
≤ Middle school	4.50	3.39	3.97
High school	53.58	53.63	53.60
≥ College	41.92	42.98	42.43
Paternal education level			
≤ Middle school	5.62	6.18	5.88
High school	41.18	40.69	40.95
≥ College	53.20	53.13	53.17

[a] For categorical variables, cell percentage (%) was a weighted percentage using survey sample weights.
[b] For continuous variables, mean and standard error of means were provided.

Table 2. Comparison of objective weight status of children with their parent-perceived weight status[a,b,c,d]

Parent-perceived status	Objective status (Percentile of BMI)				
	Underweight ($P < 5^{th}$)	**Normal ($5^{th} \leq P < 85^{th}$)**	**Overweight ($85^{th} \leq P < 95^{th}$)**	**Obese ($P \geq 95^{th}$)**	**Total[e]**
	% (SE)	**% (SE)**	**% (SE)**	**% (SE)**	**% (SE)**
Boys (n=1,699)					
Very underweight	**2.50(0.43)**	9.14 (0.80)	—	—	11.64 (0.90)
Slightly underweight/ about right	1.57(0.40)	**57.17 (1.43)**	1.87 (0.35)	0.15 (0.09)	60.75 (1.39)
Slightly overweight	0.02(0.02)	9.42 (0.85)	**9.16 (0.80)**	3.55 (0.59)	22.17 (1.17)
Very overweight	—	0.08 (0.06)	1.58 (0.33)	**3.78 (0.58)**	5.44 (0.67)
Total[e]	4.09 (0.57)	75.82 (1.24)	12.61 (0.94)	7.48 (0.80)	
Girls (n=1,529)					
Very underweight	**3.66 (0.60)**	6.02 (0.69)	—	0.05 (0.05)	9.73 (0.93)
Slightly underweight/ about right	2.51 (0.48)	**64.04 (1.44)**	2.28 (0.45)	0.27 (0.13)	69.09 (1.42)
Slightly overweight	—	7.74 (0.83)	**6.92 (0.77)**	4.37 (0.59)	19.03 (1.17)
Very overweight	—	0.12 (0.12)	0.30 (0.14)	**1.73 (0.36)**	2.15 (0.40)
Total[e]	6.17 (0.74)	77.91 (1.24)	9.49 (0.85)	6.43 (0.71)	

[a] SE, standard error.
[b] P, Percentile of BMI for age and gender, using the 2007 Korean Pediatric Growth Charts.
[c] The cell percentages (%) are weighted percentages using survey sample weights.
[d] Bold numbers indicate correct perception.
[e] The total percentage of objective or subjective measured weight status.

Table 3. Comparison of objective weight status of mothers with self-perception of their own weight status[a,b,c,d]

Self-perceived status	Objective status				Total[e] % (SE)
	Underweight (BMI < 18.5) % (SE)	Normal (18.5 ≤ BMI < 23) % (SE)	Overweight (23 ≤ BMI < 25) % (SE)	Obese (BMI ≥ 25) % (SE)	
Mothers of boys (n=1,639)					
Very underweight	**1.94 (0.50)**	0.09 (0.09)	—	—	2.03 (0.50)
Slightly underweight/ about right	3.79 (0.56)	**40.70 (1.57)**	3.24 (0.56)	0.63 (0.22)	48.36 (1.59)
Slightly overweight	—	11.31 (1.04)	**15.02 (1.13)**	12.81 (1.10)	39.15 (1.57)
Very overweight	—	—	1.49 (0.46)	**8.97 (0.94)**	10.46 (1.02)
Total[e]	5.73 (0.75)	52.10 (1.61)	19.75 (1.25)	22.42 (1.40)	
Mothers of girls (n=1,482)					
Very underweight	**1.50 (0.38)**	0.03 (0.03)	—	—	1.53 (0.38)
Slightly underweight/ about right	3.74 (0.53)	**40.77 (1.60)**	3.74 (0.67)	0.45 (0.18)	48.69 (1.63)
Slightly overweight	—	12.37 (1.15)	**14.20 (1.17)**	11.24 (1.06)	37.81 (1.67)
Very overweight	—	0.07 (0.06)	1.32 (0.44)	**10.59 (1.05)**	11.97 (1.11)
Total[e]	5.24 (0.64)	53.23 (1.61)	19.25 (1.31)	22.27 (1.39)	

[a] SE, standard error.
[b] The World Health Organization suggested that in Asian populations, being overweight should be defined as a BMI≥23 kg/m² and obesity as a BMI≥25 kg/m². These standards were applied to obesity classification in KNHANES.
[c] The cell percentages (%) are weighted percentages using survey sample weights.
[d] Bold numbers indicate correct perception.
[e] The total percentage of objective or subjective measured weight status.

2) Factors associated with parental misperception of their child's weight

Parental misperception was associated with socio-demographic factors such as age, BMI, place of residence, maternal perception of their own weight, and parental obesity, as shown in Table 4. With one year increase in age, parents of boys had greater odds for overestimation (OR=1.22, p=0.0084) and lower odds for underestimation (OR=0.83, p=0.0110). Similarly, parents of girls also had lower odds for underestimating their child's weight (OR=0.81, p=0.0125). BMI was strongly associated with parental weight underestimation and overestimation among both boys and girls. The higher the BMI, the higher the odds that parents of girls would underestimate or overestimate their child's weight (underestimate OR=1.28, p<0.0001; overestimate OR=1.16, p=0.0020) and the higher the odds that parents of boys would overestimate their child's weight (OR=1.16, p<0.0001).

Parents living in a rural area were less likely to overestimate their child's weight (OR=0.62, p=0.0423). After a gender-stratified analysis, the association was not statistically significant although such patterns also appeared among both boys and girls. Mothers underestimating their own weight were less likely to overestimate their child's weight than those estimating their own weight accurately (OR=0.59, p=0.0472). After a gender-stratified analysis, the association was not statistically significant although such patterns also appeared among both boys and girls. The association between parental obesity and parental

misperception was shown only among girls. Parents of girls whose both parents are obese were more likely to underestimate their child's weight than parents of girls whose both parents are non-obese (OR=2.61. p=0.0142). Parents of girls whose fathers are obese (but mothers are not obese) also were more likely to underestimate their child's weight (OR=1.74, p=0.0397).

Table 4. Factors associated with parental misperception of their child's weight among Korean children[a, b]

Variables	Boys and girls		Boys		Girls	
	Underestimate OR(95% CI)	Overestimate OR(95% CI)	Underestimate OR(95% CI)	Overestimate OR(95% CI)	Underestimate OR(95% CI)	Overestimate OR(95% CI)
Gender						
Boys (ref)						
Girls	1.07 (0.79-1.46)	0.94 (0.69-1.29)				
Age (years)	**0.82 (0.74-0.90)**	**1.17 (1.06-1.29)**	**0.83 (0.72-0.96)**	**1.22 (1.05-1.41)**	**0.81 (0.68-0.96)**	1.11 (0.97-1.27)
BMI (kg/m²)	**1.15 (1.08-1.22)**	**1.16 (1.11-1.22)**	1.06 (0.97-1.15)	**1.16 (1.10-1.23)**	**1.28 (1.15-1.43)**	**1.16 (1.05-1.27)**
Household equivalent income quartile						
Lowest (ref)						
Middle-low	0.85 (0.53-1.35)	1.07 (0.63-1.83)	0.70 (0.34-1.44)	1.08 (0.52-2.24)	0.95 (0.49-1.82)	0.92 (0.44-1.91)
Middle-high	1.15 (0.69-1.92)	1.16 (0.67-2.02)	1.68 (0.85-3.30)	1.21 (0.57-2.56)	0.70 (0.33-1.50)	0.98 (0.44-2.17)
Highest	0.77 (0.46-1.26)	1.07 (0.59-1.93)	0.90 (0.45-1.79)	1.00 (0.46-2.19)	0.62 (0.30-1.31)	1.03 (0.44-2.38)
Place of residence						
Urban area (ref)						
Rural area	1.22 (0.80-1.86)	**0.62 (0.39-0.98)**	1.21 (0.68-2.15)	0.57 (0.30-1.08)	1.24 (0.73-2.12)	0.68 (0.32-1.44)
Maternal perception of their own weight						
Accurate (ref)						
Underestimate	1.21 (0.77-1.89)	**0.59 (0.35-0.99)**	1.37 (0.73-2.58)	0.72 (0.35-1.49)	1.08 (0.54-2.16)	0.42 (0.17-1.07)
Overestimate	0.80 (0.50-1.28)	1.20 (0.80-1.78)	0.84 (0.45-1.56)	0.83 (0.45-1.52)	0.82 (0.42-1.57)	1.61 (0.93-2.79)
Parental obesity						
Neither parent obese						
Father only	1.33 (0.93-1.92)	0.86 (0.60-1.25)	1.10 (0.69-1.73)	0.83 (0.49-1.40)	**1.74 (1.03-2.95)**	0.95 (0.55-1.65)
Mother only	0.66 (0.39-1.12)	0.75 (0.41-1.36)	0.72 (0.35-1.47)	0.88 (0.38-2.04)	0.55 (0.27-1.13)	0.60 (0.25-1.43)
Both parents	1.59 (0.93-2.72)	1.33 (0.72-2.47)	1.00 (0.46-2.20)	1.26 (0.55-2.89)	**2.61 (1.21-5.61)**	1.40 (0.55-3.56)
Parental education (college graduation)						
Neither parent graduate						
Father only	1.11 (0.71-1.74)	0.83 (0.50-1.37)	1.78 (0.98-3.24)	1.15 (0.60-2.20)	0.65 (0.33-1.30)	0.54 (0.26-1.10)
Mother only	1.12 (0.68-1.84)	0.94 (0.49-1.82)	1.19 (0.58-2.45)	0.79 (0.31-1.99)	1.14 (0.56-2.31)	1.10 (0.48-2.53)
Both parents	0.78 (0.52-1.18)	0.87 (0.56-1.35)	0.98 (0.55-1.77)	0.99 (0.57-1.73)	0.64 (0.35-1.19)	0.73 (0.38-1.40)

[a] Odds ratio refers to the odds of incorrect perception of weight status (overestimate or underestimate). Correct weight perception (accurate) as reference.

[b] Bold numbers indicate significance at $p-$values <0.05.

4. Discussion

1) Agreement between objective weight status and parent-perceived weight status

A considerable percentage of parents misperceived their child's weight, although a number of parents placed their child in weight categories that were in accordance with their objective weight classification. Parents of both boys and girls were more likely to underestimate, rather than overestimate, their child's weight.

Due to the differences in the definition of overweight and sampling methods of the study population, the prevalence of parental misperception could vary in many studies [5, 6, 8, 9, 49, 50]. In western countries, parental misperception of their child's weight was mainly observed in overweight children [5, 8, 9, 49, 51]. A previous US study showed that most mothers of overweight and obese children misclassified their children based on their weight status, with almost all mothers of overweight children (93.6%) classifying them as about the right weight [51]. This finding might be because western countries have a higher overweight prevalence rate than eastern countries. After all, the obvious is parents often do not accurately perceive their child's weight, report low levels of concern, and are not aware of the health risks associated with excess weight [6, 8, 49, 50].

2) Factors associated with parental misperception of their child's weight

According to our results, as children get older, the probability of overestimating their child's weight gets higher and the probability of underestimating their child's weight gets lower. This finding might be attributed to the fact that young parents are excessively concerned about their child's height and body shape. In South Korea, being tall is something to envy regardless of sex, and growth-promoting attempts by parents are widespread [52]. Usually, an obsession with being tall was more serious in parents of boys and an obsession with slim body shape was more serious in parents of girls. If parents consider tall and slim children to be healthy, then they could overestimate their child's weight. Likewise, given that childhood is a critical period of growth and development not only physically but also emotionally, parental accurate perception of their child's weight is necessary to prevent childhood obesity and to prepare weight control intervention programs.

Place of residence was another factor linked with parental misperception. Parents living in a rural area were less likely to overestimate their child's weight. A similar but non-significant trend was observed in both boys and girls after a gender-stratified analysis. In rural areas of South Korea, the proportion of elderly people is relatively large. Comments and attitudes towards health by elderly people living in the community may affect young parents' weight norms.

Additionally, urban-rural differences in the extent of media exposure and socio-cultural environment could be another reason. Young parents living in an urban area seem to be more sensitive to their child's weight because of intense mass media exposure, and might be more likely to perceive their child's weight distortedly.

Our study also demonstrated that parental obesity was associated with parental misperception of their child's weight. Consistent with our findings, a previous study showed that overweight parents were more likely to misperceive their child's weight [53]. Obese parents seem to be less sensitive to their child's overweight or obesity, and are likely to judge their child's weight on a standard based on family members including themselves. Similarly, parents seem to perceive their child's weight in the way that they perceive their own weight. Mothers underestimating their own weight might be more likely to underestimate and less likely to overestimate their child's weight status. Parental perception of their own weight may be related to their cultural beliefs about body size or obesity criteria [54]. Pressure from their social and cultural environment may affect parents' weight norms, and may play an important role in parents setting their child's weight standards [55, 56]. Likewise, they seem to judge their child's weight by using their own body weight standards based on their own beliefs. Therefore, without an individualized approach that encourages the parent to

openly express those beliefs, any interventional plan is more likely doomed to failure [54].

3) Strengths and limitations

First, KNHANES is a continuous survey with nationally representative samples of Koreans that have been used for the development of Korean standards regarding health and nutrition. All children aged 6-11 years who participated in the 2009-2013 KNHANES were chosen as our study participants, and data from the study subjects' parents were secured from the same database and were subsequently matched and analyzed. Therefore, the study results could also be nationally representative. Second, this study examined factors associated with parental misperception of their child's weight according to sex, so that effective interventional strategies could be devised based on the sex-based groups. Third, our study used measured weight and height to accurately classify BMI indices for this representative sample of children.

However, there are several limitations in this study. This study is comparing two different scales and presenting them as if they are comparable. Therefore, caution is needed in interpretation of our findings. Lastly, we cannot explain the cause-and-effect relationship between these variables because of the cross-sectional nature of the study design.

Ⅲ. Chapter Two – Weight perception and its association with socio-demographic and health-related factors among Korean Adolescents

1. Objectives

The purpose of this study was to quantify the extent of weight misperception among Korean adolescents, to explore sex-based differences in socio-demographic factors associated with weight misperception, and to examine sex-based differences in the relationship between weight misperception and health-related factors.

2. Methods

1) Database and study population

This study used data obtained from the Korea National Health and Nutrition Examination Survey (KNHANES) conducted from 2009 through 2013, which was a cross-sectional and nationally representative survey examining the health and nutrition status of South Koreans. The target population of KNHANES comprises non-institutionalized Korean citizens residing in Korea. The sampling plan follows a multi-stage clustered probability design. For example, in the 2011 survey, 92 primary sampling units (PSUs) were drawn from approximately

200,000 geographically defined PSUs for the whole country [45]. A PSU consisted of an average of 60 households, and 20 final target households were sampled for each PSU using systematic sampling; in the selected households, all individuals aged 1 year and over were targeted [45]. The surveys included the Health Interview Survey, Health Examination Survey, and Nutrition Survey. The health interview and health examination are performed by trained medical staff and interviewers at the mobile examination centre, and dieticians' visits to the homes of the study participants are followed up. According to standardized protocols, all health examination procedures are performed by trained medical personnel and all equipment is calibrated periodically [45]. The response rates for the Health Interview Survey and Health Examination Survey were 79.2% (2009), 77.5% (2010), 76.1% (2011), 75.9% (2012), and 75.0% (2013). More details regarding the survey design and methods have been provided elsewhere [46].

From the five-year KNHANES datasets (2009–2013), we selected data regarding 3,947 adolescents aged 12–18 years, including their demographic characteristics, household environment, socioeconomic status, health status, and parents' health status. However, data from 271 respondents were excluded because of lack of information about their parents, and data from 291 respondents were excluded due to missing information for major variables such as body mass index and weight perception. Consequently, we selected 3,385 adolescents aged

12–18 years for the present study. Approval was obtained from the Institutional Review Board of Yonsei University's Graduate School of Public Health.

2) Measurements

Classification of objective weight status Objective weight status was determined according to a respondent's body mass index (BMI; weight in kilograms divided by the square of the height in meters), which was based on anthropometric measurements from the Health Examination Survey. The cut-points for weight classification by clinical standards are as follows: underweight (BMI < 5th percentile), normal (5th ≤ BMI < 85th percentile), overweight (85th ≤ BMI < 95th percentile), and obese (BMI ≥ 95th percentile for age and gender, using the 2007 Korean Pediatric Growth Charts [47]).

Classification of body weight perception For a measure of self-perceived weight status, respondents' perceptions about their own weight status were assessed through the question: "How do you describe your weight?" Answers were chosen from "very underweight," "slightly underweight," "about the right weight," "slightly overweight," and "very overweight." The answer was reclassified into 4 categories: very underweight, slightly underweight or about the right weight, slightly overweight, and very overweight. Self-perceived weight status was

compared to classification by objective standards mentioned above. 'Very underweight' and 'very overweight' of subjective standards correspond to 'underweight' and 'obese' of objective standards, respectively. 'Slightly underweight or about the right weight' of subjective standards corresponds to 'normal' of objective standards. Participants were then placed into one of three categories: correct perception (self-perception is concordant with the objective standard), underestimate (self-perception is in a lighter category than the objective standard), and overestimate (self-perception is in a heavier category than the objective standard).

Socio-demographic factors Household equivalent income was calculated by dividing total family income by the square root of the number of family members, and then was categorized as quartiles (lowest, middle-low, middle-high and highest). Place of residence was classified, according to the national administration system, as living in an urban area or not (e.g., living in a town or in the countryside). In consideration of the distribution in family size, the number of family members was classified into 3 categories: ≤3, 4, and ≥5 members. Parental obesity was defined as a BMI at or above 25 for a child's parents. Parental education level was classified as less than or achievement of graduation of middle

school, graduation from high school and more than or achievement of graduation of college.

Health-related factors Weight control practice during the past year was assessed with participants allowed to give four possible responses: I tried to 1) lose weight; 2) stay the same weight; 3) gain weight; or 4) I did nothing about my weight. For useful interpretation, the answer was reclassified into three categories: 1) appropriate (e.g., trying to gain weight in underweight individuals (BMI < 5th percentile), trying to maintain weight in normal weight individuals (5 ≤ BMI < 85th percentile), trying to lose weight in overweight/obese individuals (BMI ≥ 85th percentile), 2) inappropriate (e.g., trying to maintain or lose weight in underweight individuals, trying to lose or gain weight in normal weight individuals, trying to maintain or gain weight in overweight/obese individuals), or 3) do nothing.

Walking exercise was defined as indoor or outdoor walking. Vigorous intensity exercise included running, climbing, fast cycling, fast swimming, football, basketball, rope jumping, squash, singles tennis, or occupational or recreational activity involving the carrying of heavy objects. Moderate intensity exercise included slow swimming, doubles tennis, volleyball, or occupational or recreational activity involving the carrying of light objects (i.e., having greater

intensity than walking). Participants were asked how many days during the last seven days you had participated in walking, vigorous, and moderate exercises lasting at least 10 minutes at a time. Answers were grouped into three categories, considering the distribution of the number of days that participants have exercised: 'never', '1－2 days/week', or '≥3 days/week' in moderate or vigorous exercises; '7 days/week', '4-6 days/week', or '≤3 days/week' in walking exercise.

Regarding depression experience, participants answered 'yes' or 'no' to a question of whether they had experienced a depressed mood for 2 or more continuous weeks during the last one year. Stress level was assessed by asking: "How much stress do you feel on daily basis?" Answers were chosen from 'very little', 'little', 'much', and 'very much'. Smoking and drinking experience were assessed by asking: "Have you ever tried cigarette smoking/drinking alcohol, even once?" Participants were grouped into yes/no categories.

3) Statistical analysis

The five-year KNHANES datasets (2009–2013) were merged. Data in all statistical analyses for our study were weighted to account for the complex sampling design of the KNHANES. Based on a review of the literature, we first selected socio-demographic variables related to weight misperception including age, gender, BMI, household equivalence income, place of residence, number of

family members, family generation type, maternal/paternal age, maternal/paternal education level, maternal/paternal occupation, and maternal/paternal obesity from the 5-year dataset. To review the relationships between those variables and participant's weight perception (correct, underestimate, overestimate groups), chi-square tests (PROC SURVEYFREQ in SAS) were used. As a result, the factors showing a statistically significant difference ($p < 0.05$) were chosen for a multivariate logistic regression, provided that age, BMI, and household equivalence income were included irrespective of its P-value.

Similarly, we selected all variables related to health behaviors from the 5-year dataset, analyzed the relationships between those variables and their weight perception using the chi-square tests, and then selected five typical variables (weight control practice, vigorous exercise, feeling under stress, smoking experience, and drinking experience) that exhibited a statistically significant relationship ($p < 0.05$) for separate logistic regression models.

The general study population characteristics were displayed as percents weighted using survey sample weights for categorical variables, and as mean and standard error of means for continuous variables. Self-perceived weight status was compared with objective weight status based on BMI by cross-tabulation. To measure agreement between objective weight status and self-perceived weight status, kappa statistics based on the survey weighted cell percentages were

calculated. The generalized logit model (multivariate logistic regression) was used to explore sex-based differences in socio-demographic factors associated with weight misperception after accounting for primary sample units, stratification, and sample weights from the KNHANES. “Correct weight perception” served as reference for comparison. Finally, we fitted separate logistic regression models (PROC SURVEYLOGISTIC in SAS) to examine sex-based differences in the association between weight misperception (“underestimate” and “overestimate” as exposure variables; “accurate” as a reference group) and health-related factors (weight control practice, vigorous exercise, feeling under stress, smoking experience, and drinking experience as outcome variables). Age, BMI, household equivalence income, place of residence, number of family members, maternal obesity, and maternal education level were controlled for in each model. Because ten independent predictions were tested in the sex-stratified analysis, the Bonferroni correction was used to reduce the chances of obtaining false-positive results (type Ⅰ errors); P values < 0.005 were considered statistically significant. Statistical analyses were performed using the software SAS version 9.2 (SAS Institute, Cary, NC, USA).

3. Results

1) Agreement between objective weight status and self-perceived weight status

Table 5 and Table 6 present the socio-demographic and health-related characteristics of the overall sample, respectively. Table 7 displays a cross-tabulation of objective weight status with self-perceived weight status for boys and girls.

Overall, 26.2% of boys and 27.9% of girls misclassified their weight status, according to the objective standards. Among these misclassification cases, 17.0% of boys and 22.9% of girls overestimated their body weight, while 9.2% of boys and 5.0% of girls underestimated their body weight. However, 99.1% of the misclassification cases in boys and 96.7% of the misclassification cases in girls only exhibited a difference between their self-perceived and objective weight status of one position on the scale. In the underweight group, 59.7% of underweight boys believed that they were very underweight, whereas 69.9% of underweight girls considered themselves to be approximately the right weight. In the normal weight group, 75.5% of boys and 76.2% of girls believed that they were about the right weight. However, 17.7% of normal weight boys and 22.6% of normal weight girls considered themselves to be slightly overweight or obese. In addition, 47.7% of obese boys and 49.5% of obese girls considered themselves

to be slightly overweight. Based on survey-weighted cell percentages, the kappa statistic (k) is 0.4834 for boys and 0.4191 for girls, suggesting a moderate agreement between objective and self-perceived weight status.

Table 5. Socio-demographic characteristics among Korean adolescents[a,b]

Variable	Boys (n = 1,787)	Girls (n = 1,598)	All (n = 3,385)
Age (years)	15.06 (0.05)	15.06 (0.06)	15.06 (0.04)
Body mass index (BMI)	21.28 (0.11)	20.73 (0.10)	21.02 (0.07)
Household equivalence income quartile			
Lowest	24.98	25.87	25.39
Middle-low	24.88	27.07	25.90
Middle-high	26.50	23.92	25.30
Highest	23.64	23.15	23.41
Residence			
Urban area	83.60	82.44	83.06
Rural area	16.40	17.56	16.94
Number of family members			
≤3 members	25.32	20.29	22.98
4 members	50.97	47.39	49.31
≥5 members	23.71	32.32	27.71
Maternal weight status			
Underweight	4.10	3.03	3.60
Normal	68.03	69.25	68.60
Obese	27.87	27.72	27.80
Paternal weight status			
Underweight	1.69	1.69	1.69
Normal	57.08	56.41	56.77
Obese	41.23	41.90	41.54
Maternal education level			
Elementary school	5.21	5.16	5.18
Middle school	7.64	7.17	7.42
High school	58.88	59.56	59.20
≥ College	28.27	28.11	28.20
Paternal education level			
Elementary school	5.35	5.51	5.42
Middle school	11.94	7.80	10.04
High school	39.63	46.22	42.66
≥ College	43.08	40.46	41.88

[a] For categorical variables, cell percentage (%) was a weighted percentage using survey sample weights.
[b] For continuous variables, mean and standard error of means were provided.

Table 6. Health-related characteristics among Korean adolescents[a]

Variable	Boys (n = 1,787)	Girls (n = 1,598)	All (n = 3,385)
Weight control behavior			
Lose weight	26.05	49.98	37.17
Stay the same weight	15.16	17.78	16.38
Gain weight	17.37	3.24	10.80
Do nothing	41.42	28.99	35.65
Moderate exercise			
Never	43.59	57.11	49.88
1-2 days/week	27.84	27.43	27.65
≥3 days/week	28.57	15.46	22.47
Vigorous exercise			
Never	31.52	52.91	41.46
1-2 days/week	29.25	28.86	29.07
≥3 days/week	39.23	18.23	29.47
Walking exercise			
7 days/week	54.13	47.31	50.96
4-6 days/week	26.82	29.62	28.12
≤3 days/week	19.05	23.07	20.92
Feeling under stress			
Very little	2.40	4.65	3.44
Little	20.15	24.47	22.16
Much	60.03	56.37	58.33
Very much	17.42	14.51	16.07
Depression experience			
No	92.05	87.28	89.83
Yes	7.95	12.72	10.17
Smoking experience			
Yes	24.57	11.24	18.38
No	75.43	88.76	81.62
Drinking experience			
Yes	39.11	33.54	36.52
No	60.90	66.46	63.48

[a] For categorical variables, cell percentage (%) was a weighted percentage using survey sample weights.

Table 7. Comparison of objective weight status of adolescents with self-perceived weight status[a,b,c,d]

Self-perceived status	Objective status (Percentile of BMI)				Total[e]
	Underweight ($P < 5^{th}$)	Normal ($5^{th} \leq P < 85^{th}$)	Overweight ($85^{th} \leq P < 95^{th}$)	Obese ($P \geq 95^{th}$)	
	% (SE)	% (SE)	% (SE)	% (SE)	% (SE)
Boys (n=1,787)					
Very underweight	**4.32 (0.63)**	5.11 (0.70)	—	—	9.44 (0.88)
Slightly underweight/ about right	2.92 (0.46)	**56.51 (1.36)**	0.97 (0.30)	0.08 (0.05)	60.48 (1.36)
Slightly overweight	—	13.09 (0.98)	**9.68 (0.83)**	3.04 (0.46)	25.81 (1.18)
Very overweight	—	0.15 (0.12)	0.88 (0.24)	**3.25 (0.52)**	4.28 (0.61)
Total[e]	7.24 (0.76)	74.86 (1.25)	11.53 (0.92)	6.37 (0.67)	
Girls (n=1,598)					
Very underweight	**1.69 (0.34)**	0.90 (0.30)	—	—	2.59 (0.45)
Slightly underweight/ about right	4.13 (0.57)	**58.44 (1.53)**	0.58 (0.17)	—	63.15 (1.51)
Slightly overweight	0.09 (0.09)	16.48 (1.13)	**8.34 (0.84)**	3.52 (0.52)	28.43 (1.42)
Very overweight	—	0.84 (0.27)	1.40 (0.33)	**3.59 (0.58)**	5.83 (0.71)
Total[e]	5.91 (0.69)	76.66 (1.22)	10.32 (0.92)	7.11 (0.83)	

[a] SE, standard error.
[b] P, Percentile of BMI for age and gender, using the 2007 Korean Pediatric Growth Charts.
[c] The cell percentages (%) are weighted percentages using survey sample weights.
[d] Bold numbers indicate correct perception.
[e] The total percentage of objective or subjective measured weight status.

2) Factors associated with weight misperception

Weight misperception was associated with socio-demographic factors such as gender, age, BMI, income, place of residence, number of family members, and maternal education level, as shown in Table 8. Regarding gender, girls were less likely to underestimate their body weight compared to boys (OR=0.63, p=0.0112), and were more likely to overestimate their body weight (OR=1.43, p=0.0012).

Age also had significant effects. In older girls, the probability of underestimating their weight gets lower (OR=0.82, p=0.0205) and the probability of overestimating gets higher (OR=1.13, p=0.0040). However, in older boys, the probability of overestimating their weight gets lower (OR=0.88, p=0.0032). The higher the BMI, the greater the chance of boys underestimating or overestimating their weight (underestimate OR=1.12, p=0.0022; overestimate OR=1.08, $p <$ 0.0001) and the greater the chance of girls underestimating their weight (OR=1.45, $p < 0.0001$).

Boys from middle-high income households were less likely to underestimate their weight than those from lowest income households (OR=0.52, p=0.0493), and boys from middle-low income households were less likely to overestimate their weight than those from lowest income households (OR=0.60, p=0.0393).

Place of residence, number of family members, and maternal education level were associated with weight misperception among only girls. Girls living in a

rural area were less likely to overestimate their weight than those living in an urban area (OR=0.52, p=0.0061). Girls with four family members were less likely to overestimate their weight than those with three or less family members (OR=0.65, p=0.0232). Girls whose mother graduated from high school were more likely to underestimate their weight than those whose mother graduated from middle school (OR=2.78, p=0.0157).

Table 8. Factors associated with weight misperception among Korean adolescents[a,b]

Variables	Boys and girls		Boys		Girls	
	Underestimate OR (95% CI)	Overestimate OR (95% CI)	Underestimate OR (95% CI)	Overestimate OR (95% CI)	Underestimate OR (95% CI)	Overestimate OR (95% CI)
Gender						
Boys (ref)						
Girls	**0.63 (0.44–0.90)***	**1.43 (1.15–1.78)****				
Age	0.95 (0.87–1.05)	1.00 (0.95–1.06)	0.98 (0.88–1.10)	**0.88 (0.81–0.96)****	**0.82 (0.70-0.97)***	**1.13 (1.04–1.23)****
BMI	**1.20 (1.13–1.28)*****	**1.05 (1.02–1.09)****	**1.12 (1.04–1.20)****	**1.08 (1.04–1.12)*****	**1.45 (1.29–1.64)*****	1.02 (0.98–1.07)
Household equivalent income quartile						
Lowest (ref)						
Middle-low	0.82 (0.52–1.32)	0.79 (0.57–1.11)	0.78 (0.41–1.48)	**0.60 (0.37–0.98)***	0.84 (0.41–1.71)	1.00 (0.64–1.56)
Middle-high	**0.50 (0.30–0.83)****	0.77 (0.56–1.05)	**0.52 (0.28–1.00)***	0.68 (0.42–1.11)	0.52 (0.23–1.16)	0.80 (0.52–1.22)
Highest	0.80 (0.49–1.29)	**0.71 (0.50–0.99)***	0.85 (0.48–1.52)	0.64 (0.39–1.04)	0.69 (0.25–1.94)	0.79 (0.51–1.22)
Place of residence						
Urban area (ref)						
Rural area	0.84 (0.50–1.43)	0.79 (0.56–1.11)	0.79 (0.37–1.68)	1.18 (0.75–1.88)	0.91 (0.42–1.95)	**0.52 (0.32–0.83)****
Number of family members						
≤ 3 members (ref)						
4 members	1.09 (0.71-1.67)	0.98 (0.74-1.29)	1.20 (0.71-2.01)	1.58 (0.99-2.51)	0.79 (0.37-1.66)	**0.65 (0.45-0.94)***
≥ 5 members	0.83 (0.51-1.34)	1.05 (0.79-1.40)	0.73 (0.38-1.41)	1.45 (0.88-2.37)	0.81 (0.36-1.86)	0.80 (0.55-1.17)
Maternal obesity						
No (ref)						
Yes	1.12 (0.78–1.62)	1.09 (0.85–1.39)	0.93 (0.54–1.59)	1.25 (0.87–1.79)	1.49 (0.84–2.65)	0.99 (0.71–1.39)
Maternal education level						
≤ Middle school (ref)						
High school	1.51 (0.84–2.69)	0.97 (0.70–1.35)	1.22 (0.59–2.53)	0.91 (0.56–1.49)	**2.78 (1.21–6.38)***	1.00 (0.63–1.58)
≥ College	1.26 (0.66–2.41)	0.82 (0.55–1.21)	1.23 (0.56–2.69)	0.83 (0.47–1.49)	1.53 (0.57–4.07)	0.79 (0.47–1.32)

*p<.05; **p<.01; ***p<.0001.

[a] Odds ratio refers to the odds of incorrect perception of weight status (overestimate or underestimate).

[b] Gender was removed in the gender-stratified analysis.

3) Associations between weight misperception and health-related factors

Table 9 shows that weight misperception was associated with weight control practice. Compared with boys who perceived their weight accurately, boys who underestimated or overestimated their weight were more likely to attempt to lose or gain weight inappropriately (underestimate OR=2.17, p=0.0041; overestimate OR=2.37, $p < 0.0001$). Girls who overestimated their weight were more likely to attempt to lose or gain weight inappropriately (OR=3.39, $p < 0.0001$) and more likely to do nothing for weight control (OR=2.08, P=0.0020). However, girls' underestimation was not associated with weight control practice.

Boys who had ever exercised vigorously for 3 or more days during the last seven days were less likely to overestimate their weight than those who had never participated in vigorous exercises (OR=0.52, p=0.0007). Girls who had ever tried drinking alcohol were more likely to overestimate their weight than their counterparts (OR=1.70, p=0.0024). Boys who had ever tried cigarette smoking seemed to be more underestimate their weight than their counterparts, but the results was not statistically significant according to the Bonferroni correction (OR=1.68, p=0.0382).

Table 9. Associations (OR and 95% CI) between weight misperception and health-related factors among Korean adolescents[a,b,c]

Outcome variables	Boys		Girls	
	Underestimate OR (95% CI)	Overestimate OR (95% CI)	Underestimate OR (95% CI)	Overestimate OR (95% CI)
Weight control practice				
Appropriate (ref)				
Inappropriate	**2.17 (1.28–3.69) *****	**2.37 (1.55–3.64)*****	0.52 (0.24–1.16)	**3.39 (2.28–5.04) *****
Do nothing	0.86 (0.50–1.49)	1.16 (0.74–1.83)	1.38 (0.59–3.26)	**2.08 (1.31–3.32) *****
Vigorous exercise				
Never (ref)				
1-2 days/week	0.89 (0.48–1.66)	**0.58 (0.38–0.88)****	1.20 (0.64–2.25)	1.11 (0.79–1.55)
≥3 days/week	0.84 (0.49–1.44)	**0.52 (0.36–0.76)*****	0.93 (0.41–2.12)	1.22 (0.82–1.82)
Feeling under stress				
Very little/Little (ref)				
Much	0.81 (0.52–1.29)	0.90 (0.60–1.36)	1.36 (0.69–2.69)	0.83 (0.60–1.15)
Very much	0.87 (0.45–1.69)	1.12 (0.67–1.88)	0.95 (0.33–2.70)	0.83 (0.51–1.34)
Smoking experience				
No (ref)				
Yes	**1.68 (1.03–2.74)***	0.90 (0.58–1.39)	2.25 (0.79–6.42)	1.26 (0.76–2.11)
Drinking experience				
No (ref)				
Yes	0.87 (0.56–1.35)	**0.63 (0.42–0.95)***	0.87 (0.43–1.75)	**1.70 (1.21–2.39)*****

*p<.05; **p<.01; ***p<.005.

[a] Separate logistic regression models were fit for each outcome variable. Correct weight perception (accurate) as reference.

[b] Age, BMI, household income, place of residence, number of family members, maternal obesity, and maternal education level were controlled for in the models.

[c] Because of multiple comparisons (n=10), a *P*-value < 0.005 was considered significant using Bonferroni correction.

4. Discussion

1) Agreement between objective weight status and self-perceived weight status

Our study revealed that both boys and girls were more likely to overestimate, rather than underestimate, their weight. Particularly, girls were more than four-times more likely to overestimate, rather than underestimate, their weight. This finding might be attributed to the fact that exposure to thin-ideal media had a profound effect on the desire to be thinner, especially among adolescent girls. However, in Western countries, weight misperception was mainly observed in overweight adolescents possibly because a larger proportion of adolescents are overweight in Western than in Eastern nations [27]. The prevalence of weight misperception among adolescents in many countries, as reported in the literature [23, 24, 26, 57, 58], varies, and this finding might be attributed to the differences in ethnicity composition and overweight prevalence rate of the sample.

We focused on how self-perception is inconsistent with objective definition based on BMI percentiles. The categories that people use when asked about their own self-perceived weight could be different from clinical categories. Self-perception is more concerned with body image and body attractiveness, whereas clinical categories are more concerned with health. Therefore, when interpreting and evaluating our findings, researchers and policy makers should avoid

overstating the severity of this issue. Furthermore, additional studies are needed to evaluate the definition of weight misperception and the related measurements.

2) Factors associated with weight status misperception

According to our findings, in older girls, the probability of underestimating their body weight gets lower and the probability of overestimating gets higher. However, in older boys, the probability of overestimating their weight gets lower. Adolescence is an important period for body image and self-concept development, and therefore adolescents seem to become eager for a sex-specific ideal of bodily attractiveness as they age [13]. Social and cultural environment may affect adolescents' weight norms, and may play an important role in adolescents setting their own weight standards, no matter whether these standards are healthy or unrealistic [55, 56].

Household income and maternal education level were analyzed as indices of the participants' socioeconomic status (SES). Household income was linked to weight overestimation and underestimation among boys, but not among girls. In line with our results, a previous study revealed that adolescent boys from low-income households were more likely than their respective counterparts to have a discordant weight perception [28]. If underestimation is more prevalent among adolescents from low-income households, the already high prevalence of obesity

among these groups is unlikely to decrease. On the other hand, overestimation can be a risk factor for unhealthy weight control behaviors [28]. Maternal education level was also significant variable among girls. Unlike our results, according to a previous study, girls with less educated parents were more likely to perceive themselves as underweight [59]. However, Chinese girls who had highly educated parents were less likely to misperceive themselves as being overweight [23]. Moreover, a study using US representative data has shown no significant relationship between weight misperception and SES [27]. Therefore, further studies are needed to establish evidence for an association between body weight perception and SES.

Place of residence was another factor linked with weight misperception among girls. Girls living in a rural area are likely to perceive their weight more accurately. Adolescents, especially girls, living in an urban area seem to be more sensitive to their weight because of intense mass media exposure, and may be more likely to perceive their weight distortedly. Number of family members was also another associated factor among girls. Girls with four family members have probably heard comments and advices about girls' weight standards from other family members more often than those with three or less family members. These comments and attitudes from other family members towards weight standards would have affected adolescent girls' weight norms.

3) Associations between weight misperception and health-related factors

In the present study, weight overestimation was strongly related to inappropriate weight control practice among girls. However, among boys, both weight underestimation and overestimation were associated with inappropriate weight control practice. A previous study based on US nationally representative data revealed that both overweight boys and girls with accurate weight perception had appropriate weight control behaviors [21]. According to another study, weight overestimation was related to unhealthy weight control practices [60].

Female adolescents exist in a culture that bombards them with messages and images of the body ideal [61]. Thin models are hailed as the ideal body type, and these images become the standards by which the individual defines herself and others. These standards of thinness and beauty may make many adolescent girls feel overweight [61]. Thus, girls' overestimation of their weight could lead to body image dissatisfaction or distortion, and finally they could attempt to lose weight inappropriately.

On the other hand, boys are divided between those who desire to lose weight and those who wish to gain weight and musculature. Girls strive for thinness, but there may be two pathways to body dissatisfaction among boys – weight concerns and muscularity concerns [62]. Muscularity may be idealized in

boys and so, being underweight may be as likely to be stigmatized as being overweight [63]. Even normal weight boys could attempt to gain weight inappropriately because of a desire for a muscular body. Today's adolescents live in a world surrounded and defined by media [64]. For adolescents grappling with emerging pubertal changes, comparing themselves to the stars of stage and screen is unavoidable [13]. For this reason, even normal weight boys could perceive themselves as being overweight, and could attempt to lose weight for a lean, muscular body inappropriately.

Vigorous exercise was negatively associated with weight overestimation only among boys. Boys who work out vigorously regularly seem to perceive their weight more accurately. Consistent with our results, previous studies demonstrated that inaccurate weight perception in adolescents is typically negatively associated with physical activity [65, 66]. Therefore, understanding these associations is necessary to improve interventions that encourage healthy weight perception, such as nutrition and physical activity programs.

Drinking experience was also positively associated with weight overestimation among girls. According to a previous study, severe overestimation or underestimation was positively related to substance use such as smoking and drinking experience [66]. However, little is known about associations of weight misperception with health behaviors related to substance use. Therefore, further

studies are needed to understand the relationship between weight misperception and health risk behaviors.

The present findings suggest that there are gender differences in the association between weight misperception and health-related factors. Based on an understanding of weight misperception patterns and the association with health-related factors, comprehensive health promotion programs, particularly obesity prevention programs, — including regular body weight screening, checking on weight perception status, appropriate physical activities and health education — could be devised for adolescents and their parents.

4) Strengths and limitations

First, this study was based on recent nationally representative data, and therefore the results produced from this study are also nationally representative. Second, because our study examined sex-based differences in the relationship between weight misperception and health-related factors, effective interventional strategies based on gender could be devised. Third, our study used measured weight and height to accurately classify BMI indices for this representative sample of adolescents.

However, there are several limitations in this study. The definition of the variables used in our study was based on the health interview questionnaire of

KNHANES. However, some variables including weight control practice were defined operationally for useful interpretation and meaningful analysis. Lastly, we cannot explain cause-and-effect relationships because of the study's cross-sectional nature.

Ⅳ. Conclusion

Our findings suggest that a number of parents show good awareness of their child's current weight status, although a considerable percentage of parents still misperceive their child's weight. Parents of both boys and girls were more likely to underestimate, than overestimate, their child's weight. Parental misperception was associated with socio-demographic factors such as age, BMI, place of residence, maternal perception of their own weight, and parental obesity. Particularly, parental obesity was a significant variable only among girls. Therefore, understanding parental misperception patterns of their child's weight depending on sex, objective weight status and cultural background might be the initial step towards desirable interventions for weight control.

Our study revealed that both adolescent boys and girls were more likely to overestimate, rather than underestimate, their weight. Particularly, girls were more than four-times more likely to overestimate, rather than underestimate, their weight. Age and BMI were factors associated with weight misperception among both adolescent boys and girls. Household income was linked to weight overestimation and underestimation only among adolescent boys. Place of residence and number of family members were associated with weight overestimation, and maternal education level was a factor associated with weight

underestimation, only among adolescent girls. Weight overestimation was related to inappropriate weight control practice among adolescent girls. However, among boys, both weight underestimation and overestimation were associated with inappropriate weight control practice. Vigorous exercise was negatively associated with weight overestimation only among adolescent boys. Drinking experience was positively associated with weight overestimation only among adolescent girls. Based on understanding the characteristics of sex-based differences in weight misperception patterns and their association with socio-demographic and health-related factors, individualized intervention programs according to sex may be devised for adolescents and their parents.

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Korean Abstract

한국 아동 청소년의 체중 오인과 그 관련요인에 있어서 성별 차이

본 연구의 목적은 한국 아동의 부모가 자녀의 체중을 오인하고 있는 정도를 파악하고, 이러한 체중 오인과 관련된 사회인구학적 요인들에 있어서 성별 차이를 탐색해 보고자 함이다. 국민건강영양조사의 최근 5 개년(2009–2013) 자료를 기반으로, 6–11 세 아동 3,228 명을 연구 대상으로 선정하였다. 부모의 체중 오인과 관련된 사회인구학적 요인들을 탐색하기 위해 Generalized Logit Model 을 이용하였다. 남아 부모의 27.4%와 여아 부모의 23.7%는 자녀의 체중을 오인하고 있었다. 남아와 여아의 부모 모두 자녀의 체중을 실제 체중보다 더 낮게 판단하고 있었다. 부모의 체중 오인은 연령, BMI, 거주지, 엄마 자신의 체중에 대한 인지, 부모의 비만 여부와 같은 사회인구학적 요인들과 관련이 있었다. 특히, 부모의 비만은 여아에서만

유의한 변수로 나타났다. 부모의 자녀에 대한 체중 오인 패턴을 성별로 이해함으로써, 아동의 체중관리를 위한 바람직한 중재프로그램을 시작할 수 있을 것이다.

본 연구의 또 다른 목적은 한국 청소년이 자신의 체중을 오인하고 있는 정도를 파악하고, 이러한 체중 오인과 관련된 사회인구학적 요인들에 있어서 성별 차이, 체중 오인과 건강관련 변수들과의 관련성에 있어서 성별 차이를 살펴 보고자 함이다. 국민건강영양조사의 최근 5 개년(2009–2013) 자료를 기반으로, 12–18 세 청소년 3,385 명을 연구 대상으로 선정하였다. 체중 오인과 관련된 사회인구학적 요인들을 탐색하기 위해 Generalized Logit Model 을 이용하였고, 체중 오인과 건강관련 변수들과의 관련성을 파악하기 위해 각각의 Logistic Regression Model 을 적용하였다. 전반적으로 남아의 26.2%, 여아의 27.9%가 자신의 체중 상태를 잘못 분류하였다. 남녀 모두 자신의 체중을 실제 체중보다 더 높게 판단하고 있었다. 특히, 여아의 경우, 실제 체중보다 자신의 체중을 더 높게 판단하는 경향이 더 낮게 판단하는

경우보다 4 배 이상 더 많았다. 체중 오인은 성별, 연령, BMI, 가구당 소득, 엄마의 교육수준, 거주지, 가족수 등과 같은 사회인구학적 요인들과 연관이 있었다. 가구당 소득은 남아에서, 엄마의 교육수준, 거주지, 가족수는 여아에서 체중 오인과 관련이 있었다. 체중 과대평가(overestimation)는 여아에서 부적절한 체중관리행위와 관련이 있었으나, 남아에서는 체중 과대평가(overestimation) 및 과소평가(underestimation) 모두 부적절한 체중관리행위와 관련이 있었다. 정기적으로 격렬한 운동을 하는 남아는 체중을 과대평가할 가능성이 더 낮았고, 음주 경험이 있는 여아는 그렇지 않은 여아에 비해 체중을 과대평가할 가능성이 더 높았다. 청소년의 체중 오인의 성별 특성 및 건강관련 요인들과의 관련성에 대한 이해를 바탕으로, 청소년 및 부모들을 대상으로 성별에 따른 개별적인 중재 프로그램들을 고안할 수 있을 것이다.