Eating Behaviors and Body Weight in Preadolescents Classified by

Sensitivity to 6-n-propylthiouracil: A Follow-up Study

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ABSTRACT OF THE THESIS

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Overweight in children is a problem of rising significance as obesity in America becomes more widespread. Understanding factors affecting the establishment of eating behaviors in children can potentially mitigate development of adiposity. This study investigated the influence of genetic sensitivity to the bitterness of 6-n-propylthiouracil (PROP), environment and psychosocial factors on change in weight status from preschool to preadolescence. Children who originally participated in taste studies as preschoolers were identified and re-tested as preadolescents. Seventy-three children and their mothers were screened for PROP taster status and answered a questionnaire measuring dietary restraint and disinhibition. Children additionally gave three 24-hour recalls, and wore an activity monitor for 72hours. Data from the diet recalls were analyzed by nutrient composition as well as by USDA Food Group servings. For the results, phenotype of PROP taster status was stable since preschool, being satisfactorily reliable for test-retest (Cohen's Kappa >0.7). There were no significant differences among PROP taster groups for current BMI percentile or change in BMI percentile since preschool by Univariate analyses. Multivariate models provided greater insight since it provided the ability to control for other measurable forms of variance. Both

Multiple Linear Regression and Hierarchical Regression showed that the single most influential factor for predicting current weight status was preschool weight status. In addition, dietary restraint was a significant positive predictor as was the interaction between gender and PROP taster status. Within females, PROP sensitivity was a significant positive predictor for body weight, whereas this was not true for males. However, subjects had a lower incidence of overweight than the national average and tended to have high physical activity. Thus, in order to elucidate the true impact of PROP sensitivity on eating behaviors, further studies should investigate the effect of PROP taster status on body weight in female children, particularly in an overweight population.

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TABLE OF CONTENTS

Table of Contents, cont.

Table of Contents, cont.

Table of Contents, cont.

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Childhood Overweight in Western Cultures

Obesity is a chronic disease, which largely presents in adulthood due to a variety of genetic and lifestyle factors. The general public is well aware of the health concerns associated with obesity, as well as the consistent increase in its prevalence. Concerns for health and weight status have recently grown to include children and young adults (1). Due to the strong negative stigma associated with obesity, in the US "overweight" is used to describe children whose weight-for-height greatly exceeds the norm. Childhood "overweight" is defined as having a weight-for-height that falls above the 95th percentile for age and gender. "At risk for overweight" describes children whose weight-for-height falls above the 85th percentile (2). In 2004 the CDC documented that 17% of all American children were classified as overweight, with higher rates in adolescents (17%) and older children (19%) versus young children (14%). By race and ethnicity, overweight is lowest in Caucasians and highest in African Americans (2).

Until 1980, childhood overweight across all gender and ethnic groups was documented between 5 and 7% (2). Thus, in the past thirty years there has been a three-fold increase in overweight in children. Overweight and obesity are caused by long-term positive energy balance, which results in increased adiposity. Overweight in children is of increased concern because weight status tends to track over time, and overweight children are at increased risk for obesity as adults (3-5). Childhood overweight increases the risk of obesity in adulthood by 2 to 6 times that of normal-weight children (6) and also has been shown to increase the risk of cardiovascular disease symptoms (7). Children who were overweight by preschool age were still overweight during adolescence (8). Additionally, eating patterns and food behaviors that are established in childhood are believe to track into adulthood (9, 10). Thus, it is important to have a clear understanding of how food preferences, eating habits, and lifestyle behaviors develop in children. Elucidation on these characteristics could lead to new prevention strategies for obesity.

1.2 Recommendations and Current Eating Patterns in Children

The USDA establishes Dietary Reference Intakes (DRI) for adults and children. Throughout childhood, energy needs are rapidly changing secondary to growth needs. For children aged 9-13, energy needs are estimated to be 2,079 kcal/day for boys and 1,907 kcal/day for girls (11). Recommendations for dietary intake by USDA food group are as follows;

Grains: 6-11 servings
Vegetables: at least 3 servings
Fruit: 2-4 servings
Dairy: 2-4 servings
Meat 5-7 ounces.

Other foods such as added sugars, candy, sweets and snacks, are to be used sparingly. According to results from the Continuing Survey for Food Intakes by Individuals (CSFII) in 1989-1991, only about 30% of all children met the recommendations for fruit, grain, dairy and meat, and 36% for vegetables (12). Regardless of racial group or socioeconomic status, only 5% of children met the recommendations for all food groups. On the other hand, discretionary fats and sugars accounted for 40% of children's energy intake (12). The Bogalusa Heart Study found that young adults consumed only 920g of nutrient dense foods compared to 917g of soft drinks and 966g of sweets (13). The Bogalusa cohort of young adults consumed over twice as much of energy-dense, low nutrient foods compared to nutrient-dense foods.

Thus, it is no surprise that recent public and media attention has been focused on sweets and "junk foods," which are key sources of extra calories without nutritional benefits. Interestingly though, sweet beverage intake in children has been shown to relate to total energy intake, but not weight status (14). Food intake from preschoolers was evaluated based on National Health and Nutrition Examination Survey (NHANES) (15), a cross-sectional study evaluating dietary intake of Americans that included 1572 children between the ages of 2 and 5. Also, findings from the Bogalusa Heart Study indicated that eating patterns generally associated with overweight, such as intake of sweets, soft drinks and snacks, were weakly associated with weight status in children (16). The general assumption underlying the recent diet recommendations for children has been to reduce or eliminate all discretionary sweet and fat intakes in children (14), however it is unclear whether this is either necessary or effective. More longitudinal studies are needed to track changes in diet patterns, to understand whether or not they contribute to obesity, and if so, at what age these body weight differences significantly emerge. Weak associations between foods and adiposity may be meaningful since obesity as a chronic disease, may present due to such compound effects over time. If increased caloric intakes from soft drinks or sweets are not directly associated with obesity, it is important to know what other dietary patterns contribute to adiposity. It is also important to consider what psychosocial and environmental factors mediate or exacerbate weight gain leading to obesity.

1.3 Psychosocial Factors

1.3.1 Dietary Restraint and Disinhibition

Under normal homeostatic conditions, food intake is stimulated by hunger cues, in physiological response to nutrient needs. Psychological factors can also stimulate or decrease food intake independent of normal hunger cues, and they encompass both internal and external cues (16). The factors which have received the most research attention are dietary restraint and disinhibition. Dietary restraint is the cognitive intent to restrict food intake due to weight or body fatness concerns (16, 17). Disinhibition is characterized by the eating in response to emotional or external cues such as the sight or smell of food, in the absence of hunger (3, 18-21). The occurrence of emotional eating stems from the individual's inability to distinguish between hunger and the unpleasant sensations that occur from fear or anxiety arousal. The normal adrenal response is loss of appetite, but the emotional eating response leads to higher food intake (22, 23). The theory of externality specifically describes situations where individuals eat in response to the sensory cues from foods, such as sight, smell or taste, regardless of state of hunger (24, 25). This is characterized by eating past the point of satiation. Self-reported disinhibition is repeatedly associated with greater energy intakes in studies where subjects are given a preload before a meal (22, 26). Other studies have indicated that high levels of dietary restraint may induce disinhibition episodes (21, 27, 28). For example, Polivy et al. had one group of subjects deprived from chocolate for one week, simulating restraint, while another group of subjects was not deprived. When presented with chocolate, the deprived group exhibited disinhibition, consuming more than the group that was not deprived (28).

These psychological factors may have a stronger influence on energy intake compared to taste preferences, although they have not been directly compared. Such influences are of increasing concern in both normal weight and overweight individuals. Over-restriction of food can lead to disordered eating practices such as bulimia or anorexia nervosa (27), which can cause hematological, hormonal and immunity imbalances due to nutrient deficiencies in both adults and children (29-32). Young girls ages 10 to 19 recovering from anorexia nervosa experienced persisting nutrient deficiencies upon refeeding, particularly for zinc and folate (30). High levels of disinhibition and binging can lead to excess energy intake, which cumulatively can lead to obesity. A number of questionnaires have been developed to measure these factors in adults, the Dutch Eating Behavior Questionnaire, Three Factor Eating Questionnaire and Herman and Polivy Restraint Scale. Some research indicates that these questionnaires do not accurately measure acute restriction of food but only intention to restrict dietary intake (33). Of these questionnaires the DEBQ and TFEQ have been validated in children (34).

Alarmingly, both dietary restraint and disinhibition measures have been reported in children and adolescents (34-38). Extremes of these eating behaviors are of concern since they can lead to disordered eating. Dietary restraint has been reported in girls as young as 5 years old, (35, 36) and in both genders by age nine (34, 36, 38). A study by

Carper et. al. investigated the relationship among eating behaviors and body weight in 5-year-old girls (35). An age-adapted version of the DEBQ was used, and found that 33% of girls "sometimes" restrained their intake while 70% of girls reported "sometimes" externally eating. Interestingly, the parents' imposed pressure to eat was related to measures of both restraint and disinhibition in the girls. Shunk et. al. reported similar findings in girls ages 5 to 9, where at age 5, restraint was correlated with weight concerns and lower body esteem (36). By age 9, those correlations were even stronger (36).

Such relationships are important in children because of their association with body weight and development of obesity or unhealthy eating practices later in life. Goldstein et. al. found that maternal dietary restraint was a negative predictor of weight-for-height in children, both boys and girls at 9 years of age, and maternal disinhibition was associated with higher energy intake in girls (39). However, in that study, children were within normal range for body weight. Other studies have shown that overweight in children was positively associated with maternal restraint (8, 40), as well as the child's self-reported restraint (34, 38). Thus, parental and children's own intentions to restrict food intake and weight concerns do not necessarily correspond with effective restriction of food intake in order to control body weight.

As mentioned previously, these same relationships have been reported in adults as well. Polivy et al. demonstrated that in adult restrained eaters, food deprivation conditions led to increased cravings and subsequent intake (28). Children's intentions to self-restrict food intake may potentially continue into adulthood, which could induce high levels of dietary restraint, disinhibition and weight concerns, as opposed to effective weight management practices as adults. Presently, no longitudinal studies have investigated how dieting behaviors in children related to weight management practices as adults. It is important to understand how these psychosocial factors track into adulthood and relate to adult body weight status.

1.3.2 Self-Efficacy

Self-efficacy (SE) is another factor that is believed to influence food choices in children. SE is one's perceived ability to make behavioral choices. When related to food intake, this measures the degree to which the child believes he or she can make personal food choices, indicating autonomy in food-related decision making (41).

1.3.3 Social Norms and Family Environment

There are also a set of learned cultural and social norms relating to food consumption and behaviors. Food is generally consumed in a social context, where the environment can play a powerful role in establishing normal and appropriate behaviors (9). For example, when children are served a disliked vegetable in the context where other children are choosing and preferring them, liking increases for those disliked vegetables (42). Children learn by modeling behavior, including eating behaviors. Parents also serve as important models for children. A recent study by Zabinski et al showed that even up through adolescence, parental concerns and household rules were the primary influencers of child fruit and vegetable intake (43). In a family weight loss study by Epstein et al., greater weight loss in children occurred in the social context of a parent participating with them in the weight loss program. Many of the social norms discussed are secondary to the subconscious learning that occurs with repeated food exposure and modeling, which will be discussed below.

It is difficult to separate the genetic influence from the environmental influence that parents provide their children. Undoubtedly, both parents provide a strong influence on the weight status of their children, in that when one or both parents are overweight or obese, an overweight child is much more likely to remain overweight through childhood and adolescence (5). Francis et al. recently tracked girls' weight changes from age 5 to 13, and found that weight gain was greatest in girls who had two parents overweight (4). Rate of weight gain was greater in that group compared to girls who had only one overweight parent, regardless of whether the mother or father was the overweight parent. Other studies have only addressed the maternal influence on girls body weights (35). However, maternal influences may not be as preeminent as previously thought. Epstein et. al. found that in weight loss programs for children, there was greater effectiveness if the opposite sex parent participated with the child (44). For the girls, weight loss was greatest if the father participated, but there was no significant weight loss if the mother participated, or if the child participated by herself. The same pattern of effectiveness was observed in boys.

1.4 Environmental Factors

Aside from the behavioral and psychosocial factors mentioned above, the child's physical environment has an important influence on the development of obesity. Of the environmental factors, the ones believed to be most influential on weight status are physical activity level and socioeconomic status (SES). Often times these two can be closely linked due to factors relating to safety in playing outdoors and in opportunities for team sports and other extracurricular activities.

1.4.1 Physical Activity Level

Since development of overweight is the result of a long-term positive energy balance, reduced activity is equally as important as excess energy intake. The typical American sedentary lifestyle affects children as well, where they sit in a classroom all day, only to come home to watch television or play video games. Studies have repeatedly shown that children with a high physical activity level (PAL) are less likely to be overweight than children who are not engaged in regular activity or with excessive time watching television (45-47). The effect of physical environment can be underestimated as well. Children who live in homes and neighborhoods that are conducive to regular activity might be at a lower risk for developing overweight (48). Roemmich et al. investigated the relationship between neighborhood housing density and access to parks or recreational facilities with physical activity in children (48). Housing density was positively related to boys' PAL, but not girls. Proximity to parks and recreational areas was positively correlated to both girls and boys PAL, suggesting that it is equally reinforcing for activity in children.

1.4.2 Socioeconomic Status (SES)

As children transition into adulthood, physical environment alone can account for approximately 50% of overweight in adolescents (49). Children living in higher SES households have greater availability of healthy foods, which tend to be more expensive. Also, many public schools are cutting costs for physical education, and membership to community or club sports teams can be costly as well. In adult women classified by employment grade, the higher the income, the lower the BMI, waist circumference and waist to hip ratio (50). In the low income group, 64.7% of subjects were overweight or obese, compared to 54.1% in the middle income group and only 40% in the high income group (50). When investigating the food purchases of youth, it was found in a simulation study that purchases of food are directly dependent on their price, regardless of health consequences (51). Children ranked preferences for a variety of snack foods, both healthy and unhealthy. Healthy foods included fruits and vegetables while unhealthy foods included snack foods such as chips, candy or cookies (51). When children had more money to spend, they did not make substitutions for their preferred food, even if the price of the favored food increased. However, when children had less money to spend, they most often chose the cheaper food, regardless of food preferences. For example if the child's favorite fruit or vegetable was more expensive than a snack food of lower favor, they most frequently chose the cheaper food, despite previously stated preferences. Thus, it is suggested that only in situations of excess income will children choose a preferred food that is more expensive. Another study investigated the effects of SES, and its relationship with perceived benefits of diet quality and barriers due to food price with diet quality as an outcome. There was a positive relationship between SES and diet quality, which was attenuated by perceived barriers. So even for individuals with a higher SES, if there is a high perceived food cost, this can lead to poor diet quality as well. Perceived benefits were found to be an independent factor leading to higher diet quality.

1.5 Taste Preferences

Aside from parental influence and psychosocial factors, taste preferences have a strong influence on the development of eating pattern in children. Taste is the primary determinant of children's food preferences. Since unhealthy eating behaviors can be key contributors to overweight and obesity later in life, a deeper understanding of the development of food preferences might elucidate driving forces of unhealthy behaviors. Once it is understood how these preferences are established and naturally transition, nutrition professionals can offer more effective guidance for developing healthy eating behaviors and weight management in children.

1.5.1 Innate Preferences

From infancy, humans have an innate preference for sweet and dislike for bitter (52, 53). Sweet taste is associated with available energy in the form of carbohydrate, which is needed for rapid growth and development. Bitterness is generally associated with toxins and poisonous substances that should be avoided. Preference for sweet persists through adulthood, however, the magnitude of this preferences declines with age. Children are less discriminating of concentrated sweets, and have higher preferences for concentrated sweets than adults. For example, children ages 8 to 10 perceived lower intensity of high concentrations of sucrose in water and orangeade, but rated higher pleasantness for those solutions (54). Adolescents' intensity and pleasantness ratings fell between those of the children and adults. On the other hand, Temple et al. found that children gave higher maximum ratings to concentrated sucrose solutions, but shorter persistency of sweetness compared to adults (55, 56). Also, children have greater difficulty in discriminating individual tastants in complex taste mixtures (56). For example, in mixtures with a low level of sucrose but moderate NaCl, children could not detect the presence of sweet taste at a level above chance. One study by Menella et al found that sucrose suppressed bitterness intensity, but children were still able to recognize bitter taste, even with high levels of sucrose (57). Since from an evolutionary perspective innate preferences serve crucial biological functions for survival, it is not surprising that these preferences are so robust. However, in the present food environment, safe, nutritionally-dense food is widely available and these innate preferences could foster excess energy intake.

1.5.2 Food Exposure

In addition to innate preferences, repeated exposure to foods and specific flavors can contribute to preference for these foods. On a global perspective, this is observed in cultural food preferences, and research studies from Mennella et al. have shown that infants preferred flavors from their mothers' diets (58, 59). These findings were shown evident for flavors from dietary compounds fed during pregnancy as well as during breast feeding. Thus, children have begun to develop flavor preferences during infancy. Aside from mere exposure, the manner in which foods are made available or presented to children can affect preferences. For new or disliked foods, liking of that food generally increases with repeated exposure (9, 60). Wardle et al. demonstrated this through an intervention study. Children were exposed to an unfamiliar vegetable daily for two weeks where they watched the experimenter consume the vegetable and then ask the child to taste it and rate their liking on a 5-point facial hedonic scale. After rating how much they liked the taste, children were offered an ad lib snack of the vegetable. The study found that children like the vegetable significantly more than at baseline, and without reward using exposure only, children consumed almost 9 pieces more than the unexposed group and had a 2 point increase in liking. Also, when foods are used as a behavioral reward for children and otherwise restricted, preference for the reward foods increases. This is primarily observed when access to palatable foods is restricted, and those foods are concomitantly used as rewards (9).

1.6 Genetic Sensitivity to 6-n-propylthiouracil

Genetic sensitivity to the bitterness of 6-n-propylthiouracil (PROP) may serve as a marker for food perception and preference (61, 62). Ability to taste PROP or phenothiocarbamide (PTC) is genetically determined by a 3-amino-acid single nucleotide polymorphism (63). The gene Tas2R38, which codes for the bitter receptor, is located on chromosome 7q, and the two haplotypes are PAV and AVI (64, 65). The taster (T) phenotype is strongly associated with the PAV/PAV or AVI/PAV haplotypes, and non-taster (NT) with the AVI/AVI haplotypes. There is also a third haplotype, AAV, of which individuals are classified as medium taster status, along with heterozygous individuals (66). The AAV haplotype is much less common than the PAV and AVI haplotypes (64). The bitter receptor is sensitive to the C-N-S moiety of PROP and PTC, which are similar in structure to isothiocyanates (ITC). This class of compounds is found in high concentrations in cruciferous green vegetables such as those in the *Brassicae* family, and responsible for their bitter taste (67). Specific examples of ITCs are sulfurophane in broccoli, goitrinogen in rapeseed and allicin in garlic, and are generally disliked by consumers in high amounts (68, 69).

Individuals are categorized into one of three groups based on sensitivity to PROP; super tasters (ST), those most sensitive to the bitterness of PROP, medium tasters (MT), and non-tasters (NT), those insensitive to the bitterness of PROP. In adults, increased PROP sensitivity has been associated with decreased liking and intake of bitter foods (70), increased sensitivity to the astringency of green tea (71), heightened sensitivity to the burn of capsaicin (72), heightened perception of fat texture (73) and lower liking of sucrose (74). There are differences in prevalence of the ST phenotype between genders and among different ethnicities in that there are more taster females than males (75). Ethnic differences will not be addressed in this paper, however in Caucasian populations, approximately 25-30% are non-tasters, 45-40% medium-tasters and 30% super-tasters.

1.6.1 Anatomical Differences Among PROP Taster Groups

Aside from taste receptor differences, ST also have a higher density of fungiform papillae than NT (75). It is not known whether the ST pheonotype is strictly related to the Tas2R38 gene or also with a separate gene controlling density of papillae. Nonetheless, repeatedly, the ST are shown to have a higher density of papillae than NT (75-77). Higher papillae density is associated with increased Trigeminal innervation to the tongue, resulting in tasters having greater sensitivity to textures and chemical feeling factors (78). In support of this, ST have shown to have heightened sensitivity to the oral burn of capsaicin (72), increased astringency from green tea (71), and greater discretion for the texture of fat (73, 76).

1.6.2 Differences Among PROP Taster Groups in Adults

1.6.2.1 Preferences for Fat by PROP Taster Status

The current literature is conflicting on the fat preferences of individuals grouped by PROP taster status. Studies have clearly shown tasters to have greater discretion for fat texture in dairy (73) and salad dressing (76). Hayes et.al. found that ST had a heightened perception for the creaminess of fat in sweetened dairy beverages (79). This was only evident in whole milk and cream, which have higher levels of fat. Also, this phenomenon was unaffected by sucrose concentration. Likewise, Kirkmeyer et al. found ST to use a greater number of terms to describe the creaminess of dairy, and texture perceptions were more important than flavor perceptions in rating liking attributes of dairy (73). For salad dressings, ST but not NT were able to perceive the differences in fat content between regular and reduced fat dressings (76). Interestingly, NT preferred the high-fat salad dressing more, even though they were not able to detect the difference in fat content. With regard to consumption studies, research has shown conflicting results. In a study by Kamphuis, ST were found to eat a higher percentage of fat in buffet-style meals (80) but there were no differences in caloric intake or grams of fat consumed. Similarly, a study by Yackinous found NT to consumer a lower percentage of dietary fat than ST based on food frequency questionnaires, but there was no difference in total energy intakes (81). On the other hand, a recent study by Drewnowski found no relationship between PROP sensitivity and fat preference (82). Thus, there appear to be differences in fat perception between NT and ST, but it is unclear to what degree this affects food preferences and dietary intake in adults. Once individuals have reached adulthood, there are a number of psychosocial factors, such as dietary restraint, that have strong associations with decreased preference for fatty foods (83-85). Environmental and behavioral influences could have a more profound affect on the reported food preferences in adults.

1.6.2.2 Preferences for Sweet by PROP Taster Status

Overall, studies indicate that ST perceive greater intensity for sweetness and also have lower liking for sweets. Looy & Weingarten first found that individuals with increased PROP sensitivity were more likely to be “sweet dislikers,” while those with lower intensity were more probable of being “sweet likers” (52). Yeomans reported that adult ST showed a stronger dislike for concentrated sucrose than the other taster groups (74), whereas another study in female adults showed no correspondence between taster status and preference for sweet foods (57). Yeomans’ study showed that NT were more likely to be “sweet likers” compared to ST, who were primarily “sweet dislikers” (74). Still another study (79) showed that when classified by genotype, ST perceive greater intensity from sweetened dairy. A study by Drewnowski et al. tested hedonic response and intensity perception over a range of sucrose/ fat mixtures in women, and did not find heightened PROP sensitivity associated with enhanced perception of sweetness (86).

1.6.2.3 Relationship Between PROP Taster Status and Body Weight

In adult women, PROP taster status has shown to be related to body weight in that NT were found to have higher BMIs than ST. One study in middle-aged adult women showed that NT women had higher BMIs, percent body fat and tricep skinfolds than ST women, which are indicative of greater adiposity (87). Another report showed that NT mean BMI was 6 points higher than ST mean BMI, but only in unrestrained women (88). Other studies have not found any differences in body weight status by PROP taster groups, however psychosocial factors were not accounted for (68). A recent study by Drewnowski showed that NT women had higher dietary energy intakes (82), however there were no significant differences in body weight, but again psychosocial factors were not taken into account. If not taken into consideration, robust eating behaviors such as restraint and disinhibition could conceal potential differences in body weight due to PROP taster status.

1.6.3 Differences Among PROP Taster Groups in Children

1.6.3.1 Children's Food Preferences by PROP Taster Status

Studies in preschool children have shown many of the same food intake patterns as in adults in preferences for fats and bitter vegetables. Specifically, studies by Keller *et al*. and Bell *et al*. have investigated food preferences and habitual intake in children with respect to their PROP taster status (89-91). When looking at habitual food intake via food frequency questionnaire, NT girls consumed 2 to 3 more servings of discretionary fats per day and liked whole milk more than tasters (89). In a second study in preschool children by Keller et al., non-tasters were found to consume a greater amount of high-fat meats, associated with overall higher protein intake (90). With respect to bitter foods, both Keller and Bell found differences among preschool children. In the first cohort, Keller found tasters to have lower liking of raw broccoli and American cheese. Bell et al., found that in a free-choice snack NT children consumed more vegetables than tasters, particularly bitter vegetables. The findings related to food preferences are in agreement with the patterns reported in adults

On the other hand, intake and preference for sweets in young children are opposite to those in adults, with respect to PROP taster status. In the second study by Keller et al., tasters consumed more sweets than non-tasters (90), which is opposite the findings in adults. Sweet food intake was reported using a food frequency questionnaire (FFQ), and the "sweets" group included table sugar, soft drinks, candy and bakery sweets. Similar findings were reported by Menella *et.al*, when investigating sweet preferences of children with a mean age of 8yrs (57). Tasters were found to prefer higher concentrations of sucrose solutions and like sweeter breakfast cereals. Thus, adults and children differ in their liking of sweets with respect to taster status. As previously explained, in adults, NT perceived lower intensity and greater liking for sweets and concentrated sweet solutions. In general, children have higher preference for sweets compared to adults, but the nature of this transition and its time course are poorly understood.

Body weight differences between taster groups were found in one cohort of Keller's studies, in that non-taster boys had higher BMI percentiles than taster boys but no differences were found in girls. Another study investigated weight differences in older children grouped by PROP taster status, but found no differences in body weight (39). There were overall caloric differences, with NT eating almost 200kcal/day more than ST, however there were not the differences in fat intake among taster groups as Keller et al reported (39). It is unclear the mechanism leading to increased dietary intake and adiposity among non-tasters. Non-tasters might consume more of all foods, or may be predisposed to consume more of certain types of foods, such as discretionary fats, or may consume more within certain environments. It is necessary to further investigate the relationship between PROP taster status, body weight, and dietary intake throughout childhood. Since psychosocial factors and environmental conditions can also affect taste preferences, it is important to consider those factors which also affect dietary intake.

1.7 Summary

Numerous studies on PROP taster status have been conducted in young children and adults, but there is a current gap in literature investigating how these food preferences change between different time points. Only one study has investigated differences in food intake in pre-adolescent children with regard to PROP taster status. Very little information is known about the changes that occur between early and late childhood, leading into adulthood. There are no follow-up studies in the literature investigating differences among PROP taster groups. One important outstanding issue is the stability of the PROP taster phenotype at different points in childhood. It is necessary to conduct a follow-up study on children who were tested in preschool, to investigate whether PROP phenotype is stable later in childhood, and whether or not the eating patterns observed in preschool have remained. Additionally, it is not known how strongly psychosocial factors and parental factors influence eating behaviors and taste preferences in preadolescents.

CHAPTER 2: OBJECTIVES

The current research is a follow-up study of the preschool children who participated in the previous studies in this laboratory (89-91). Important measurements include evaluating to PROP taster status, food preferences, dietary intake, dietary restraint, disinhibition, physical activity and body weight. The aim of this study is to identify dietary and lifestyle changes that occur in children from preschool to preadolescence, which may be associated with increased body weight.

Objective 1: To determine if PROP taster status is a stable phenotype, with children being grouped similarly at ages 4 to 5 years and at preadolescence.

Hypothesis: Preschool and current measurement of PROP taster status will be satisfactorily reliable in classifying individuals according to genetic sensitivity to PROP.

Objective 2: To determine current patterns of food intake among PROP taster groups and compare these patterns to those observed when subjects were young children.

Hypothesis: Children will show the same food intake patterns in preadolescence as preschool where NT will consume less sweets, but more fats and bitter vegetables than tasters.

Objective 3: To determine if current weight differences in preadolescent children exist among PROP taster groups, and if there are changes since preschool.

Hypothesis: NT will exhibit the highest current BMI percentiles and greatest increase in weight status since preschool.

Objective 4: To determine the roles and interactions between PROP taster status, psychosocial and family environment factors in weight status of preadolescent children.

Hypotheses: Children's and mother's restraint and emotional eating will be positively correlated with the child's weight status. Children's self-reported self-efficacy and social norms will be positively correlated with fruit and vegetable intake.

CHAPTER 3: METHODS

3.1 Subjects

This study was a follow-up study of children who originally participated in this laboratory's taste studies as preschoolers at the Nutritional Sciences Preschool. Qualifying children participated in one of three studies by this laboratory investigating the relationship between PROP taster status and food preferences and body weight. The total number of children participating in the preschool studies was 154, and 148 of those were located in the New Jersey Metropolitan area. Families of these children were located and recruited to participate in the study. A description of the study was mailed to each household, and followed up by a telephone call. Parents gave written informed consent for themselves, as well as assent for their children (Appendix A). Research protocols were approved by Rutgers University Institutional Review Board for human subjects. Participants were screened to ensure that there was no recent illness and that they were not taking medications that would interfere with taste perception. Upon completion of the study children were compensated with an individual check for $50.

3.2 Classification of PROP Taster Status

As preschoolers, children were classified using a one-solution method modified by Keller from the Lawless method (92). Children tasted one solution of 0.56 mM

PROP and were allowed a two-alternative response of "yes" or "no." Those who responded that they did not taste anything and did not make classic rejection signs (grimace or frown) were classified as non-taster (NT). Children who responded that the solution had a taste were then asked what it tasted like. Responses of "bad," "sour," "bitter", "yucky" or classic facial rejection signs were classified as tasters. Children with ambiguous reactions were retested.

In the current study, subjects were classified as non-taster (NT), medium taster (MT) or super-taster (ST) according to the paper disk method, previously tested for validity and reliability in both preadolescents and adults (39, 93). In this method, individuals are classified based on intensity ratings to PROP on the labeled magnitude scale (LMS), using paper disks impregnated with NaCl and PROP. The LMS is a semi-logarithmic 10cm linescale that is also anchored with the descriptors, "barely detectable," "weak," "moderate," " strong," and "strongest imaginable." Descriptors are assigned numerical values from 0 to 100. A paper disk impregnated with 1.0 mol/L NaCl was used as a standard, where subjects first rate the intensity of the sodium disk. Taste intensity of NaCl does not vary by PROP taster status, so this sample functions as a standard. NT give higher intensity ratings to NaCl compared to PROP, MT give approximately equal ratings and ST give much lower intensity ratings to NaCl than PROP. Then subjects taste a second paper disk impregnated with 50 mmol/L PROP. Paper disks are given via monadic presentation. Subjects were instructed to rinse with spring water at room temperature before and after tasting each paper disk. Subjects were categorized into one of the three groups based on numerical cutoffs such that less than 17mm is NT, 18-68mm is MT, and over 69mm is ST. One advantage to separating subjects into three distinct groups is that it allows for differentiation between MT and ST, which enables comparisons between NT and ST. The PROP taste test was conducted twice, and ratings were averaged if reported intensity differed.

3.3 Body Measurements

Each child's height and waist circumference in centimeters and weight in kilograms was measured at the first visit, in the child's home. For height, children were instructed to stand against a wall with bare feet flat on the floor and shoulder blades and head against the wall, chin parallel to the floor. Height was measured by tape measure. Weight in kg was measured to the nearest 0.1 kg using an electronic scale (Best Wright BWB-800, Brooklyn, NY). Height, weight, gender and age in months was used to calculate weight-for-height, or body mass index (BMI) percentile and z-score for each child using SAS Statisitcal Software (SAS Institute Inc., Cary, NC) . A child having a BMI percentile between the 85th and 95th percentile is classified as "at risk for overweight," above the 95th as "overweight," and below the 5th as "underweight." Also, triceps skinfold was measured three times, which were averaged. For the parents, height and weight was measured in the same manner as the children. In adults, weight-for-height is calculated using BMI, which is in units of kg/m2. Adults having a BMI between 25 and 30 are classified as "overweight," and over 30 as "obese."

3.4 Diet Intake

Three 24-hour recalls were taken from each child, from one weekend day and two non-consecutive weekdays. One benefit of using computerized 24-hour recalls compared to diet records is that the subject has a lower tendency to modify daily eating patterns due to conscious biases about food and nutrition (94). The 24-hour recall captures a retrospective look at food intake, and when averaged over three days, captures the best representation of habitual diet and intake patterns, and has been validated in children as young as 5-7 years on a group level (95). Also, 24-hr food recalls have been used in longitudinal studies such as the Bogalusa Heart Study to track eating patterns over time (13, 96).

The Nutrient Data System for Research (Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN) multiple-pass approach was used to collect diet information. Two recalls were taken in person and one over the telephone. In cases where the child was unsure of details about food intake, the mother or father was asked to provide help. In the first pass of the multiple-pass approach the child lists the meals and foods eaten during the day. Going chronologically through the day incorporated context reminders, which aids children's memories during food recalls (97). At this stage, a booklet with pictures of standard serving sizes is provided to the subject for reference. Then, the interviewer thoroughly reviews the list, collecting details about serving sizes, preparation, and specific brand information. Afterwards, the interviewer recites the list one final time, probing for any missed information. Nutrient output from food recalls included calories, macronutrients, vitamins, minerals and non-nutritive substances such as caffeine and artificial sweeteners.

3.5 Food Groups

Individual foods were grouped together to further investigate diet patterns by habitual intake of food categories. NDS-R output files automatically separate foods into 160 different food groups with serving sizes based on standard USDA reference amounts. Those food groups were condensed into standard USDA Food Guide Pyramid groups (98) (grains, fruit, vegetables, meat, dairy, fats) with sweets, sugars and snack foods excluded. Components of the snack food category were compared as a whole, and then sweet foods and snacks were further separated into taste-based categories of added sugars, sweet beverages, candy, sweet-fat, and salty snacks. A description of food groups is displayed in Table 1.

Table 1: List and description of food groups and standard serving sizes used for analysis of dietary intake.

USDA Main Groups	
Grains	1 oz bread, pasta, or other grains
Fruit	1/2 cup chopped fruit or 100% fruit juice
Vegetables	1/2 cup chopped, cooked or 100% vegetable juice. 1 cup leafy greens. This group includes non-starchy vegetables such as squash and carrots, as well as potatoes and corn.
Dairy	8 fluid oz milk, 1/2 cup cottage cheese, plain yogurt, 1 oz cheese.
Meat/ Nuts/ Legumes	1 oz red meat, poultry, pork, game or nuts. 2 Tbsp nut butters. 1/2 cup beans.
Fats	1 tsp butter, margarine or oil. 1 Tbsp salad dressings, creamy sauces and gravy. 1 Tbsp reduced fat margarine spreads. 2 Tbsp reduced fat salad dressings.
Sweets & Snacks	
Sweet Beverages	8 fluid oz sweetened (regular or artificial) fruit drink, soda, or tea.
Added Sugars	1 tsp table sugar. 1 Tbsp jam, jelly, syrup, sweet sauces or frosting.
Candy	1 oz chocolate candy, taffy, fruit snacks, bubblegum, and other confections.
Sweet-fats	Cakes, cookies, pies, doughnuts. 1/2 cup ice cream, pudding or sweetened yogurt.
Salty Snacks	1 oz chips, crackers or popcorn.
Total Snacks	All sweet foods (added sugars, candy, sweet-fat) and salty snacks.

3.6 Physical Activity

Physical activity level was measured using the Actigraph GT1M activity monitor (ActiGraph LLC, Pensacola, FL). The activity monitor was worn around the waist for a consecutive 72hours, and was removed only for bathing or swimming. Each child kept a log of times that the activity monitor was removed for water sports, bathing, or other reasons. Using Actigraph GT1M software, the "combination equation" was used to derive energy expenditure for the duration of wearing the activity monitor. The other equations provided, the Freedson equation (FE) and Work-Energy Theorem equation, tended to over or underestimate energy expenditure. The FE is most accurate at high intensity activity levels (99). Total energy expenditure was averaged over the time actually worn to derive average energy expenditure per 24-hour period.

3.7 Dietary Restraint

Dietary restraint and disinhibition were measured using the Dutch Eating Behavior Questionnaire (DEBQ), which is included in Appendix B. The DEBQ is a 33-item questionnaire that measures restraint, emotional eating and external eating. Emotional eating is further divided into sub-categories of clearly labeled emotions and diffuse emotions. Children and mothers each filled out individual questionnaires, each about his or her own eating behaviors. The DEBQ has been frequently used in adults but was also validated for use in children (34, 38). Some investigators had parents fill out the DEBQ about their child, but to avoid potential bias, here the children filled out the questionnaires themselves. They were instructed to ask the investigator if they did not understand the question. The questionnaire uses a 5-point scale where 1= never, 2=rarely, 3 = sometimes, 4 = often and 5 = very often. Averages were calculated for the categories of restraint, emotional eating and external eating.

3.8 Self-Efficacy, Social Norms and Intrinsic Motivation

Children filled out questionnaires measuring self-efficacy in the area of fruit, vegetable and water intake. This measured the child's perceived ability in preparing or asking to purchase fruits, vegetables and water at school, in the home, and at fast food restaurants. A social norms questionnaire investigated the level of influence that parents and peers concepts of normal health behaviors influenced the child's beliefs. Intrinsic motivation (IM) questionnaire measured the degree to which the child is self-motivated towards performing specific health-related behaviors. The difference between SE and IM is that SE measures the child's perceived ability, and IM measures the desire to make health-based decisions. These three questionnaires were focused on health behaviors related to fruit, vegetable and water intake. Questions addressed both positive and negative outcomes towards eating fruits and vegetables, and drinking water. Responses were coded as "0" for "no/none", "1" for "yes/some", and in the SN questionnaire "2" for "3-4 servings/ a lot". These answers were then summed to obtain three separate raw scores per questionnaire, one each for fruit, vegetables, and water heath behaviors. A similar questionnaire has been previously validated in fifth grade children where SE responses were correlated with actual consumption during school lunch (100). To measure the influence of these behaviors in the current study, raw scores were correlated with average fruit, vegetable and water intake as self-reported from the 24-hr recalls.

3.9 Study Design

Interview #1

Consent forms

PROP taste test

Cheek swab for genetic analysis

Anthropometrics

Food recall #1

Questionnaire distribution

Telephone Interview

Food recall #2

Interview #2

Actigraph activity monitor

Repeat PROP taste test

Food recall #3

Pick up questionnaires

3.10 Statistical Analysis

PROP taster classifications from preschool and pre-adolescence were compared for test-retest reliability using Cohen's Kappa statistic. Since as preschoolers, children were only classified as taster or non-taster, subjects classified as MT and ST were grouped together and compared against the preschool "taster" group for reliability, and current NT were compared against the preschool "non-tasters."

Weight status and diet information were analyzed by Analysis of Variance (ANOVA) with PROP taster status, gender and the taster by gender interaction as factors. Energy expenditure in calories was used to adjust for activity, but then was removed from ANOVA analyses due to the weak effect across variables in the models. Diet recalls collected over the phone were compared to dietary recalls done in person to see if that resulted in reporting differences. Pearson's Correlations among weight status, caloric intake, energy expenditure and restraint and disinhibition were investigated. Food intake, child eating behaviors, mothers' weight and eating behaviors, and physical activity were factors for regression modeling for BMI percentile, BMI z-score and change in BMI percentile. Backward and forward stepwise regression were conducted for all children, boys alone and girls alone.

Results from the correlation analyses and multiple regression analyses were used in creating a model for logistic regression to predict overweight. Children whose weight-for height fell above the 85^{th} percentile were classified as "event" and all others "non-event." This formulated an equation to generate relative risk and odds ratios in predicting a child's risk of becoming overweight/at risk during preadolescence, based on specific influential factors. For eating behaviors used in the logistic regression, a median split was used to classify children and mothers as restrained vs. non-restrained, external vs. non-external eaters, and emotional vs. non-emotional eaters. This classification was used because it is preferred to have dichotomous or classification variables in logistic regression models when possible. Percent concordance and goodness of fit statistics (Akaike Information Criterion, Schwartz Criterion) were compared between models to select the best fit model giving the highest sensitivity and selectivity predictions. For all statistical analyses SAS was used, and significance was established at $p<0.05$.

Additionally, Multiple Linear Regression (MLR) and correlation matrix outcomes were used to identify factors that significantly contributed to weight status in children. These key variables and interactions were entered into a Hierearchical Regression model listing main effects first then interactions, with BMI z-score as the outcome variable. The first step included age, gender and taster status. The second step included the child's preschool weight status and energy expenditure (kcal/day). In the third step, child's psychosocial factors were included. The 4th and 5th steps included factors that accounted for maternal influence. The 4th step was mother's BMI, and 5th step mother's restraint and disinhibition. The 6th step was the taster by gender interaction. The 7th and final step was interactions between mother's weight status and psychosocial factors.

CHAPTER 4: RESULTS

4.1 PROP Taster Status

Sixty-three families participated in the study; 62 mothers, 40 fathers and 73 (45 boys, 28 girls), children between the ages of 7 and 15. There were 10 sibling pairs. From the children available for contact, there was a 49% response rate. Among the subjects that completed the current study, 20 were follow-up from the Keller 2002 study (89), 21 from Keller 2004 (90) and 32 from Bell & Tepper (91).

Children were classified by taster status according to the paper disk method (Zhao). There were 18 NT (25%), 39 MT (53%) and 16 ST (22%). Incidence of each group was similar to previously reported ranges among Caucasians of 30% NT, 45-50% MT and 25-30% ST. The current and preschool PROP taster classifications of the follow-up children were compared for test-retest reliability and were found to have a Cohen's kappa of 0.76. A cutoff as greater than 0.70 is considered satisfactorily reliable. Since preschool classifications were bimodal, taster and non-taster, children with current taster status of MT and ST were grouped together as "tasters." This indicates stability of the PROP phenotype measured at 2 time points in childhood, and methods used are satisfactorily reliable in classifying children. As anticipated, NT rated NaCl as having higher taste intensity than PROP, MT rated the two similarly, and ST rated PROP as having a much higher taste intensity than the NaCl control (Figure 2). Comparison of NaCl and PROP ratings are displayed in Figure 2. There were differences in NaCl ratings in that NT gave higher intensity ratings than MT and ST

($p<0.05$, F=3.67). For PROP ratings, ST have highest ratings, followed by MT and then NT ($p<0.001$, F=199.1). For the mothers, there were 13 NT, 35 MT and 13 ST. For the fathers, 31 participated and there were 12 NT, 17 MT and 2 ST. There were not enough participating fathers to look at differences by PROP taster status. The same pattern of comparison for PROP vs. NaCl ratings by taster status was observed in mothers.

Cheek swabs were analyzed for the Tas2r38 gene located on chromosome 7q, which codes for the bitter taste receptor that recognizes PROP/PTC. In comparison between the phenotype and haplotype information, there was 77.8% agreement between AVI/AVI and NT phenotype. When AVI/ PAV and PAV/PAV genotypes were grouped together, there was 96.4% agreement with phenotype taster classification. The contingency coefficient was 0.6259 ($\chi^2<0.01$). Also, there were 7 subjects who had a rare genotype, AAV. Six of those were AAV/PAV and the other one was AAVAVI. Subjects with at least one AAV allele were grouped in with the other heterozygous individuals. When genotypes were compared to MT and ST phenotypes, % agreement with the phenotype taster classifications was less (see Table 2).

Table 2: Table of subject Tas2r38 genotype and percentage of genotype classification that agrees with taster status phenotype

	n	NT	MT	ST
AVI/ AVI	17	77.8%	4.2%	0.0%
AVI/ PAV*	49	22.2%	66.8%	40.0%
PAV/ PAV	5	0.0%	27.0%	60.0%

*Also included are carriers of the AAV variant.

4.2 Demographics

The subject population was relatively uniform in terms of race, education and household income. Subjects were 86% white/Caucasian, and 100% of parents had a technical school degree or some college. The majority of parents (83.5%) had a college or post-graduate degree. Also 88% of children's households had an annual income above $50,000, with 8.2% (n=6) non-response. Thus, as high as 96% of the subject population could fall into the middle-income bracket. Of those, almost 50% have reported annual household incomes above $100,000 per year. See Table 3 for details.

4.3 Weight Status

Among all of the children, 8.2% were "overweight" and 21.2% were "at risk for overweight." Although 6.1% of girls were overweight, and 11.5% of boys, this was not statistically different. The children who participated in the current study did not have different prevalence of overweight compared to the entire group of potential subjects. As a group, the mean BMI percentile was 57.7 ± 3.2 percentile, and during preschool mean BMI percentile was 58.6 ± 3.8. Preschool and Current BMI percentile by taster group and gender are displayed in Figures 7 and 8.

There were no significant differences in mean BMI percentile, change in BMI percentile, waist circumference or triceps skin-fold among PROP taster groups or between genders. Change in BMI percentile since preschool was strongly positively correlated with current BMI percentile ($r=0.53$, $p<0.001$), but negatively correlated with

Table 3: Family demographics of study participants.

Race	**n**	**%**
African American	1	1.37
White/ Caucasian	63	86.3
Asian	7	9.59
Hispanic	2	2.74
TOTAL	73	100
Ethnicity	**n**	**%**
Pureto Rican	3	4.11
Other Hispanic	3	4.11
Cuban	1	1.37
Chinese	4	5.48
Korean	2	2.74
Vietnamese	2	2.74
European/ None	58	79.5
TOTAL	73	100
Parent's Education	**n**	**%**
Technical School	2	2.74
Some college	10	13.7
College	25	34.2
Graduate school	36	49.3
TOTAL	73	100
Household Income	**n**	**%**
<50K	3	4.11
50K - 80K	11	15.1
80K-100K	18	24.7
>100K	35	47.9
NA	6	8.22
TOTAL	73	100

preschool BMI percentile ($r=-0.58$, $p<0.001$). This indicates that for this group, heavier (overweight or at risk for overweight) preschool children had a decrease in BMI percentile as they moved into preadolescence, but those currently at higher BMI percentiles had a significant increase since preschool. Change in BMI percentile by gender and PROP taster status is displayed in Figure 9. Mean BMI percentiles for subjects during preschool and currently are depicted in Figures 7 and 8, in which subjects are grouped by the preschool classifications. As a whole group, BMI percentile was not related to age. Also, there was no significant difference in BMIs among PROP taster groups for the mothers ($p=0.34$). There were not enough fathers who participated in the study to investigate weight differences as a function of taster status.

4.4 Dietary Intake: Nutrients

There were no significant differences in caloric intake or percent macronutrients by PROP taster status. Boys consumed an average of 1,988 kcal/day, which was significantly greater than the girls ($F_{1,72}= 5.05$, $p<0.01$), who consumed an average of 1667 kcal/day. Both genders had similar proportions of macronutrient intakes ($p>0.05$). Range of caloric intake for 3-day averages was 1262 to 4092 kcal/day. Potential underreporting was addressed by removing subjects who had energy intakes of less than Basal Energy Expenditure based on standard equations for age, height and weight, and did not have corresponding decrease in BMI percentile. After subjects were removed, there were no differences from the entire cohort. Thus, reported means and probabilities correspond to the entire cohort (n=73). There was a trend ($F_{2,72}$=2.81, p=0.067) for NT to consume more Vitamin E than MT and ST. There were no differences in other vitamin and mineral intakes by taster status, and there were no significant differences in nutrient intake by gender.

Table 4: Age, weight status, energy expenditure, and dietary intake (nutrients) by PROP taster status and gender. Mean ± SEM. Differences among taster groups are noted by different letters. Differences between genders are noted by asterisk.

	Non	**Medium**	**Super**	**Male**	**Female**
Age (mo)	113.2 ± 5.0	127.5 ± 4.5	122.8 ± 5.1	123.4 ± 4.0	122.2 ± 4.2
BMI Z-score	0.2 ± 0.2	0.4 ± 0.2	0.1 ± 0.3	0.3 ± 0.1	0.2 ± 0.2
Current BMI %ile	55.0 ± 5.2	61.0 ± 4.4	52.7 ± 7.5	58.7 ± 3.9	56.1 ± 5.4
Preschool BMI %ile	63.8 ± 6.0	57.7 ± 4.8	55.1 ± 6.9	56.9 ± 4.2	61.4 ± 5.3
Change in BMI %ile	-8.8 ± 6.5	2.9 ± 5.2	-2.4 ± 7.4	1.8 ± 4.5	-6.1 ± 5.8
Energy Expenditure (kcal/day)	187.0 ± 23	227.6 ± 26	172.3 ± 29	213.2 ± 2.4	192.9 ± 18
Energy Intake (kcal/day)	1885 ± 94	1887 ±76	1786 ±97	1988 ± 69*	1667 ± 55
Energy density (kcal/g intake)	1.0 ± 0.001	1.0 ± 0.001	1.1 ± 0.1	1.0 ± 0.001	1.0 ± 0.001
Vitamin A (IU)	5487 ± 1110	5194 ± 546	3256 ± 356	5289 ± 615	4128 ± 415
Vitamin E (mg)	6.5 ± 0.7	5.0 ± 0.6	5.0 ± 0.6	5.8 ± 0.4	4.7 ± 0.4
Vitamin K (ug)	40.0 ± 6.3	66.5 ± 8.4	40.6 ± 5.2	59.3 ± 7.4	46.9 ± 5.7
Vitamin C (mg)	79.8 ± 8.9	78.0 ± 7.7	53.7 ± 5.5	73.1 ± 6.2	73.3 ± 8.3
Folate (ug)	410 ± 31	431 ± 25	372 ± 49	423 ± 25	397 ± 29
Ca (mg)	853 ± 94	1035 ± 47	900 ± 87	979 ± 54	931 ± 57
% Fat	30.1 ± 0.8	31.5 ± 0.9	31.3 ± 1.5	31.8 ± 0.8	30.1 ±0.9
% Carbohydrate	57.7 ± 1.2	54.9 ± 1.1	55.9 ± 2.0	55.1 ± 1.0	57.0 ± 1.1
% Protein	13.5 ± 0.6	14.8 ± 0.4	14.1 ± 0.6	14.4 ± 0.4	14.2 ± 0.4

Cal/ kg EE	5.9 ± 0.7	5.5 ± 0.4	4.9 ± 0.6	5.7 ± 0.4	5.2 ± 0.5

4.5 Dietary Intake: Food Groups

Average daily intakes of standard USDA, sweets and snack food groups are defined in Table 1 for PROP taster groups and genders. The only difference among PROP taster groups was that MT consumed more servings of fruit per day ($F_{2,72}$=3.14, p=0.05) compared to ST, but not NT. Boys ate more average daily servings of grains ($F_{1,72}$=3.86, p=0.05) and meats ($F_{1,72}$=6.57, p<0.05) than the girls. Intakes by gender are shown in Figure 5.

For sweet food groups and snack food intake there were significant differences among PROP taster groups (Figures 3 and 4). ST consumed more servings of candy per day than NT and MT ($F_{2,72}$=3.00, p=0.05), but this was largely influenced by the ST boys. There was a significant interaction effect between taster status and gender, where ST boys consumed more servings of candy per day than any other sub-group ($F_{5,72}$=3.65, p<0.05), which shows in Figure 6 the LS Means. There were no other differences among taster/gender subgroups. There was a trend for NT to consume more sweet-fat foods and total sweet foods (candy, added sugars, and sweet-fat), but these did not reach statistical significance (Figure 3). However, NT consumed more daily servings of salty snacks than both MT and ST ($F_{2,72}$=6.80, p=0.01). Also, when all snack foods were grouped together, NT consumed more total snack foods than both MT and ST ($F_{2,72}$=7.02, p=0.02).

Table 5: Average dietary intake of food groups (servings/ day) by PROP taster status and gender. Mean + SEM. Differences among taster groups are noted by different letters. Differences between genders is noted by asterisk.

Food Group	Non (n-18)	Medium (n=39)	Super (n-16)	Male (n=45)	Female (n=28)
Grains	5.1 ± 0.3	6.2 ± 0.4	5.1 ± 0.6	6.1 ± 0.3*	5.1 ± 0.4
Fruit	1.6 ± 0.3	1.8 ±0.2	1.0 ±0.2	1.6 ±0.2	15 ± 0.2
Vegetables	1.4 ± 0.2	1.7 ± 0.2	1.2 ± 0.2	1.6 ± 0.2	1.3 ± 0.1
Fatty Meat	1.0 ± 0.2	2.2 ± 0.3	2.4 ± 0.5	2.6 ± 0.3	1.7 ± 0.3
Total meat	3.9 ± 0.6	3.8 ±0.3	3.8 ±0.7	4.4 ± 0.4 *	3.0 ± 0.3
Dairy	1.3 ± 0.2	0.9 ± 0.2	1.6 ± 0.3	1.7 ± 0.1	1.5 ± 0.2
Candy	0.2 ± 0.06^{B}	0.2 ± 0.05 ^{B}	0.5 ± 0.1^{A}	0.3 ± 0.1	0.2 ± 0.1
Sugars	1.0 ± 0.4	0.7 ± 0.1	0.7 ± 0.1	0.8 ± 0.2	0.7 ± 0.2
Sweet-fat	1.7 ± 0.3	1.2 ± 0.1	1.2 ± 0.2	1.3 ± 0.1	1.4 ± 0.1
Total Sweet Foods	3.0 ± 0.5	2.0 ± 0.2	2.4 ± 0.3	2.3 ± 0.3	2.3 ±0.3
Salty Snacks	1.2 ± 0.2 ^{A}	0.5 ± 0.08 ^{B}	0.6 ± 0.1 ^{B}	0.8 ± 0.1	0.5 ± 0.1
Total Snack Foods	4.1 ± 0.5 ^{A}	2.5 ± 0.2 ^{B}	2.9 ± 0.4 ^{B}	3.1 ± 0.3	2.8 ± 0.3
Sweet Beverages	1.0 ± 0.1	1.0 ± 0.2	0.9 ± 0.3	1.1 ± 0.2	0.8 ± 0.2
Water	2.0 ± 0.3	1.6 ± 0.2	1.4 ± 0.3	1.8 ± 0.2	1.4 ± 0.2
Regular Fat	2.4 ± 0.3	2.4 ± 0.3	1.6 ± 0.2	2.5 ± 0.3	1.7 ± 0.2
Reduced Fat	0.4 ± 0.2	0.7 ± 0.1	1.1 ± 0.3	0.8 ± 0.1	0.7 ± 0.2
Total Fat	2.8 ± 0.3	3.1 ± 0.3	2.7 ± 0.4	3.2 ± 0.3	2.5 ± 0.2

4.6 Dietary Restraint and Disinhibition

External and emotional eating scaled responses from the DEBQ were normally distributed. Child's restraint was positively skewed, so a log transformation was used to correct for skewness. There were no significant differences in children's dietary restraint, external eating or emotional eating, neither among taster groups nor between genders.

Table 6: Mean DEBQ scores by PROP taster status and gender for children (n=73). Mean ± SEM

	Non	Medium	Super	Male	Female
Age	113.2 ± 5	127.5 ± 4.5	122.8 ± 5.1	123.4 ± 4	122.2 ± 4.2
Emotional	1.58 ± 0.12	1.69 ± 0.12	1.68 ± 0.2	1.61 ± 0.1	1.74 ± 0.1
External	3.04 ± 0.19	2.85 ± 0.13	2.75 ± 0.2	2.97 ± 0.1	2.72 ± 0.2
Restraint	1.52 ± 0.16	1.8 ± 0.15	1.59 ± 0.2	1.55 ± 0.1	1.93 ± 0.2

There were relationships among eating behaviors and weight status, however. Pearson's correlation analysis showed that children's restraint was modestly positively related to current and preschool BMI percentiles, and age with Pearson's correlation coefficients of $r=0.37$ ($p<0.01$), $r=0.33$ ($p<0.01$), and $r=0.30$ ($p=0.01$) respectively. There was also a moderate positive relationship between restraint and emotional eating ($r=0.32$; $p<0.01$). There was no relationship between externality, emotionality and current BMI percentile, preschool BMI percentile or calorie intake. Also, there was a small positive relationship between calorie intake and external eating ($r=0.25$; $p=0.04$). No relationship was present between calorie intake and restraint nor emotional eating. Thus child restraint was moderately related to body weight variables, but not energy intake, and neither component of disinhibition, emotional or external eating, were related to body weight or energy intake.

4.7 Mothers' Dietary Restraint and Disinhibition

Mean scores for all maternal eating behaviors were normally distributed about the means, which are found in table 7. However, restraint and external eating scores were not different between overweight/obese mothers and normal weight mothers. There was a relationship between the mother's emotional eating and her own BMI ($r=0.42$, $p<0.001$). Overweight/obese mothers (BMI>25) had a mean emotional eating score of 2.5, which was significantly higher than normal weight mothers ($p<0.05$) whose mean emotional eating score was 2.1. Neither mother's own restraint nor external eating were correlated with her BMI, and there were no differences in restraint or external eating scores between normal weight and overweight/obese women.

Mothers' external eating was related to children's external eating ($r=0.30$; $p<0.05$) but mothers' and children's emotional eating and restraint were not related. Mothers' emotional eating was not related to children's restraint, emotionality, calorie intake, or BMI percentile. Mothers' dietary restraint was the only cognitive variable that was positively related to the child's current BMI percentile (0.32, $p<0.01$). Also, mother's BMI was correlated with the child's dietary restraint ($r=0.31$; $p=0.01$). Thus mother's dietary restraint is related to the child's weight status, mother's weight status is related to the child's dietary restraint, and mother's weight status is related to the child's weight status, but dietary restraint is not related between mother and child.

Table 7: Maternal age, weight status and psychosocial factors. Means ± SEM for mothers grouped by PROP taster status.

	Non (n=13)	Medium (n=35)	Super (n=13)
Age	43.8 ± 1.1	43.8 ± 0.9	42.4 ± 1.5
BMI	27.6 ± 1.9	25.1 ± 0.9	26.7 ± 1.3
Restraint	3.15 ± 0.21	3.02 ± 0.12	2.97 ± 0.23
Emotional Eating	2.36 ± 0.18	2.27 ± 0.1	2.26 ± 0.2
External Eating	3.01 ± 0.12	3.02 ± 0.08	3.27 ± 0.14

4.8 Self-Efficacy, Social Norms, Intrinsic Motivation

Neither SE, SN nor IM were related to reported fruit, vegetable or caloric intake. Categories of fruit IM and vegetable IM were highly correlated with each other, but not with reported intake. The same pattern was observed for SN, but slightly weaker, in that fruit SN and vegetable SN were positively correlated with each other, but not to reported intake. Due to low correlations, these parameters were not included in subsequent analyses.

4.9 Regression Analysis for Weight Status (BMI Z-score)

4.9.1 Multiple linear regression results

Multiple linear regression was used to determine the factors that accounted for the variance in current BMI percentile z-score. Backward and forward stepwise regressions were used to identify the best-fit model, which accounted for 52.6% of the variance. Factors included in every model were preschool BMI z-score, age in months, gender, PROP taster status, energy expenditure, caloric intake, child's DEBQ factors, and mother's DEBQ factors. In the best model, the following factors were positively related to current BMI z-score; taster-by-gender interaction, child's restraint, energy expenditure and preschool BMI z-score. The following factors were negatively related to current BMI z-score; gender, taster status and age. For each model, the following factors were initially included but removed due to lack of significance; caloric intake, child's external eating, child's emotional eating and maternal restraint, external and emotional eating. Maternal BMI was excluded from model due to collinearity with child's restraint. Colinearity was determined by observing changes in r^2 and significance in stepwise regressions. Also, as reported in the previous section, mother's BMI and child's restraint were modestly correlated ($r=0.31$; $p<0.01$). Maternal BMI and child's restraint accounted for significant variance in regression models when each factor was entered first, but upon entering the other factor, significance was lost. Maternal emotional eating and external eating were also collinear, and the multiple weak relationships among variables complicated the regression models when all variables were initially included.

The presence of a taster/gender interaction as a significant contributor to variance in BMI percentile led to fitting of regression models by gender. The best model for boys -accounted for 45% of the variance in BMI percentile and included 4 variables. Variables with positive parameter estimates were child's restraint, preschool BMI percentile and energy expenditure, and the variable with a negative parameter estimate was age. In the girls' model only 2 variables were significant; restraint and taster status, which accounted for 43% of variance. Both variables had positive parameter estimates, and thus were positively related to BMI percentile.

Table 8: Multiple linear regression variables for predicting BMI z-score. Variables that were not significant in predicting BMI z-score at p=0.05 were removed from the model.

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	1.55	0.57	2.89	7.43	0.0087
Gender	-1.50	0.52	3.26	8.40	0.0055
Taster*gender	0.73	0.25	3.47	8.93	0.0042
Child's restraint	0.59	0.20	3.27	8.43	0.0054
Taster	-0.86	0.36	2.25	5.80	0.0196
Age (months)	-0.01	0.00	3.16	8.14	0.0062
Preschool BMI z-score	0.19	0.08	2.05	5.27	0.0257
EE	0.00	0.00	3.61	9.29	0.0036

Table 9: Multiple linear regression variables for predicting BMI z-score for females. Variables that were not significant in predicting BMI z-score at p=0.05 were removed from the model.

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F	Partial r^2
Intercept	6.13	16.04	54.74	0.15	0.707	-
Child's restraint	10.34	4.63	1874	5.00	0.039	0.167
Taster	17.88	6.13	3190	8.51	0.0096	0.265

Table 10: Multiple linear regression variables for predicting BMI z-score for males. Variables that were not significant in predicting BMI z-score at p=0.05 were removed from the model.

Variable	Parameter Estimate	Standard Error	Type II SS	F-value	Pr > F
Intercept	67.67	17.61	5489	14.76	0.0005
Dietary Restraint	10.65	4.68	1928	5.19	0.029
Preschool BMI Percentile	0.22	0.12	1261	3.39	0.074
Age (mo)	-0.41	0.14	3410	9.17	0.0047
Energy Expenditure	0.052	0.024	1790	4.81	0.0352

4.9.2 Logistic Regression

Logistic regression was used to predict risk of overweight status, based on the children's current weight status. Children with a BMI percentile above 85% were considered "at risk" for overweight and all others were "not at risk." The best-fit model had an 84% concordance rate in probability for predicting "at risk" status (Wald Chi-square $p<0.05$). No factors were found to have a protective effect, and those that increased the risk of overweight were preschool BMI percentile and maternal restraint (see Table 11). Maternal BMI, the child's restraint, taster status and gender did not significantly predict BMI percentile in this model. Since the taster-gender interaction did not significantly affect the risk of overweight in this model, no further logistic regressions were investigated. Thus, weight status at preschool and maternal restraint influenced the risk of being overweight, but not maternal BMI, child's restraint, PROP taster status, gender, or the taster-gender interaction.

Table 11: Logistic Regression model for predicting "At Risk for Overweight"

Variable	Odds Ratio Estimate	95% Wald Confidence Limits	p-value
Preschool BMI Percentile	1.045	1.01 – 1.08	0.0039
Mothers Dietary Restraint	7.21	1.79 – 29.02	0.0054
Variables Removed		**Wald Chi-square**	**p-value**
Mothers BMI		0.53	0.467
Taster Status		0.98	0.322
Gender		0.83	0.362
Taster x Gender Interaction		2.76	0.097
Mothers' External Eating		3.09	0.079

4.9.3 Hierarchical Regression

In the Hierarchical Regression, variables were entered as main effects first, then interactions. Main effects were entered in steps to determine the proportion of variance that is contributed by the separate factors, or groups of factors. In step 1, age, taster status, and gender were entered into the model and together did not account for significant variance. Within step 1, gender and taster status did not meet the probability cutoff of $p<0.05$, but since the interaction between the two was of interest, they were left in the model. In step 2 preschool BMI percentile was entered, and accounted for an additional 10.5% of variance. In step 3 child's restraint was entered and accounted for an additional 7% of variance in child's BMI z-score. Maternal BMI, emotional eating and restraint were entered in steps 4 and 5, but neither accounted for significant variance. In step 6 the taster by gender interaction was entered, which accounted for 5.0% of variance. Also, upon entering the interaction term, the main effects of taster and gender had significant effects in the model. In step 7 the interaction between mother's BMI and her external eating was entered, and accounted for 4.3% of the variance in child's BMI percentile. All together, the adjusted r^2 was 0.468, indicating that the model accounted for 46.8% of the variance in child's BMI percentile. Interactions between gender and restraint, and child and mother's restraint scores were investigated, but these terms did not account for significant variance so were excluded. Proportion of variance accounted for by each step of the Hierarchical Regression is shown in Figure 10.

Table 12: Hierarchical regression for BMI z-score. Each step has percent of variance, and p-value for the step, with individual parameter estimates for significant variables. Variables not contributing to significant variance (p>0.05) are italicized.

Step Number and Variable(s)	Parameter Estimate	p-value
Step 1: NSD		
Age		
Taster status		
Gender		
Step 2 (28.5%)		p<0.01
Preschool BMI z-score	0.241	
Energy expenditure	0.003	
Step 3 (7.1%)		p=0.01
Child's restraint	0.125	
Step 4: NSD		p=0.14
Mother's BMI		
Step 5: NSD		
Mother's restraint		
Mother's emotional		
Step 6 (6.0%)		p=0.02
Taster x gender	0.542	
Step 7 (4.8%)		p<0.05
Mother: BMI x emotional	0.061	
Total: 46.4%		

CHAPTER 5: DISCUSSION

5.1 Stability of PROP Taster Status

The phenotype of PROP taster classification remained stable from preschool to preadolescence. This is the first study that has measured the stability of the phenotype over a 5 to 10 year period, and adds support for continued use of the phenotype versus genotype in measuring PROP sensitivity and comparing food preferences. Measuring PROP phenotype is a time and cost efficient method of measuring taster status, which has shown to be related to the haplotype classification of the Tas2R38 gene. Based on this knowledge, findings in food preferences differing by PROP taster status may be compared throughout childhood. Since PROP phenotype is stable, this may help explain interactions between environment and taster status. It is necessary to track PROP taster phenotype into adulthood so that comparisons and conclusions may be drawn for adults, and not just children.

5.2 Dietary Intake

The subjects who participated in this study were a demographically homogenous group of children. They were primarily Caucasian, from upper-middle class families with well-educated parents. It is not surprising within this demographic, to see normal body weights and dietary intakes, following current recommendations. In this study, child taster status was not independently related to differences in caloric intake and subsequent development of overweight in preadolescent children as hypothesized. Nontasters did not have a higher caloric intake, which would be indicative of future weight gain. Estimated dietary needs for children ages 9 to 13 are 2,079 kcal/day for boys and 1,970 kcal/day for girls. The boys' average intake was 1,988 kcal/day, which was right at the recommendations. Girls consumed an average of 1,667 kcal/day, which was 300kcal/day less than the recommendations. Underreporting could be the source of this deficit, particularly when dietary restraint is involved (101), and in the current study, dietary restraint was reported in both children and mothers. However, as a group, the boys maintained weight status and girls decreased in weight status since preschool, suggesting that energy intake was consistent with weight status. We also examined reported energy intakes relative to calculated resting energy expenditure x 1.2 and found no discrepancies. Children who reported energy intake less than REEx1.2 were found to have a decrease in BMI percentile relative to their preschool BMI percentile.

Although there were no differences in caloric intake by taster status, this could be due to dietary intake balancing with energy needs, as reflected in the children's normal body weights. It was surprising to find a normal weight population, with only 8% overweight, when the national averages are 17 to 19% overweight for this age group. Interestingly, there were significant and important differences among taster groups for food group intake. When in preschool, tasters consumed more sweets and more discretionary fats than non-tasters (89, 90). For these same children at preadolescence, there was an opposite trend in NT children consuming more sweet-fat foods, and a significant difference in NT consuming more overall snack foods. The ST group consumed significantly more candy than the other two groups, which was primarily driven by the ST boys. Intake differences from preschool to preadolescence for sweet foods are indicative of taste preference changes for sweets among taster groups. Among children ages 5 to 10 years, tasters have shown to have greater preference for concentrated sweets, and NT have lower preferences for sweets (57). Also, ST preschoolers were found to choose milk over cheese, while NT chose cheese over milk (102). The authors partially explained this by the sweeter taste of milk versus cheese, milk being 41.7% sugar by dry weight in the form of lactose (102). Contrarily, adult ST have lower preference for sweets and NT have higher preference for sweets (74). It appears that during childhood, preferences for sweet foods change with respect to taster status but it is not known when exactly this change occurs. This study indicates that changes in sweet preferences are beginning to take place during middle childhood or preadolescence. At this age, the phenomenon could be mid-transition, explaining the conflicting results for the subgroup of candy compared to the other sweet foods. Another explanation could be that girls' taste preferences transition at an earlier age than boys, in the same physiological time frame as puberty. One shortcoming of this study was that the child's stage in puberty was not captured, and is still a current research gap. This could have an important effect on changes in taste preferences and eating behaviors. One particular study by Whissell-Buechy found that for PTC tasters, females completed puberty earlier than NT females while the reverse was true for males (103). Other studies have indicated that overweight is associated with earlier maturation (104, 105).

External eating was also correlated with daily servings of sweet-fat foods and caloric intake in the current study, but these differences did not influence body weight.

Together, these results indicate that although external eating and taster status may be associated with increased dietary intake, other behavioral and environmental factors, such as restraint or parental control might counterbalance weight gain. However, eating behaviors, learned from parents, may continue throughout adulthood and may lead to excess weight gain if nutritionally unbalanced. Adult obesity and unhealthy eating behaviors are associated with subsequent overweight in their children (5, 106).

A similar study from this laboratory by Goldstein et al. investigated differences in dietary intake by PROP taster status in a slightly younger cohort and found NT had greater energy intakes than ST. These differences were not related to increased intake from specific food groups (39). Nontasters consumed about 250 kcal/day more than ST, however physical activity was not taken into account. Similar to the current study, Goldstein et al. found no differences in children's weights by taster status. Results from these two studies indicate that underlying differences due to taster status may be present, however, focusing on taster status alone gives an incomplete picture of the development of eating habits and weight status (61, 67). The present study also investigated the relationships among parents' weights, child's weight and eating behaviors to understand the interactions affecting dietary intake. These relationships will be addressed in more detail further in this section.

On the other hand, there were significant differences in dietary intake by gender. As mentioned previously, boys had a higher average daily caloric intake than the girls, and this difference can be accounted for by specific food groups. Boys consumed more grains, meat and discretionary fats, indicating they ate more main course or entrée type foods. This is consistent with previously reported food preferences in adults, where males reported higher preference for meat than females (107). Their increased intake was not a result of eating more of all foods compared to girls, but from main course items. Although this is healthier than increased intake from snack foods and "empty calories," the boys did not have corresponding higher intakes of fruits, vegetables, or dairy. Diet quality of preadolescents overall is mediocre, lacking in fruits, vegetables and dairy (12). There were no differences among PROP taster groups in fruit or vegetable intake, however, mean intakes were low making differentiation difficult. Also, there were no systematic differences in fruit or vegetable liking by taster group. One shortcoming with the questionnaire used is that it only gave subjects 3 choices, "Dislike", "Like a little", and "Like a lot." There was no neutral option for "Neither like nor dislike." Hedonic scales should have balanced choices for like and dislike with a neutral center according to current accepted sensory practices (108).

5.3 Weight Status

Nontasters did not have higher current BMI percentiles than MT and ST as hypothesized, nor did they exhibit a greater increase in weight status since preschool, as measured by change in BMI percentile. However, PROP taster status significantly contributed to weight status in the MLR and Hierarchical regression models. The relatively small subject population did not provide enough statistical power to explore in depth the relationship between gender and PROP taster status. Also, boys did not exhibit a greater change in weight status compared to girls, which is the pattern of the national average. Overall, the strongest predictors of overweight from the MLR and

Hierearcical regressions were preschool weight status and the child's self-reported dietary restraint. The collinearity between child's dietary restraint and mother's weight status made it difficult to compare the independent effects of those two variables. Based on the Pearson's correlations, influence was similar, both having a correlation coefficient of approximately 0.30. There are other psychosocial factors which indirectly played a role in development of overweight in children.

It is not surprising that preschool weight status was a strong predictor of weight status during preadolescence. Vogels et al. recently showed how children tend to track in weight status (8). At 12yrs, child weight status was associated with weight status throughout previous childhood as early as one year of age. Children overweight at age 12 had higher BMIs than normal weight children by age 4 (8). The only other predictors of weight status were father's BMI and maternal restraint.

Some studies have found associations between disinhibition and body weight in both children (4) and adult women (50), while others have found no relationship to body weight in children (34, 35). Some researchers believe that these eating behaviors may be genetically modified, stating that these behaviors exhibit some degree of heritability (4, 109). Francis et al did not find a relationship between parents and young girls' disinhibition at age 5, but found modest relationships by ages 11 and 13 (4). If disinhibition is genetically versus environmentally acquired, it is assumed that the phenotype would be measurable even at young ages. Francis' group concluded that the parallel patterns of change in disinhibition with weight status still provided some support for the eating behavior as a phenotype (4). Faith et al. found greater disinhibition in 5 yr old boys at risk for obesity, and attributed it to a genetic basis

(109). Although the predisposition to disinhibiton may be heritable, environmental factors are most important in development of disinhibited eating, with only 6% to 28% being attributed to genetics (110). Thus, the etiology and environmental conditions leading to disinhibition are still unclear (4).

One strength of the DEBQ versus Three Factor Eating Questionnaire (TFEQ) or Eating Inventory (EI) is that the two major components of disinhibition, emotionality and externality, are separated. TFEQ and EI are other commonly used questionnaires to evaluation dietary restraint and disinhibition measures. In this study, both child's and mother's emotional eating, but not external eating, were positively related to overweight and obesity. There was no direct relationship between external eating and weight status in either mothers or children. Wardle et al. had similar findings in that children reporting restraint had higher body weights, and external eating was associated with higher energy intake, but lower body weights (34, 111). Emotional eating appeared to be enhanced by restraint and, subjects reporting emotional eating were more likely to feel fat, found it harder to stop eating and reported binging (34). Furthermore, negative emotions, such as stress or body dissatisfaction, have had stronger associations with overeating versus positive emotions (112). Both the current study and Wardle's report are suggestive that the emotional triggers for disinhibition have a strong relationship with the development of obesity and are perhaps of greater importance than external cues. Mothers reporting emotional eating had higher BMIs than normal mothers. However, in the present study, emotional eating was not associated with caloric intake or pre-adolescent body weight in children.

Another explanation is that being overweight or obese could lead to development of an emotional tie with palatable foods due to phases of severe restriction and failed dieting attempts (113). Interestingly the child's emotional eating was related to the child's preschool weight status, and not current weight status. This tends to support the latter explanation in that overweight triggers emotional eating. Children overweight during preschool may develop emotional ties with food, and use food as a comfort for stress. Perhaps in the current study, parental controls help manage the weight of children reporting emotional eating, potentially explaining the absence of a relationship between emotional eating and weight status in children. It is possible that when parental controls are removed later in life, children exhibiting high emotionality will engage in binging, which can lead to obesity and/or eating disorders. It is perhaps a vicious cycle, with emotionality spurring unhealthy eating patterns which lead to overweight, which only exacerbate the emotional connections with food. Due to parental controls, weight differences due to this may not present until adulthood. Further studies would need to be conducted to investigate the exact etiology of emotional eating and its relationship to overweight.

A proportion of external eating appears to be mediated by the emotional eating factor, however, external eating without emotional ties is not related to weight status in children and mothers in the current study. External eating has even been negatively associated with body weight in children, and has been suggested that this could be a normal eating behavior (34). This could be in part representing homeostatic appetitive response and lack of dietary restraint. Child's external eating was also weakly related to caloric intake and intake of sweet-fats, but had no relationship with body weight.

The child's external eating was positively correlated with the mother's external eating. Perhaps this is representing the shared environment such that snack foods or highly palatable foods, which incite external eating, are more readily available. A low level of reported external eating may be normal in healthy children, and in this study, the child's external eating factor may be more indicative of a lack of dietary restraint. As mentioned, child's external eating was weakly correlated with caloric intake, but unrelated to current weight status or change in BMI percentile since preschool.

The multiple correlations among weight status and eating behaviors in both the child and mother made the selection of variables for regression modeling difficult (Figure 1 Flow diagram). Although many of the correlations were low, there were many interrelated variables, such as maternal emotional eating which was correlated with both maternal BMI and external eating. The variables that seemed to have the most direct effect on child's weight status based on correlations were preschool weight status, mother's weight status and both child and maternal restraint. Child's emotional eating and external eating were indirectly related to child overweight via restraint and preschool weight status. Maternal emotional eating was indirectly related to child weight status via maternal BMI. Thus, although direct relationships between emotional eating, external eating and child weight status cannot be drawn, trickle down effects appear to occur through dietary restraint and maternal weight.

In the hierarchical regression, maternal weight status was entered in the 4^{th} step, and did not account for significant variance in the model, but was collinear with child's restraint. This indicates that when controlled for confounding variables, mother's weight status by itself account for as much variance as has been indicated in a study by

Birch, (40)where mother's BMI was a modest predictor of girls' weight. In the current study, mother's BMI was positively correlated with the emotional eating factor of the DEBQ and the interaction between mother's weight and emotional eating accounted for 4.3% of variance in the child's weight status based on results from the hierarchical regression. This indicates that the influence of maternal BMI accounts for more than simply genetic variation in weight or body type. Maternal eating behaviors play a significant, indirect role in the development of overweight in children (114), perhaps mediated by interactions between weight status and psychosocial factors. Francis et al found that maternal weight control and dietary restraint were related to child's feeding restriction and these relationships were stronger in overweight mothers versus normal weight mothers (114). Parental restriction of food is predictive of overweight in children (35). These models are not taking into account the direct influence the mother has over child eating behaviors as might be captured in the Child Feeding Questionnaire (CFQ).

Information on child feeding practices and maternal restriction of children's food intake could be helpful in interpreting relationships found in the current study between eating behaviors and child weight status. The CFQ is a 31-item questionnaire developed by Birch et al (115) that measures parental child feeding practices such as restriction, perceived child weight, concern about child weight, pressure to eat, and monitoring. Birch and colleagues have shown that factors of food restriction and concern about child weight are particularly predictive of overweight (35) and disinhibition (113). As reported in the study by Goldstein et al. using a stepwise MLR model, four CFQ variables accounted for variance in child weight status, whereas maternal restraint was only marginally significant in the model (39). Children of disinhibited mothers had higher caloric intakes, primarily driven by the girls. However, mother's weight status, but not disinhibition, was predictive of child weight status (39). Conversely, girls of overweight parents were shown to have higher levels of disinhibition compared to girls with normal weight parents (4). Thus there appears to be a relationship between parental and child weights, mediated by disinhibited eating (4). These findings are similar to the present study, where maternal disinhibition is positively associated with child's weight status, an effect that presents stronger in girls than boys. Subjects in Goldstein's study were of similar age ranges, only slightly younger, and from similar demographics, giving further support to the suggestion that parental influence via eating behaviors and feeding practices affects child weight status. Although the current study did not directly measure parental influence on feeding practices, it is possible that parental influence on child eating behaviors persists, even through high school age, leading to behaviors that continue through adulthood. Zabinski et al. reported that for high school children, parental concerns and household rules about fruit and vegetable intake had the strongest relationship with actual fruit and vegetable intake, compared with peer and self-motivation influences (43). To date, no study has investigated in adults the affect of parental influence on feeding behaviors when they were children.

5.4 Dietary Intake Comparisons with National Averages

Although this subject population had healthy body weights, appropriate caloric intake and macronutrient intake, they had low fruit, vegetable and dairy consumption. In 1992 the USDA issued the Food Guide Pyramid and Dietary Guidelines, setting children's recommended dietary intake as 2-4 servings of fruit, 3-5 servings of vegetables and 2-3 servings of dairy. When revised in 2005, USDA's new Food Guide Pyramid and Dietary Guidelines focused on individualized diet plans and was vague in recommendations for number of servings. The MyPyramid for Kids suggests consuming 2 ½ cups of vegetables, 1 ½ cups of fruit, 6oz of grain with at least 3oz from whole grain, 5oz of lean meat and 3 cups of dairy, which is based on a 1,800 kcal/day diet (98). DRI caloric recommendations are higher than the Dietary Guidelines. For individualized guidelines, one must use the MyPyramid website to decipher what the exact individual recommendations are based on sex, age and physical activity level. In the currents study, boys consumed 1.64 ± 0.16 servings per day of fruit, and girls consumed 1.46 ± 0.20 servings per day, which are approximately equivalent to ¾ cup chopped fruit or fruit juice. Thus, based on the recommended fruit intake, , both genders were at least ½ serving below recommendations from the 1992 Dietary Guidelines, and ¾ cup below the 2005 Dietary Guidelines. For vegetables, boys consumed 1.61 ± 0.16 average servings per day and girls consumed 1.33 ± 0.14 average servings per day, which again are approximately equivalent to ¾ cup chopped or cooked vegetables, vegetable juice, or 1 ½ cups raw, leafy vegetables. Compared to recommended intakes for vegetables, both genders were at least 1 ½ servings below the 1992 Dietary Guidelines and 1 to 1 ¾ cups below the 2005 Dietary Guidelines.

If any population of children would be expected to meet the recommendations for fruits and vegetables, it would be children in affluent well-educated families. It is known that produce is more expensive than low-nutritive snack foods, and this is one of the major barriers preventing lower class families from maintaining a healthy lifestyle (116). Higher SES and employment grade is associated with lower BMI in women (50), and higher diet quality (116). Higher perceived benefits were related to higher diet quality, and higher perceived barriers were related to lower diet quality (116). Epstein's study on microeconomics of food purchasing clearly displayed that when funds are short, young adults will sacrifice nutrition before taste (51). So, in a population where the financial constraints affecting the majority of US children are not present, and perceived barriers are low, one would expect higher fruit and vegetable intake. Thus, the assumption that affluence and normal body weights are indicative of healthy eating behaviors is not supported by the current study. Perhaps healthy eating behaviors are being practiced at some level, but not completely according to recommendations.

Barriers such as food availability that are traditionally reported to be linked with low fruit and vegetable intake (117) are not present in this population. Produce was readily available to children in this study; on the average there were 10 different fruits and 8 different vegetables available in each household. Also, the children were homogenous in their self-efficacy and intrinsic motivation. They believe that healthy eating behaviors are important and eat some fruits and vegetables, but did not reach the recommendations.

One possible explanation is that the exact recommendations of daily servings of fruit and vegetables may not be clearly communicated to parents and to children. Both fruit and vegetable intakes are associated with a healthy lifestyle, but even educated families are not putting the education into practice. Although individual diet plans for each person in the country, as promoted by the 2005 Dietary Guidelines, might be ideal, it may not have practical implications in guiding the general public to achieve and maintain a healthy lifestyle. Individuals must go through the website to receive their individual plan, and specific recommendations are complex, giving serving recommendations ranging from daily to weekly. This study is indicative that MyPyramid and the new recommendations may not have made an effective difference on the eating patterns of children among the Caucasian middle-income population. Consuming "some" fruits and non-starchy vegetables daily is clearly a part of this population's eating habits, but current public education does not communicate specific guidelines or motivate children to efficaciously follow recommendations.

Unfortunately, fruit and vegetable intakes were not the only food groups with inadequate consumption. Children also did not consume enough dairy, which was reflected in the inadequate calcium intake. Calcium intake was approximately 300mg below the RDA's for both girls and boys, equivalent to one cup of milk, which was the amount children's dairy intake fell short of recommendations. The only other nutrients that were below recommendations were Vitamin E and magnesium for both genders, and iron for females. Although dietary intake was lacking in key food groups, children made caloric compensations through intake of energy dense yet low-nutritive snack foods. As a whole, the group consumed about 3 servings per day of candy, sweet-fat foods, added sugars, or salty snacks, which are all low in nutritive value. These consumption patterns are similar to those reported from CSFII (12). Compared to results from the Bogalusa Heart Study where children consumed twice as much low diet-quality food compared to nutrient-dense food (13), children in the current study consumed more fruits, vegetables and dairy, and less sweetened soft drinks.

5.5 Taster Status and Gender

In both MLR and hierarchical models, the taster by gender interaction accounted for significant variance in the child's weight status, modeled using BMI z-score. When separate regressions were run for each gender with BMI percentile as the dependent variable, taster status was significant in the model for girls but not boys, indicating differences in preadolescent body weight due to taster status occur only in females. In support of these findings, studies on an isolated population in Italy (unpublished) failed to show weight differences in men across all age groups, but found differences in unrestrained women over the age of 50. The older women had slightly higher BMIs than the younger women, suggesting that differences in body weight due to taster status are most often observed in overweight women, versus normal weight women. Two studies in this laboratory have shown differences in body weight in women by taster status (87, 88). In both studies, BMI was inversely related to taster status in that NT had the highest BMIs and ST had the lowest BMIs. In the study by Tepper et al., NT had a mean BMI 6 units higher than ST for unrestrained women (88). Goldstein et al found similar differences among women, regardless of dietary restraint (87). The current study, however, opposes those findings, in that there were no differences in maternal BMI by taster status, regardless of restraint score.

One possible explanation for finding no differences in weight as a function of PROP taster status in mothers is that the BMI's of women participating in the current study were slightly lower and less varied than the women in the Goldstein and Tepper studies. In the current study, the average BMI of mothers was 25.9 ± 0.7 kg/m^2 (n=60), whereas for the women in Golstein's study the mean BMI was 26.6 ± 1.3 kg/m^2 (n=40) (118), and 27.4 ± 0.8 kg/m^2 (n=86) in Tepper's study (88). Other studies in normal weight populations have not found differences in body weight among taster groups (70, 81, 82). In the study by Yackinous, both men and women participated, and the subjects were normal weight (BMI 21.3 ± 2.7 kg/m^2) college-aged (19.7 ± 2.3 years) adults. One shortfall of many of the current studies, is that the subject populations are normal-weight young-adults, tested while in college, which is a unique lifestyle uncommon to the general public. Thus, conclusions from those studies cannot be generalized to the American population. Although many adults begin gaining weight in early adulthood, weight gain and adiposity become exacerbated during middle-age in the context of a sedentary lifestyle. Small differences in dietary intake associated with taster status or eating behaviors in general might not have an immediate impact on body weight but could have a cumulative effect over time, particularly in the context of a sedentary lifestyle.

In light of such, it is not surprising no differences in weight status among the children were found, since similar to mothers, they were of normal weight and were physically active. As indicated in previous research, overweight children have a much greater risk of developing obesity in adulthood and are therefore a more appropriate subject population for research. One difficulty in the nature of behavioral studies is that the subjects are self-selected, and not taken from a random sample. It is highly likely that more health-conscious mothers would be interested in enrolling their children in a study investigating eating habits and health behaviors. Such bias cannot be controlled for. However, the prevalence of overweight in preschool was not different between the children who participated in the study and the children who did not. Subject recruitment was limited to those who had participated in previous studies with the Rutgers Nutritional Sciences Preschool. Parents intentionally enrolled their children in a preschool that administered healthy snacks and included nutrition lessons, indicating that this group is likely more nutritionally-aware than the general public.

5.6 Dietary Restraint and Gender

The gender by restraint interaction in the children was not related to weight status, indicating that dietary restraint had a similar effect in both genders with respect to body weight. Additionally, the self-reported dietary restraint was not higher in girls than boys as previous studies in children have suggested (111).

Although there were no self-reported differences in dietary restraint, in the current study the girls had an overall decline in BMI percentile at follow-up, though not statistically different, while the boys had no change. This could be due to the relatively small subject size and an inability to detect true differences in eating patterns. In both genders, however, there was a positive relationship between age and dietary restraint, in that the older children showed greater weight concerns and were more likely to be restricting dietary intake. Thus, in the present study, concern about body weight control existed in both boys and girls. This research, in a demographically similar population, demonstrates that restrained eating and weight control do not exist in girls alone. According to the CDC's reports from NHANES data, 19.1% of non-Hispanic white adolescent boys are overweight, which is an increase from the national average of

13.9% in preschool (2). This data indicates that other factors, such as environment, physical activity or psychosocial factors, could greatly attenuate the nation-wide pattern of childhood obesity in both girls and boys.

In support of these findings, Tepper et al found dietary restraint to be present in both adult men and women (84). Neither male nor female restrained eaters had higher BMI's than nonrestrained eaters, but did exhibit different eating patterns based on self-reported food intakes. Restrained adults, both male and female, ate more low-fat foods and diet soda, and less fatty foods such as red meat, oils, snacks, pizza and French fries (84). Also, there were differences in restrained women's eating patterns when separated by activity level in that restrained women with high activity consumed an even lower-fat diet, in line with health recommendations at the time (84). Tepper suggested that the dietary restraint concept needed to incorporate body aesthetic and health goals that interact with restraint in influencing eating behaviors.

The current study indicated that although dietary restraint was positively associated with weight status in the children, 79% of children were within normal weight-for-heights (less than the 85^{th} percentile). Also, the women participating in the current study were mostly normal weight (BMI 24.9 kg/m2), with no differences by dietary restraint. This indicates that within certain environments or paired with certain health goals, dietary restraint can help in weight management. However, since maternal dietary restraint was also predictive of overweight in children, there are likely other behavioral or environmental factors mediating this relationship. Future studies in larger cohorts of subjects should investigate the relationships among dietary restraint, health beliefs and goals, and physical activity in older children and their mothers to better identify eating patterns and environments related to healthy dietary restraint and weight management.

It is important to note that even in a fairly homogenous, well-educated, normal-weight population, dietary restraint still shows a moderate relationship with childhood overweight in both boys and girls. A low level of dietary restraint or maternal restraint could help prevent overweight, but a higher level of restraint could lead to intensified weight struggles and unhealthy eating behaviors, independent of gender. Some children in the current study have restrained dietary intake, whether by self or mother, and appear to track slightly higher along the BMI percentile curves compared to children who have very low dietary restraint. This dietary restraint could make it more difficult to assess the impact of PROP taster status. A similar study should be repeated in an overweight population of children to determine if when unrestricted, the excess energy intake can be partially accounted for by taster status. More specifically, this study should be repeated in young girls, because as early as preadolescence, these taste differences seem to be primarily in females as demonstrated by the strong interaction between taster and gender.

5.7 Summary & Conclusions

Overweight and obesity track throughout childhood into adulthood, so efforts to reduce the prevalence of obesity must begin in childhood. Since it is clear that the eating environment created by parents affects development of childhood overweight, moderation of parental eating behaviors, such as disinhibition, dietary restraint, and weight concerns, must be considered as well. Effective weight management programs for children must include parents or legal guardians, and must also address the child's own psychosocial and behavioral attitudes about food. Simply administering information about a healthy diet is not sufficient. Weight management programs must specifically address dietary restraint in both the child and the mother, and emotional eating in the mother. Although there is benefit in teaching the child basic nutrition and weight management strategies via public education, these will likely continue to be ineffective until the entire family is engaged.

Additionally, the current study affirmed that PROP taster status is stable and does affect eating behaviors and weight status, but the exact mechanism is inconclusive. Future studies investigating the role of PROP taster status in development of eating behaviors and obesity could provide further insight, thus strengthening weight management programs. The current study and previous studies from this laboratory indicate that there are different eating patterns among taster groups, primarily where NT have higher intake of snack foods or overall calories (39). As adults, NT are more accepting of concentrated sweets, and have less discretion for fats. Perhaps because the children in the current study were within normal weight-for-height ranges and active, small differences in food intake patterns related to PROP taster status did not influence weight. Overall, the effect of PROP taster status on body weight was small and of a similar magnitude to child dietary restraint. Hence, in this study, PROP taster status had more of an underlying versus robust influence on body weight in that it was a significant predictor in each of regression models, but there were not significant differences among groups at this time point. These patterns begin in childhood, and seem to manifest as body weight differences primarily in adult females, where NT females tend to have greater adiposity than ST (39, 88). Thus, NT females could be at a greater risk for weight control problems, particularly when unrestrained. Further research on the effects of PROP taster status on eating behaviors is warranted in children exhibiting greater differences in weight status. In an overweight population of children, differences in weight due to eating patterns related to PROP taster status may already have emerged. The weight differences previously reported (39) might only be statistically detectable in populations that are already overweight and sedentary. Therefore, further studies should address overweight, sedentary children to better explore the influence of PROP taster status on weight.

The single most influential factor on child weight, however, was preschool weight status, which alone predicted 24% of current weight status. Thus, these children are tracking normally and the factors that influenced weight at 4 to 5 yrs appear to be influencing weight currently. Eating patterns established as early as preschool could continue to influence eating habits, and subsequently body weight, through late childhood. In conclusion, targeting eating behaviors earlier in the life span, such as preschool, potentially has a more robust influence on body weight later in life.

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Figure 1: Diagram representation of correlations among variables. The diagram depicts the relationships among weight status and eating behaviors in children, with the top half displaying the child's own behaviors and the bottom half the mother's eating behaviors (grey). Solid lines with arrows depict correlations. Pearson's correlation coefficients appear above the respected lines. Broken lines depict relationships found in regression analysis. For correlation analysis "Childhood Weight Status" was measured by BMI Percentile and for regression, BMI z-score.

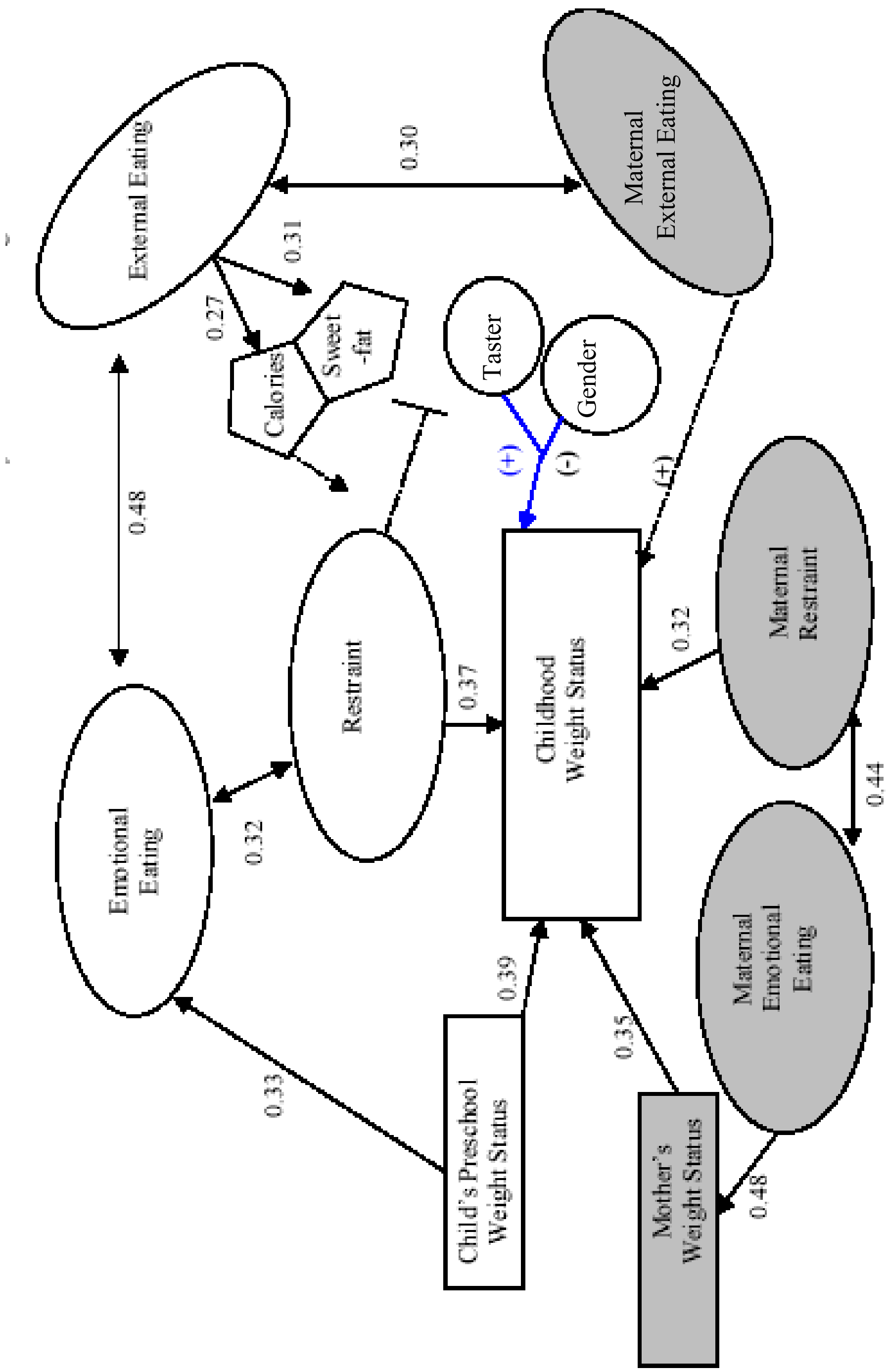


Figure 2: NaCl and PROP ratings of subjects by PROP taster group based on Labeled Magnitude Scale (LMS) ratings.

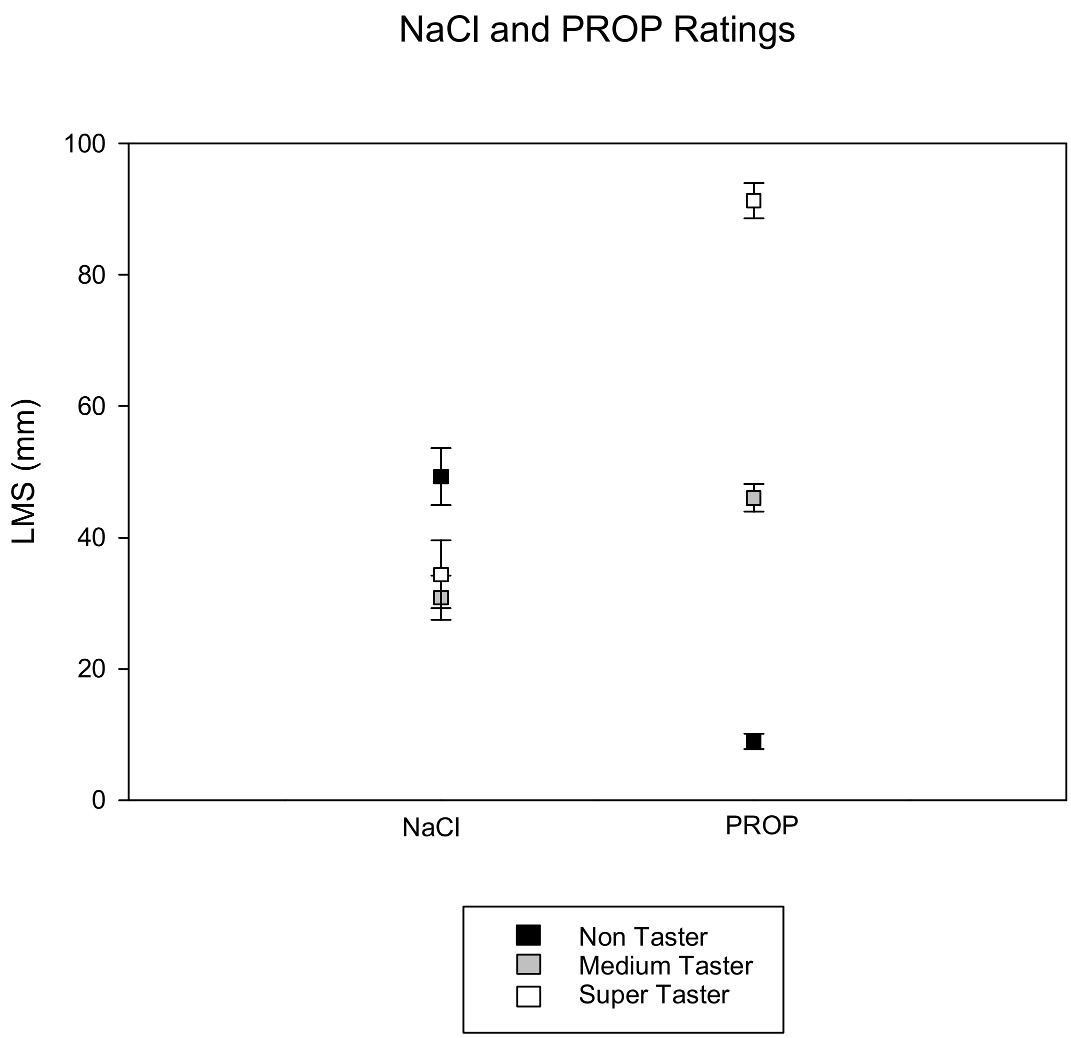


Figure 3: Average daily intake of sweet foods, salty snacks and total snack foods by taster status. Non-tasters consumed significantly more salty snacks and total snack foods compared to medium and super-tasters ($p<0.05$).

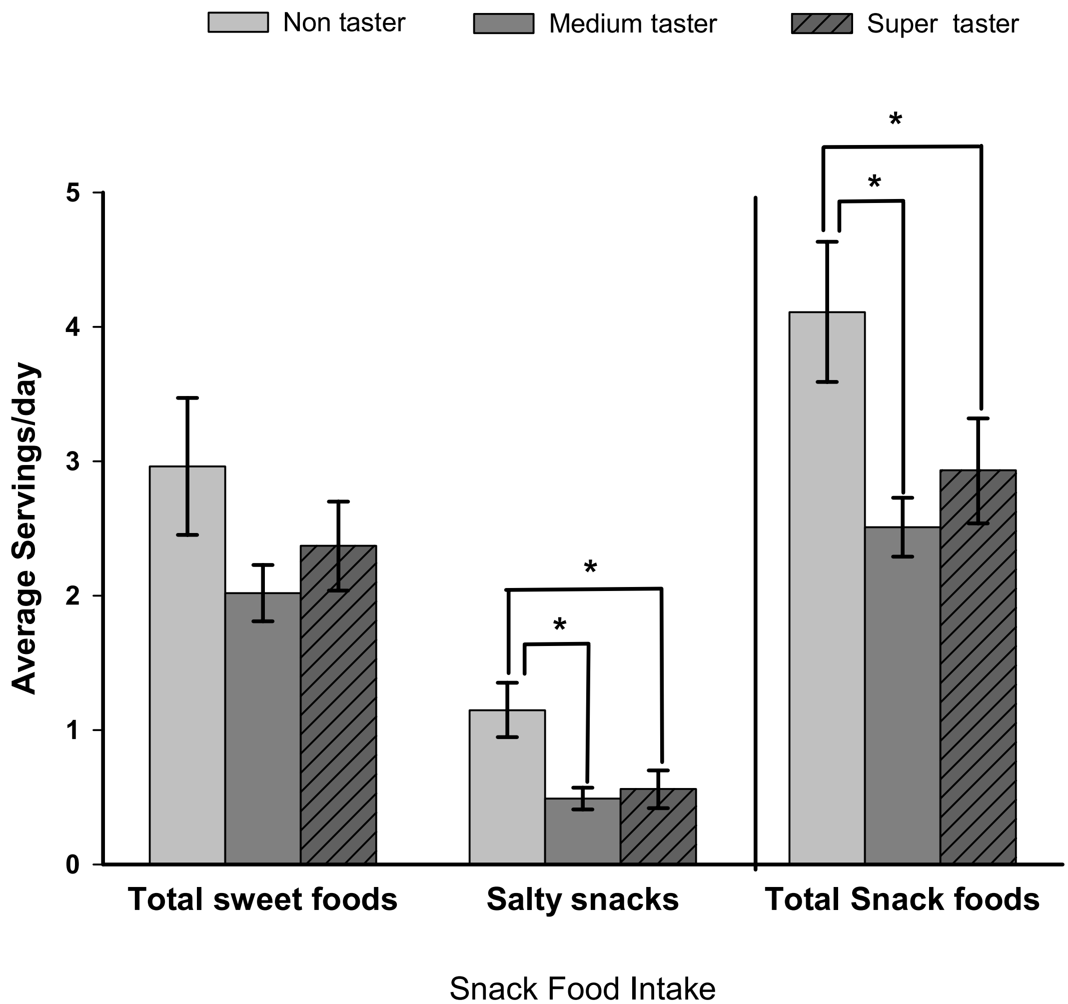


Figure 4: Intake of sweet food groups and total sweets by PROP taster status. Super-tasters consumed more candy than medium and non-tasters. There were directional trends for NT to consumer more sugars and total sweet foods, and a trend for NT to consume more servings of the sweet-fat group, although none reached statistical significance at $p<0.05$.

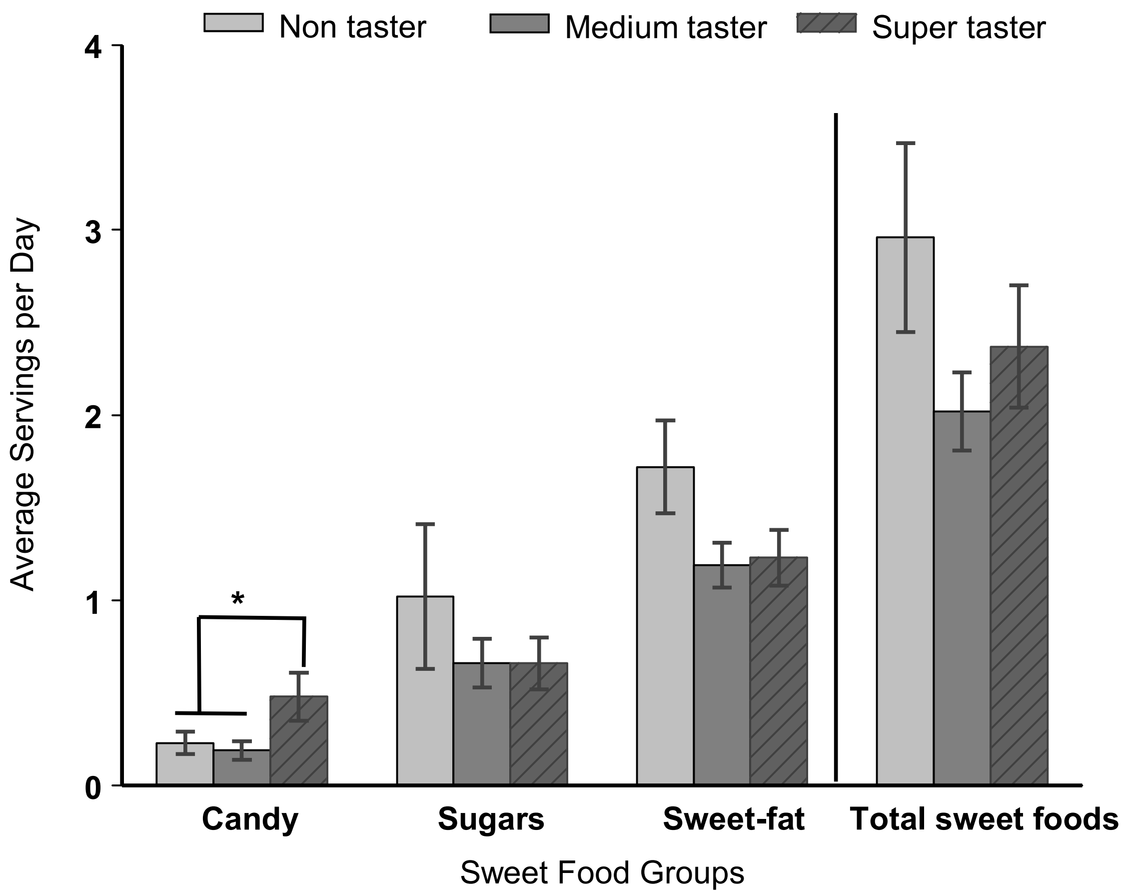


Figure 5: Intake of UDSA food groups in average servings per day by gender. Males consumed significantly more grains and meats than females ($p<0.05$).

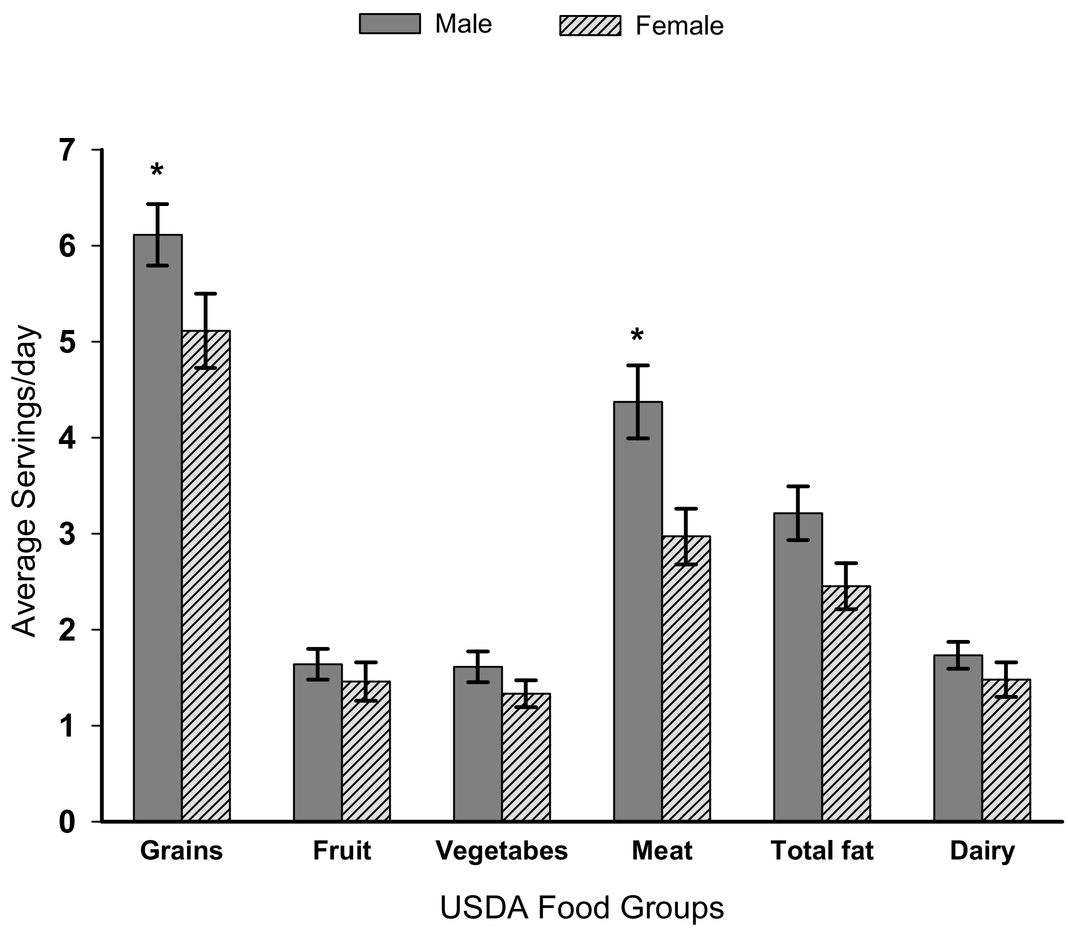


Figure 6: Servings of candy (average svgs/day) by gender and PROP taster status. Boy super-tasters consumed significantly more candy than the other 5 groups ($p<0.05$), however servings were less than 1 svg/ day.

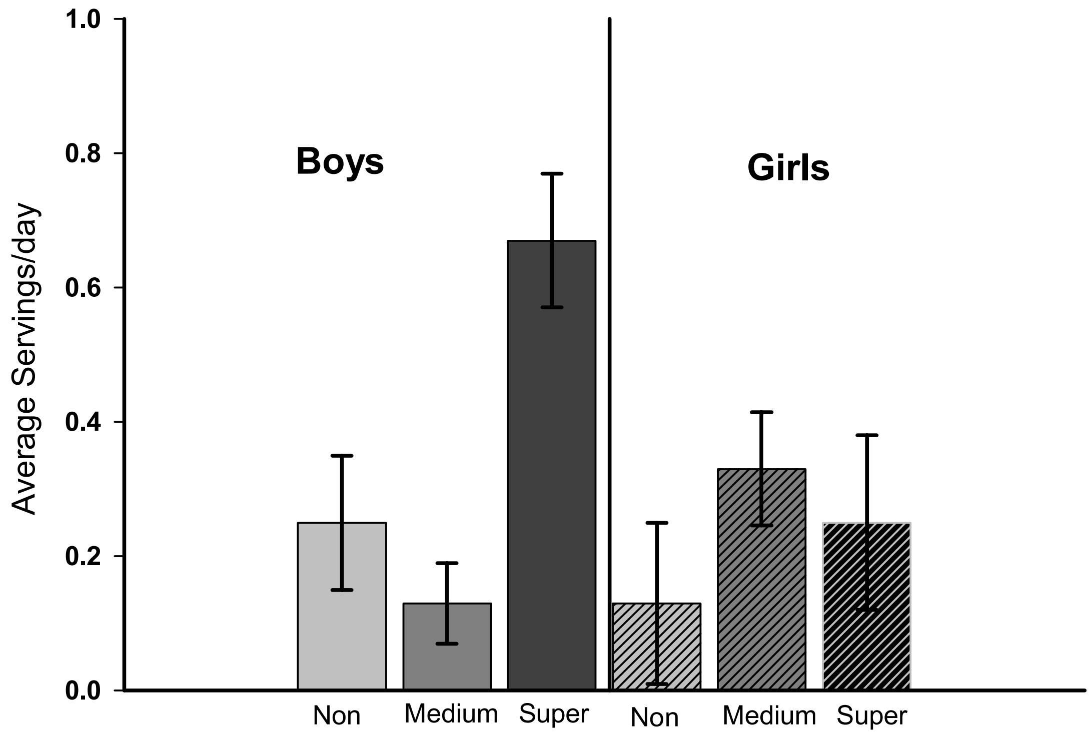


Figure 7: Preschool and Current BMI Percentiles by gender and preschool taster status classification. No significant differences between groups at either time point.

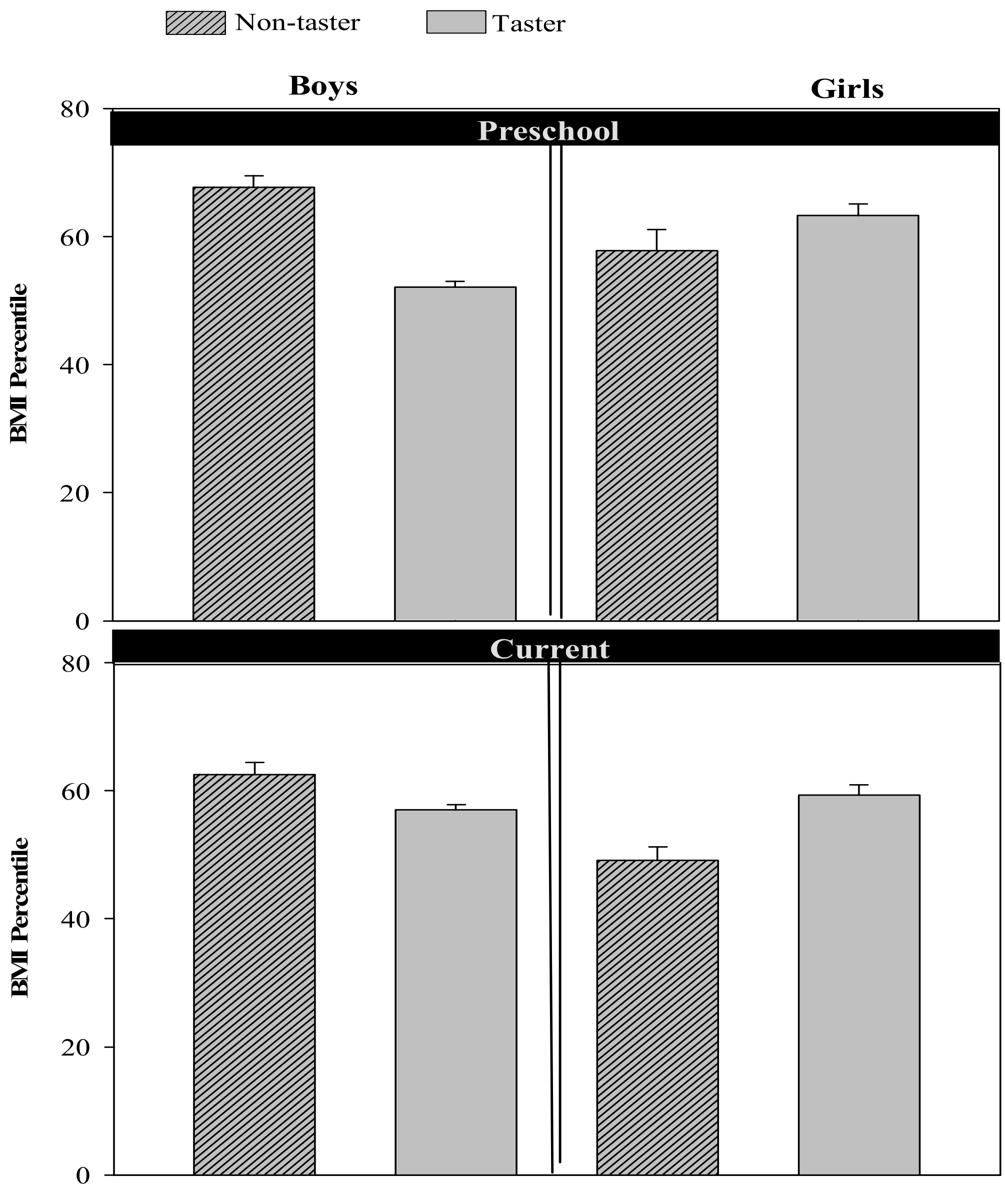


Figure 8: Current BMI Percentile by gender and current PROP taster status classification (Non, Medium, Super). No significant differences among groups.

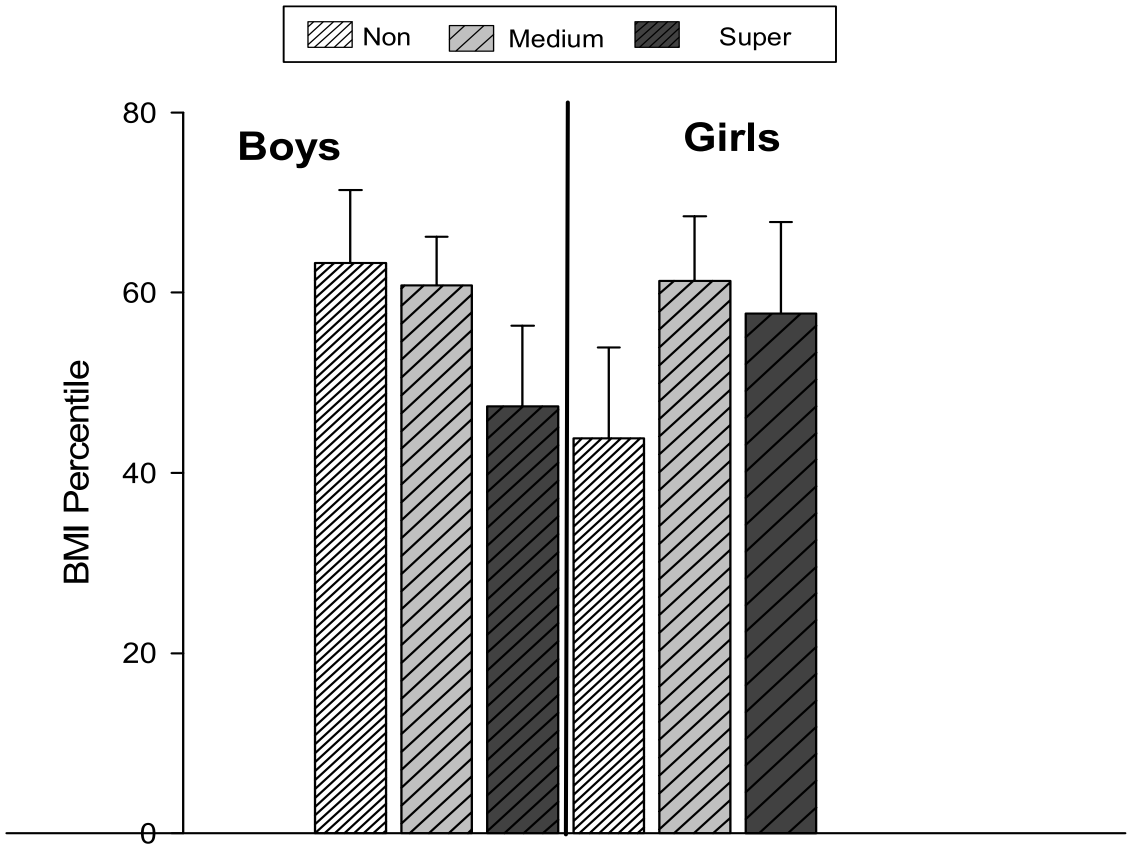


Figure 9: Change in BMI percentile from preschool to preadolescence by gender and PROP taster status. There were NSD among groups for gender, taster or interaction groups.

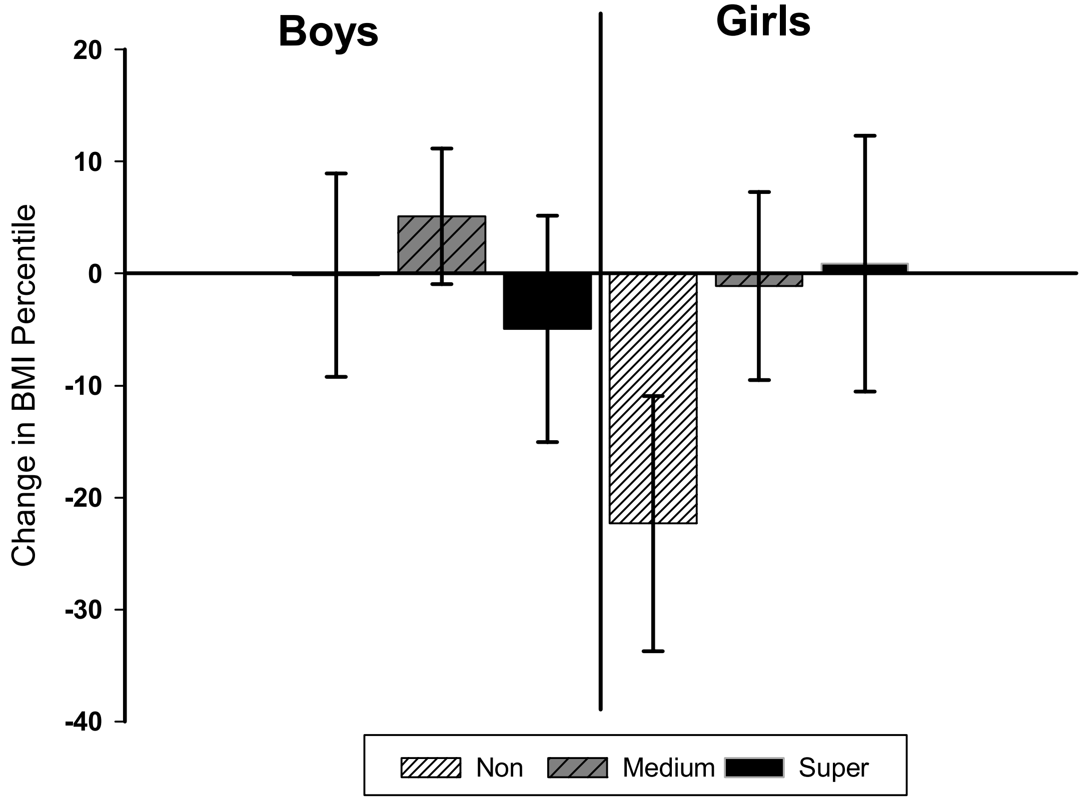
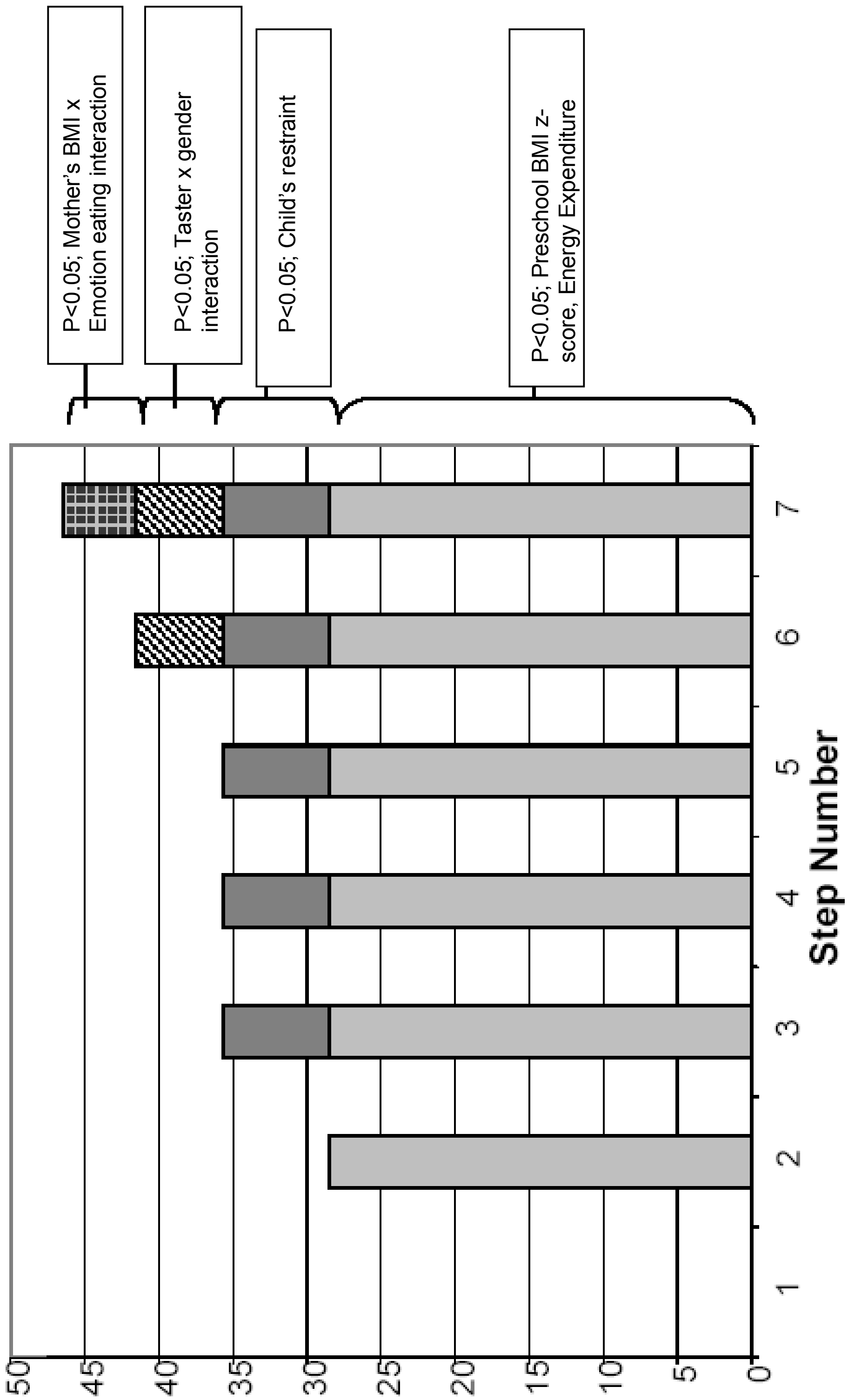


Figure 10: Steps of Hierarchical Regression in predicting BMI z-score. Steps 2, 3, 6 and 7 accounted for significant variance. See Table 9 for variables accounting for variance in BMI z-score.



APPENDIX A

Consent Forms

ID#___

CONSENT FORM

TASTE GENETICS – FAMILY STUDIES
Follow-up Study

Principal Investigator: Beverly J. Tepper, Ph.D.
Sensory Evaluation Laboratory (Room 211)
Department of Food Science, Rutgers University
65 Dudley Road, New Brunswick, NJ 08901
(732) 932-9611 x 221 email: tepper@aesop.rutgers.edu

PURPOSE: Genetic differences in taste are believed to play an important role in food selection, which is known to have a long-term impact on nutrition and health. This study will examine the relationship between bitter taste sensation and food preferences, eating habits and general measures of health and well-being. The overall goal of this project is to gain a better understanding of how food preferences and eating habits change during childhood and adolescence. Both parents and children will be asked to participate in this study.

Child participation:

My child will be asked to rate the taste of paper disks. The paper contains a substance called PROP, which can be bitter tasting to some people. PROP is non-toxic and has been used in taste studies in both children and adults for more than 50 years. My child will be asked to provide a food recall for 2 weekdays and 1 weekend day. My child will be interviewed by the researcher about what he/she ate during the previous day. Each interview will take about 30 min to complete. Two interviews will be conducted face-to-face with my child and a third interview will be conducted by telephone. Standard measures of body composition will be collected and may include: height, body weight, skin fold thickness, and waist and hip circumference. My child will also complete questionnaires about his/her food habits, physical growth and eating attitudes. My child's physical activity will be measured by an Actigraph, activity monitor which is worn around the waist. He/she will wear this device for 3 consecutive days, including while sleeping.

Parent participation:

Both parents will be asked to rate the paper disks and to complete brief nutritional questionnaires. Standard measures of body composition will also be collected.

Time-period of participation:

The researcher will come to my home on 2 occasions. During the first home visit, the researcher will administer the taste tests, collect the body measurements and distribute the questionnaires. The first diet recall will also be collected.

____

(initials)

Approximately two weeks later, the researcher will return to my home to collect the completed questions and explain the Actigraph procedures. Another diet recall will be completed. Between the two visits, the researcher will contact my child by telephone to conduct the remaining diet recall.

RISKS/BENEFITS: Participation in this study poses no forseeable risks to me, or my child's health. My participation in this study will benefit society by providing a better understanding of how eating habits develop in children.

COMPENSATION: For my family's participation, my child will receive a gift certificate in the amount of **$ 50**. This amount will be pro-rated if my child does not complete all the activities.

MY RIGHTS AS A RESEARCH SUBJECT/CONFIDENTIALITY: Participation in this study is completely voluntary and I have the right to withdraw myself or my child at any time without explanation or penalty. The information collected in this experiment will be kept strictly confidential. Our identities will be protected by a code number, and all data will be kept in a locked filing cabinet or in pass-word protected computer files.

AGREEMENT: I have read the above description. All my questions have been answered to my satisfaction and I agree voluntarily to allow my child to participate. I understand that I have the right to withdraw myself/my child at any time without penalty. I also understand that Rutgers University has made no general provision for financial compensation or medical treatment for any physical injury resulting from this research. If I have any questions about this research, I can contact the Principal Investigator at the number listed above or the Rutgers University Institutional Review Board for the Protection of Human Subjects, Office of Research and Sponsored Programs, 3 Rutgers Plaza, New Brunswick, NJ 08901-8559. Tel: 732-932-0150 ext. 2104 or Email: humansubjects@orsp.rutgers.edu

☐ Verbal assent of child to participate

______________________________	______________________________
Name of child (print)	Signature of parent or guardian
______________________________	______________________________
Name of parent (print)	Signature of parent
______________________________	______________________________
Name of parent (print)	Signature of parent
______________________________	Date ______________________
Signature of Witness	

I have received a copy of this statement for my records ________ (initials)

This informed consent form was approved by the Rutgers Institutional Review Board for the Protection of Human Subjects on ________; approval of this form expires on ________.

Genetics and Taste Perception Study

Genetic Testing

Cells will be collected by gently brushing the inside of the cheek with a soft brush. There is no discomfort from this procedure. The genetic material you provide will allow us to determine whether you are positive or negative for a gene that controls bitter taste sensitivity. This information will help us confirm the results of our behavioral tests and better understand the inheritance of this gene. The genetic material you provide will be used solely for this purpose and will not be sold or donated to a third party for unrelated purposes. If you agree to participate in this procedure please sign and date below. If you decline to participate in this procedure you can still participate in the main study.

______________________ ____________

Signature of participant Date

Genetics and Taste Perception Study

Genetic Testing

Cells will be collected by gently brushing the inside of your child's cheek with a soft brush. There is no discomfort from this procedure. The genetic material your child provides will allow us to determine whether he/she is positive or negative for a gene that controls bitter taste sensitivity. This information will help us confirm the results of our behavioral tests and better understand the inheritance of this gene. The genetic material your child provides will be used solely for this purpose and will not be sold or donated to a third party for unrelated purposes. If you agree to have your child participate in this procedure please sign and date below. If you decline to have your child participate in this procedure, he/she can still participate in the main study.

____
Child's name

______________________________ ____________
Signature of parent/guardian Date

❑ Assent of child

APPENDIX B

Questionnaires

Family Demographics

Instructions

Please complete this form to the best of your knowledge. These questions are about your child who will participate in our PROP project. When you are finished, please have your child return this completed form with the signed consent to the PROP staff at your child's school.

GENERAL INFORMATION ABOUT YOUR CHILD

"Would you please provide the following information about your child?"

1. Date of birth: ☐☐ ☐☐ ☐☐☐☐
month day year

2. "Were they born in the United States?" **Ye** ☐ 1 **No** ☐ 2

a. ***If "No,"*** "Please write in the country where they were born": ____________________

3. "To which of the following races do you consider your child to belong? You may choose all that apply."

☐ 1 Black or African-American
☐ 2 White
☐ 3 American Indian or Alaska native
☐ 4 Asian or Pacific islander
☐ 5 Hispanic or Latino
☐ 6 Other *(please specify):* ____________________

4. "In addition, which of the following groups describes your child's ethnicity? You may choose all that apply."

☐ 1 African ***(please specify):*** ____________________
☐ 2 West Indian / Caribbean ***(pls specify)****:* ____________________
☐ 3 Mexican / Mexican-American/ Chicano
☐ 4 Puerto Rican
☐ 5 Cuban
☐ 6 Central American
☐ 7 Other Latino/Hispanic **(*please specify):*** ____________________
☐ 8 Asian Indian
☐ 9 Japanese
☐ 10 Chinese
☐ 11 Korean
☐ 12 Filipino
☐ 13 Vietnamese
☐ 14 Other Asian ***(please specify):*** ____________________
☐ 15 Native Hawaiian
☐ 16 Guamanian or Chamorro
☐ 17 Samoan
☐ 18 Tongan
☐ 19 Other ***(please specify):*** ____________________

☐20 **None of the above**

5. *"Does your child have a history of or are they being treated for any of the following medical conditions?" (Please check all that apply.)*

☐1 Diabetes

☐2 Heart problems

☐3 Blood problems (haemophilia)

☐4 Kidney problems

☐5 PKU (phenylketonuria)

☐6 Otiitis Media (chronic ear infection, especially as a young child)

☐7 Severe hayfever or allergies

☐8 Asthma

6. *"Has your child had a cold/flu or ear infection in the past 2 weeks?" (Please check one.)*

☐1 YES ☐5 NO

If yes, please describe:

____

____

7. *"What, if any, prescription medications is your child currently taking and how often?"*

____

____

8. *"Has your child been to the dentist in the past 2 weeks?" (Please check one.)*

☐1 YES ☐5 NO

FAMILY INFORMATION

"Would you please provide the following information about your family?"

1. What is the highest education level finished among all the people living in ***your child's*** home?
(Please "X" only one answer)

☐1 6th grade or less

☐2 8th grade or less

☐5 Technical School

☐6 Some College

☐ 3 Attended some High School

☐ 4 High School Graduate or GED

☐ 7 College Graduate

☐ 8 Post Graduate Study

2. What was the approximate total income, before taxes, of your household in 2004? Please include wages, salaries, social security, interest, child support, public assistance, unemployment compensation, rent from property and all other income. ***(Please "X" only one answer)***

☐ 1 Less than $5,000

☐ 2 $5,000 - $9,999

☐ 3 $10,000 - $19,999

☐ 4 $20,000 - $29,999

☐ 5 $30,000 - $39,999

☐ 6 $40,000 - $49,999

☐ 7 $50,000 - $59,999

☐ 8 $60,000 - $69,999

☐ 9 $70,000 - $79,999

☐ 10 $80,000 - $89,999

☐ 11 $90,000 - $99,999

☐ 12 Over $100,000

3. ***"How many of the following do you or members of your household have in your home? Please place an "X" in the appropriate box. Only count those that are in <u>working</u> condition."***

3. VCR players:	0 ☐	1 ☐	2 ☐	3 or more ☐
4. DVD players:	0 ☐	1 ☐	2 ☐	3 or more ☐
5. Cell phones:	0 ☐	1 ☐	2 ☐	3 or more ☐
6. Pagers:	0 ☐	1 ☐	2 ☐	3 or more ☐
7. Automobiles (motorcycles, cars, pickups, vans, SUV's, etc.):	0 ☐	1 ☐	2 ☐	3 or more ☐
8. Color Televisions:	0 ☐	1 ☐	2 ☐	3 or more ☐
9. Computers used by your family:	0 ☐	1 ☐	2 ☐	3 or more ☐
10. Dishwashers:	0 ☐	1 ☐	2 ☐	3 or more ☐
11. Microwave ovens:	0 ☐	1 ☐	2 ☐	3 or more ☐
12. Do you own the home in which ***your child*** lives?	Yes ☐$_1$	No ☐$_2$		
13. Does ***your child*** have a TV in their bedroom?	Yes ☐$_1$	No ☐$_2$		

HOUSEHOLD MEMBERSHIP

"We would like to ask some questions about the members of your household."

1. "Besides yourself, how many other adults live in your household?"

"Please describe the other adults in your household. It's easiest if we start wit the oldest household member first and work our way down to the youngest. Excluding yourself, how is each adult related to your child participating in the "What's Your PROP?" project?" (Please put a circle around the appropriate number).

Adult	Mother	Aunt	Grandmother or Great Aunt	Female NPG[1]	Other Female Adult	Father	Uncle	Grandfather or Great Uncle	Male NPG[1]	Other Male Adult
a. Oldest	1	2	3	4	5	6	7	8	9	10
b.	1	2	3	4	5	6	7	8	9	10
c.	1	2	3	4	5	6	7	8	9	10
d.	1	2	3	4	5	6	7	8	9	10
e.	1	2	3	4	5	6	7	8	9	10
f.	1	2	3	4	5	6	7	8	9	10
g.	1	2	3	4	5	6	7	8	9	10
h.	1	2	3	4	5	6	7	8	9	10
i.	1	2	3	4	5	6	7	8	9	10
j.	1	2	3	4	5	6	7	8	9	10

2. "Besides ***your child participating in the "What's Your PROP?" project***, how many sisters, brothers and other children live in your household?

"Now, please describe the sisters, brothers and other children in your household. It's easiest if we start with the oldest and work our way down to the youngest. Excluding your child participating in the "What's Your PROP" project, how is each child related to them?" (Please put a circle around the appropriate number. Include the age of each child in the last column.)"

Children	Sister	Other Female Child	Brother	Other Male Child	Child's Age
a. Oldest	11	12	13	14	|___|___|
b.	11	12	13	14	|___|___|
c.	11	12	13	14	|___|___|
d.	11	12	13	14	|___|___|
e.	11	12	13	14	|___|___|
f.	11	12	13	14	|___|___|
g.	11	12	13	14	|___|___|
h.	11	12	13	14	|___|___|

Thank you. You are done with this form. Please have your child return this form along with the signed consent allowing your child to participate in the "What's Your PROP?" project to one of the PROP staff at your child's school.

What Foods Do You Like?

We would like to know how much you like the following foods. Please put an "x" in the box below your response. The responses are: I do not like this; I like this a little; I like this a lot.

Foods							
1. 100% Orange juice	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**11. Plums**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
2. 100% Apple juice	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**12. Kiwi**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
3. 100% Grape juice	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**13. Strawberries**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
4. Other 100% juice	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**14. Pineapple**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
5. Bananas	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**15. Grapefruit**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
6. Apples	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**16. Fruit salad or Fruit cocktail**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
7. Cantaloupe or Mush melon	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**17. Applesauce**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
8. Grapes	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**18. Watermelon**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
9. Oranges	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**19. Raisins**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
10. Pears	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**20. Dried fruit**	I do not like this ☐	I like this a little ☐	I like this a lot ☐

We would like to know how much you like the following foods. Please put an "x" in the box below your response. The responses are: I do not like this; I like this a little; I like this a lot.

Foods							
21. Peaches	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**31. Tomatoes**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
22. Carrots	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**32. Broccoli**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
23. Celery	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**33. Lettuce**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
24. Greens (spin-ach, collar, tur-nip, kale)	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**34. Green beans**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
25. Spinach	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**35. Cole slaw**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
26. French fried potatoes	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**36. Cooked beans (pinto, black eyed peas, pork'n beans)**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
27. Potato salad	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**37. Sweet potatoes**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
28. Other white potatoes	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**38. Cabbage**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
29. Corn	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**39. Okra**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
30. Green peas	I do not like this ☐	I like this a little ☐	I like this a lot ☐				

We would like to know how much you like the following drinks. Please put an "x" in the box below your response. The responses are: I do not like this; I like this a little; I like this a lot.

Drinks							
1. Soft drinks, regular	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**10. Snapple, regular**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
2. Soft drinks, diet	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**11. Snapple, diet**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
3. Koolaid, regular	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**12. Iced tea, regular**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
4. Koolaid, diet	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**13. Iced tea, diet**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
5. Fruit drink, regular	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**14. Fruitopia, regular**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
6. Fruit drink, diet	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**15. Fruitopia, diet**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
7. Punch, regular	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**16. Sunny Delight**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
8. Punch, diet	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**17. Capri Sun**	I do not like this ☐	I like this a little ☐	I like this a lot ☐
9. Powerade/ Gatorade	I do not like this ☐	I like this a little ☐	I like this a lot ☐	**18. Bottled Water**	I do not like this ☐	I like this a little ☐	I like this a lot ☐

What Do Others Think?

DIRECTIONS: These questions are about fresh, canned, and frozen fruit and 100% fruit juice. Remember, one portion of fresh fruit is about the size of a regular orange, or about ½ cup of canned fruit or frozen fruit, or ¼ cup of dried fruit. A portion of 100% fruit juice is a little less than the amount of milk in a carton of milk you get during school lunch. Please check the box under the statement that most closely describes what you think about each statement. There are no right or wrong answers, just what you think. *(CHECK ONLY ONE BOX FOR EACH.)*

1. Does your mother (or guardian) think eating fruit is an important thing to do?	YES ☐	NO ☐			
2. How much do you want to do what your mother (or guardian) wants?	None ☐	A Little ☐	A Lot ☐		
3. How much fruit does your mother (or guardian) usually eat each day?	None ☐	Some ☐	A Lot ☐		
4. Do your best friends think that eating fruit is a healthy thing to do?	YES ☐	NO ☐			
5. Do your best friends think eating fruit is a cool thing to do?	YES ☐	NO ☐			
6. How much fruit do your best friends want you to eat each day? (also add Don't know)	None ☐	1 portion ☐	2 portions ☐	3 or more portions ☐	Friends don't care ☐
7. How much do you want to do what your best friends want?	None ☐	A Little ☐	A Lot ☐		
8. On the average, how much fruit do your best friends eat each day?	None ☐	Some ☐	A Lot ☐		
9. Would your best friends make fun of you if you chose fruit to eat?	YES ☐	NO ☐			
10. Do kids your age think eating fruit is a healthy thing to do?	YES ☐	NO ☐			
11. Do kids your age think eating fruit is a cool thing to do?	YES ☐	NO ☐			
12. How much fruit do kids your age usually eat each day?	None ☐	Some ☐	A Lot ☐		

DIRECTIONS: These next questions are about fresh, canned, and frozen vegetables. One portion of vegetables is ½ cup of cooked vegetables. Please check the box under the statement that most closely describes what you think about each statement. There are no right or wrong answers, just what you think. *(CHECK ONLY ONE BOX FOR EACH.)*

13. Does your mother (or guardian) think eating vegetables are an important thing to do?	YES ☐	NO ☐			
14. How many vegetables does your mother (or guardian) want you to eat each day?	None ☐	1 portion ☐	2 portions ☐	3 or more portions ☐	Mother doesn't care ☐
15. How many vegetables does your mother (or guardian) usually eat each day?	None ☐	Some ☐	A Lot ☐		
16. Do your best friends think eating vegetables is a healthy thing to do?	YES ☐	NO ☐			
17. Do your best friends think eating vegetables is a cool thing to do?	YES ☐	NO ☐			
18. How many vegetables do your best friends want you to eat each day?	None ☐	1 portion ☐	2 portions ☐	3 or more portions ☐	Friends don't care ☐
19. On average, how many vegetables do your best friends eat each day?	None ☐	Some ☐	A Lot ☐		
20. Would your best friends make fun of you if you chose vegetables to eat?	YES ☐	NO ☐			
21. Do kids your age think eating vegetables is a healthy thing to do?	YES ☐	NO ☐			
22. Do kids your age think eating vegetables is a cool thing to do?	YES ☐	NO ☐			
23. How many vegetables do kids your age usually eat each day?	None ☐	Some ☐	A Lot ☐		

DIRECTIONS: These next questions are about bottled water and water from the tap. A portion of water is a glass or bottle of water equal to the amount of milk you get in a carton of milk during school lunch (8ounces. or 1 cup). . Please check the box under the statement that most closely describes what you think about each statement. There are no right or wrong answers, just what you think. *(CHECK ONLY ONE BOX FOR EACH.)*

24. Does your mother (or guardian) think drinking water is an important thing to do?	YES ☐	NO ☐			
25. How much water does your mother (or guardian) want you to drink each day?	None ☐	1 portion ☐	2 portions ☐	3 or more portions ☐	Mother doesn't care ☐
26. How much water does your mother (or guardian) usually drink each day?	None ☐	Some ☐	A Lot ☐		
27. Do your best friends think drinking water is a healthy thing to do?	YES ☐	NO ☐			
28. Do your best friends think drinking water is a cool thing to do?	YES ☐	NO ☐			
29. How much water do your best friends want you to drink each day?	None ☐	1 portion ☐	2 portions ☐	3 or more portions ☐	Friends don't care ☐
30. On average, how much water do your best friends drink each day?	None ☐	Some ☐	A Lot ☐		
31. Do kids your age think drinking water is a healthy thing to do?	YES ☐	NO ☐			
32. Do kids your age think drinking water is a cool thing to do?	YES ☐	NO ☐			
33. How much water do kids your age usually drink each day?	None ☐	Some ☐	A Lot ☐		

What I Think I Can Do

Please check the box under the statement that most closely describes how much you agree or disagree with each statement. There are no wrong answers. *(CHECK ONLY ONE BOX FOR EACH.)*

How sure are you that you can….

34.	…ask someone in family to buy your favorite fruit or vegetables at least one time?	Not Sure ☐	Sure ☐
35.	…ask someone in family to buy your favorite fruit or vegetables every week?	Not Sure ☐	Sure ☐
36.	…ask someone in family to buy 3 fruit or vegetables at least one time?	Not Sure ☐	Sure ☐
37.	…ask someone in family to buy 3 fruit or vegetables at least every week?	Not Sure ☐	Sure ☐
38.	…drink a glass of your favorite 100% fruit juice or eat a piece of fruit for breakfast at least one time?	Not Sure ☐	Sure ☐
39.	…drink a glass of your favorite 100% fruit juice or eat a piece of fruit for breakfast at least 4 days a week?	Not Sure ☐	Sure ☐
40.	…eat 1 portion of vegetable at lunch at least one time on a school day?	Not Sure ☐	Sure ☐
41.	…eat 1 portion of vegetable at lunch at least 4 days a week at school?	Not Sure ☐	Sure ☐
42.	…1 portion of fruit at lunch at least one time on a school day?	Not Sure ☐	Sure ☐
43.	eat 1 portion of fruit at lunch most school days?	Not Sure ☐	Sure ☐
44.	…eat 1 portion of vegetable for lunch at least one time on a non-school day, including weekend?	Not Sure ☐	Sure ☐
45.	…eat 1 portion of vegetable for lunch for most non-school days, including weekends?	Not Sure ☐	Sure ☐
46.	…eat 1 portion of fruit for lunch at least one time on a non-school day, including weekend?	Not Sure ☐	Sure ☐
47.	…eat 1 portion of fruit for lunch most non-school days, including weekends?	Not Sure ☐	Sure ☐

How sure are you that you can….

48. …cut up 1 portion of vegetable and eat it with a dip for a snack at least one time?	Not Sure ☐	Sure ☐
49. …can cut up 1 portion of vegetable and eat it with a dip for a snack at least 4 days a week?	Not Sure ☐	Sure ☐
50. …eat 1 portion of fruit for a snack at home at least one time?	Not Sure ☐	Sure ☐
51. …eat 1 portion of fruit for a snack at home at least 4 days a week?	Not Sure ☐	Sure ☐
52. …ask someone in family to serve 2 vegetables for dinner at least one time?	Not Sure ☐	Sure ☐
53. …ask someone in family to serve 2 vegetables for dinner most nights?	Not Sure ☐	Sure ☐
54. …ask someone in family to serve 1 fruit instead of your usual des-sert for dinner at least 1 time?	Not Sure ☐	Sure ☐
55. …ask someone in family to serve 1 fruit instead of your usual des-sert/dinner most nights?	Not Sure ☐	Sure ☐
56. …eat 1 portion of fruit for dinner or supper at home at least one time?	Not Sure ☐	Sure ☐
57. …eat 1 portion of fruit for dinner or supper at home most nights?	Not Sure ☐	Sure ☐
58. …eat 2 portions of fruit at least 4 days a week?	Not Sure ☐	Sure ☐
59. …eat 2 portions of fruit at least 4 days a week, even when you are stressed?	Not Sure ☐	Sure ☐
60. …eat 3 portions of vegetables at least 4 days a week?	Not Sure ☐	Sure ☐
61. …eat 3 portions of vegetables at least 4 days a week, even when you are stressed?	Not Sure ☐	Sure ☐
62. …eat 1 portion of fruit at a fast food place at least one time?	Not Sure ☐	Sure ☐
63. …eat 1 portion of fruit most times when you eat at a fast food place?	Not Sure ☐	Sure ☐

How sure are you that you can….

64. …eat 1 portion of vegetable at a fast food place at least one time?	Not Sure ☐	Sure ☐
65. …can eat 1 portion of vegetable most times when you eat at a fast food place?	Not Sure ☐	Sure ☐
66. …eat 1 portion of fruit at a cafeteria place at least one time?	Not Sure ☐	Sure ☐
67. …eat 1 portion of fruit most times when you eat at a cafeteria?	Not Sure ☐	Sure ☐
68. …eat 1 portion of vegetable at a cafeteria at least one time?	Not Sure ☐	Sure ☐
69. …eat 1 portion of vegetable most times when you eat at a cafeteria?	Not Sure ☐	Sure ☐
70. …drink 4 glasses or bottles of water at least one day?	Not Sure ☐	Sure ☐
71. …drink 4 glasses or bottles of water at least 4 days a week?	Not Sure ☐	Sure ☐
72. …drink 6 glasses or bottles of water at least one day?	Not Sure ☐	Sure ☐
73. …drink 6 glasses or bottles of water at least 4 days a week?	Not Sure ☐	Sure ☐
74. …drink only water whenever you are thirsty for at least one day?	Not Sure ☐	Sure ☐
75. …drink only water whenever you are thirsty at least 4 days a week?	Not Sure ☐	Sure ☐
76. …drink 6 glasses or bottles of water at least 4 days a week, even when stressed?	Not Sure ☐	Sure ☐

What Foods Do You Have at Home?

Did you have each of the following foods in your home in the last week? Please check the "YES" or "NO" box for each food.

100% Fruit Juices and Fruit					
1. 100% Orange juice	Yes ☐	No ☐	12. Kiwi	Yes ☐	No ☐
2. 100% Apple juice	Yes ☐	No ☐	13. Strawberries	Yes ☐	No ☐
3. 100% Grape juice	Yes ☐	No ☐	14. Pineapple	Yes ☐	No ☐
4. Other 100% juice	Yes ☐	No ☐	15. Grapefruit	Yes ☐	No ☐
5. Bananas	Yes ☐	No ☐	16. Fruit salad or Fruit cocktail	Yes ☐	No ☐
6. Apples	Yes ☐	No ☐	17. Applesauce	Yes ☐	No ☐
7. Cantaloupe or Mush melon	Yes ☐	No ☐	18. Watermelon	Yes ☐	No ☐
8. Grapes	Yes ☐	No ☐	19. Raisins	Yes ☐	No ☐
9. Oranges	Yes ☐	No ☐	20. Dried fruit	Yes ☐	No ☐
10. Pears	Yes ☐	No ☐	21. Peaches	Yes ☐	No ☐
11. Plums	Yes ☐	No ☐			

Continue on next page.

Did you have each of the following foods or drinks in your home <u>in the last week</u>? Please check the "YES" or "NO" box for each food.

Did you have each of the following foods or drinks in your home <u>in the last week</u>? Please check the "YES" or "NO" box for each food.

Vegetables					
1. Carrots	Yes ☐	No ☐	10. Broccoli	Yes ☐	No ☐
2. Celery	Yes ☐	No ☐	11. Lettuce	Yes ☐	No ☐
3. Greens (Spinach, Collard, Turnip, Kale)	Yes ☐	No ☐	12. Green beans	Yes ☐	No ☐
4. French fried potatoes	Yes ☐	No ☐	13. Cole slaw	Yes ☐	No ☐
5. Potato salad	Yes ☐	No ☐	14. Cooked beans (pinto, black-eyed peas, pork 'n beans)	Yes ☐	No ☐
6. Other white potatoes	Yes ☐	No ☐	15. Sweet potatoes	Yes ☐	No ☐
7. Corn	Yes ☐	No ☐	16. Cabbage	Yes ☐	No ☐
8. Green peas	Yes ☐	No ☐	17. Okra	Yes ☐	No ☐
9. Tomatoes	Yes ☐	No ☐			

Drinks					
1. Soft drinks, regular	Yes ☐	No ☐	10. Snapple, regular	Yes ☐	No ☐
2. Soft drinks, diet	Yes ☐	No ☐	11. Snapple, diet	Yes ☐	No ☐
3. Koolaid, regular	Yes ☐	No ☐	12. Ice tea, unsweetened	Yes ☐	No ☐
4. Koolaid, diet	Yes ☐	No ☐	13. Ice tea, sweetened	Yes ☐	No ☐
5. Fruit drinks, regular	Yes ☐	No ☐	14. Fruitopia	Yes ☐	No ☐
6. Fruit drinks, diet	Yes ☐	No ☐	15. Sunny Delight	Yes ☐	No ☐
7. Punches, regular	Yes ☐	No ☐	16. Capri Sun	Yes ☐	No ☐
8. Punches, diet	Yes ☐	No ☐	17. Bottle Water	Yes ☐	No ☐
9. Powerade/Gatorade	Yes ☐	No ☐	18. Water from the faucet	Yes ☐	No ☐

What & When I Eat (DEBQ)

Please read each question and then decide whether each item is true for you, using the following rating scale: never; rarely; sometimes; often; very often. Check the box that corresponds to your rating. Please answer all items. (CHECK ONLY ONE BOX FOR EACH.)

1.	Do you have the desire to eat when you are irritated	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
2.	If food tastes good to you, do you eat more that usual?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
3.	Do you have a desire to eat when you have nothing to do?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
4.	If you have put on weight, do you eat less than you usually do?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
5.	Do you have a desire to eat when you are depressed or discouraged?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
6.	If food smells and looks good, do you eat more than usual?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
7.	How often do you refuse food or drink offered because you are concerned about your weight?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
8.	Do you have a desire to eat when you are feeling lonely?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
9.	If you see or smell something delicious, do you have a desire to eat it?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
10.	Do you have a desire to eat when somebody lets you down?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
11.	Do you try to eat less at mealtimes then you would like to eat?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
12.	If you have something delicious to eat, do you eat it straight away?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
13.	Do you have a desire to eat when you are cross?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
14.	Do you watch exactly what you eat?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
15.	If you walk past the baker do you have the desire to buy something delicious?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
16.	Do you have a desire to eat when you are approaching something unpleasant to happen?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
17.	Do you deliberately eat foods that are slimming?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
18.	If you see others eating, do you also have the desire to eat?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
19.	When you have eaten too much, do you eat less than usual the following days?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
20.	Do you get the desire to eat when you are anxious, worried to tense?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐

21. Do you find it hard to resist eating delicious foods?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
22. Do you deliberately eat less in order not to become heavier?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
23. Do you have a desire to eat when things are going against you or when things have gone wrong?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
24. If you walk past a snack bar or a café, do you have the desire to buy something delicious?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
25. Do you have the desire to eat when you are emotionally upset?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
26. How often do you try not to eat between meals because you are watching your weight?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
27. Do you eat more than usual, when you see others eating?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
28. Do you have a desire to eat when you are bored or restless?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
29. How often in the evening do you try not to eat because you are watching your weight?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
30. Do you have a desire to eat when you are frightened?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
31. Do you take into account your weight with what you eat?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
32. Do you have a desire to each when you are disappointed?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
33. When you are preparing a meal are you inclined to eat something?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐
34. How often do you try unfamiliar foods?	Never ☐	Rarely ☐	Sometimes ☐	Often ☐	Very Often ☐

What I Think And Feel

Please read each question carefully. Please check the box under response of how true the statement is of you.

35. I like everyone I know.	Always true of me ☐	Sometimes true of me ☐	Not sure ☐	Never true of me ☐
36. I am always kind.	Always true of me ☐	Sometimes true of me ☐	Not sure ☐	Never true of me ☐
37. I always have good manners.	Always true of me ☐	Sometimes true of me ☐	Not sure ☐	Never true of me ☐
38. I am always good.	Always true of me ☐	Sometimes true of me ☐	Not sure ☐	Never true of me ☐
39. I am always nice to everyone.	Always true of me ☐	Sometimes true of me ☐	Not sure ☐	Never true of me ☐
40. I tell the truth every single time.	Always true of me ☐	Sometimes true of me ☐	Not sure ☐	Never true of me ☐
41. I never get angry.	Always true of me ☐	Sometimes true of me ☐	Not sure ☐	Never true of me ☐
42. I never say things I shouldn't.	Always true of me ☐	Sometimes true of me ☐	Not sure ☐	Never true of me ☐
43. I never lie.	Always true of me ☐	Sometimes true of me ☐	Not sure ☐	Never true of me ☐

Why Would I Want to Eat Fruit or Vegetables?

DIRECTIONS: These questions are about why you might eat fruit. Different children have different reasons for eating fruit. Please check the box under the statement that most closely describes how true each statement is for you. There are no wrong answers. *(CHECK ONLY ONE BOX FOR EACH.)*

A reason I do not usually eat fruit is because….

1. I don't know of any good reason why I should eat fruit.	YES ☐	NO ☐
2. I never thought about it.	YES ☐	NO ☐

A reason I usually eat fruit is because….

3. I want others to see me as a healthy eater.	YES ☐	NO ☐
4. I want others to see me as cool.	YES ☐	NO ☐
5. I want to be different from my friends.	YES ☐	NO ☐
6. my friends like me better when I eat fruit.	YES ☐	NO ☐
7. others make me do it.	YES ☐	NO ☐
8. I will be punished if I do not eat fruit.	YES ☐	NO ☐
9. my parents reward me when I eat fruit.	YES ☐	NO ☐
10. I do not want others to think of me as a junk food junkie.	YES ☐	NO ☐
11. I feel like I have to.	YES ☐	NO ☐
12. I would feel bad about myself if I didn't.	YES ☐	NO ☐
13. I would feel guilty if I ate candy instead of fruit.	YES ☐	NO ☐

A reason I usually eat fruit is because….

14. I do not want to disappoint someone who means a lot to me.	YES ☐	NO ☐
15. I would not feel good about myself if I didn't eat fruit.	YES ☐	NO ☐
16. I want others to think better of me.	YES ☐	NO ☐
17. it is important to me to eat fruit.	YES ☐	NO ☐
18. eating fruit is good for my health.	YES ☐	NO ☐
19. it makes me happy.	YES ☐	NO ☐
20. I want to take care of myself.	YES ☐	NO ☐
21. I want to eat food other than junk food.	YES ☐	NO ☐
22. fruit tastes good.	YES ☐	NO ☐
23. it is fun to eat fruit.	YES ☐	NO ☐
24. I enjoy eating fruit.	YES ☐	NO ☐

DIRECTIONS: These questions are about why you might eat vegetablaes. Different children have different reasons for eating vegetables. Please check the box under the statement that most closely describes how true each statement is for you. There are no wrong answers. *(CHECK ONLY ONE BOX FOR EACH.)*

A reason I do not usually eat vegetables is because….

1. I don't know of any good reason why I should eat them.	YES ☐	NO ☐
2. I never thought about it.	YES ☐	NO ☐

A reason I usually eat vegetables is because….

3. I want others to see me as a healthy eater.	YES ☐	NO ☐
4. I want others to see me as cool.	YES ☐	NO ☐
5. I want to be different from my friends.	YES ☐	NO ☐
6. my friends like me better when I eat vegetables.	YES ☐	NO ☐
7. others make me do it.	YES ☐	NO ☐
8. I will be punished if I do not eat vegetables.	YES ☐	NO ☐
9. my parents reward me when I eat vegetables.	YES ☐	NO ☐
10. I do not want others to think of me as a junk food junkie.	YES ☐	NO ☐
11. I feel like I have to.	YES ☐	NO ☐
12. I would feel bad about myself if I didn't do it.	YES ☐	NO ☐
13. I would feel guilty if I ate candy instead of vegetables.	YES ☐	NO ☐
14. I do not want to disappoint someone who means a lot to me.	YES ☐	NO ☐

15. I would not feel good about myself if I didn't eat vegetables.	YES ☐	NO ☐
16. I want others to think better of me.	YES ☐	NO ☐
17. it is important to me to eat vegetables.	YES ☐	NO ☐
18. eating vegetables is good for my health.	YES ☐	NO ☐
19. it makes me happy.	YES ☐	NO ☐

A reason I usually eat vegetables is because….

20. I want to take care of myself.	YES ☐	NO ☐
21. I want to eat food other than junk food.	YES ☐	NO ☐
22. vegetables taste good.	YES ☐	NO ☐
23. it is fun to eat vegetables.	YES ☐	NO ☐
24. I enjoy eating vegetables.	YES ☐	NO ☐

DIRECTIONS: These questions are about why you might drink water. Different children have different reasons for drinking water. Please check the box under the statement that most closely describes how true each statement is for you. There are no wrong answers.
(CHECK ONLY ONE BOX FOR EACH.)

A reason I do not usually drink water is because….

1. I don't know of any good reason why I should drink water.	YES ☐	NO ☐
2. I never thought about it.	YES ☐	NO ☐

A reason I usually drink water is because….

3. I want others to see me as a healthy drinker.	YES ☐	NO ☐
4. I want others to see me as cool.	YES ☐	NO ☐
5. I want to be different from my friends.	YES ☐	NO ☐
6. my friends like me better when I drink water.	YES ☐	NO ☐
7. others make me do it.	YES ☐	NO ☐
8. I will be punished if I do not drink water.	YES ☐	NO ☐

A reason I usually drink water is because….

9. my parents reward me when I drink water.	YES ☐	NO ☐
10. I do not want others to think of me as a sweet drink junkie.	YES ☐	NO ☐
11. I feel like I have to.	YES ☐	NO ☐
12. I would feel bad about myself if I didn't drink water.	YES ☐	NO ☐
13. I would feel guilty if I drank sweet drinks instead of water.	YES ☐	NO ☐
14. I do not want to disappoint someone who means a lot to me.	YES ☐	NO ☐

15. I would not feel good about myself if I didn't drink water.	YES ☐	NO ☐
16. I want others to think better of me.	YES ☐	NO ☐
17. it is important to me to drink water.	YES ☐	NO ☐
18. drinking water is good for my health.	YES ☐	NO ☐
19. it makes me happy.	YES ☐	NO ☐
20. I want to take care of myself.	YES ☐	NO ☐
21. I want to drink something other than sweet drinks.	YES ☐	NO ☐
22. water tastes good.	YES ☐	NO ☐
23. it is fun to drink water.	YES ☐	NO ☐
24. I enjoy drinking water.	YES ☐	NO ☐

What I Think Will Happen If….

If I eat fruit and vegetables every day….

25. …my friends will make fun of me.	YES ☐	NO ☐
26. …it will keep me from getting fat.	YES ☐	NO ☐
27. …my family will be proud of me.	YES ☐	NO ☐
28. …I will have a prettier smile.	YES ☐	NO ☐
29. …my friends will not come to my house to eat.	YES ☐	NO ☐
30. …my friends will start eating them too.	YES ☐	NO ☐
31. …I will be healthier.	YES ☐	NO ☐
32. …I will have more energy.	YES ☐	NO ☐
33. …I will have stronger eyes.	YES ☐	NO ☐
34. …I will become stronger.	YES ☐	NO ☐
35. …I will have less energy than if I eat a candy bar.	YES ☐	NO ☐
36. …I will think better in class.	YES ☐	NO ☐
37. …I will not enjoy eating that meal or snack.	YES ☐	NO ☐