

A Model of the Home Food Environment Pertaining to Childhood Obesity

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Abstract:

The home food environment can be conceptualized as overlapping interactive domains composed of built and natural, socio-cultural, political and economic, micro-level and macro-level environments. Each type and level of environment uniquely contributes influence in a mosaic of determinants depicting the home food environment as a major behavior setting for child dietary behavior and the development of obesity. Obesity is a multi-factorial problem, and the home food environmental aspects described in the present paper represent a substantial part of the full environmental context in which a child grows, develops, eats, and behaves.

Key words: home food environment, obesigenic, obesogenic, obesity, children

## A Model of the Home Food Environment Pertaining to Childhood Obesity

In the United States, children and adolescents (under age 18) as a whole are faring poorly in meeting recommended nutritional goals.<sup>1-3</sup> Many children are consuming excess calories and exceeding recommended intakes of total fat, saturated fat, added sugar, and sodium.<sup>4</sup> Recent data from the Centers for Disease Control and Prevention show only about 20% of adolescents reported eating five or more fruits and vegetables a day in the past week.<sup>3</sup> Such nutritional shortcomings can result in both short- and long-term health problems, such as obesity, which has seen an extraordinary increase in prevalence over the past thirty years (figure 1).<sup>5,6</sup> Poor eating habits and obesity contribute to the development of health burdens such as hypertension, dyslipidemia, chronic inflammation, asthma, endothelial dysfunction, hyperinsulinemia, diabetes, cardiovascular disease, certain cancers, and premature death.<sup>7</sup>

Children's eating patterns are strongly influenced by environmental characteristics.<sup>8</sup> Despite the growth of fast food, convenience foods, and trends toward increased eating away from home, about two-thirds of the foods children consume is from home.<sup>9</sup> Home and family environments are essential in the development of food preferences and consumption habits, and families represent a promising avenue toward improvement of children's eating habits and prevention of obesity.<sup>10,11</sup> Although parental and familial contributions to obesity are well documented, research has insufficiently addressed the bigger picture or full environmental context of nutrition-related behaviors and adiposity status of children.<sup>10</sup> Specifically, the home food environment has not been consistently defined or measured in this body of literature.

Childhood obesity is a multi-factorial problem, and a variety of approaches have been used to study the problem, and to create and test interventions.<sup>10</sup> Egger and Swinburn argued for an ecological approach, conceptualizing obesity as a normal response to an abnormal

“obesogenic” environment.<sup>12</sup> As the interplay of environmental factors and health behaviors continues to emerge as a science, a need exists for attention to one of the most influential environments for the development of eating behaviors and obesity in children: The home. Therefore, the purpose of this paper is to review selected literature relevant to the home food environment’s influence on obesity, and to present an ecologically informed model for future research and intervention in the home food environment, which provides a majority of children’s dietary intake.

This model of the home food environment pertaining to childhood obesity (figure 2) is composed of three domains, each with macro-level and micro-level contributions. Micro-level components are defined here as those most proximal to a child’s home life, whereas macro-level components are defined as existing at the larger community level, with potential carry-over into the child’s home life. Built and natural environments are those composed of physical structures. Political and economic environments are those composed of financial resources, policies, and laws. Socio-cultural environments are those composed of social interactions, demographic characteristics, and secular trends. Components may interact across domains, represented here via bi-directional arrows connecting the three domains. For example, a parent’s education level can influence the family’s socioeconomic status, which can influence parenting practices, each impacting the degree to which fresh fruit is available and accessible at home. Although micro-level components are contained within the macro-level, the collection of micro-level components across a population also shapes the macro-level environment. The extent and quality of these micro-level and macro-level components in the home will combine to bring the full home food environment picture into focus. From there, the influence of the home environment on the

dietary intake of children can be moderated or mediated by factors within the individual child.<sup>12,13</sup> What follows is a selected review of literature illustrating this model.

### Political and Economic Environments

As the global economy continues to develop, international political and trade practices influence the types and costs of foods grown and brought to market, as well as trends in employment, wages, and other factors shaping our way of life. Within nations, states, and communities, laws and policies determine our financial resources, available foods, and food costs. From international levels to the neighborhood, political and economic environments play a role in shaping the home food environment.

#### Macro-level

**Food Pricing:** The financial costs of foods are strongly related to the likelihood of those foods being present in the home. In a nationally representative sample of almost 3000 adults, Glanz and colleagues found that cost was second only to taste as a criterion for food selection, as nutritional concerns and weight impact were much less important in food choice.<sup>14</sup> In small-scale experiments, researchers have found that pricing strategies directly influence food purchases.<sup>15-17</sup> French, Story and Jeffery reported that household income is associated with the types of foods consumed: Higher income families are more likely to purchase healthful foods.<sup>18</sup> In related articles applying national dataset findings from France, Drewnowski and Darmon found that lean meats, fish, fresh vegetables and fruit generally cost more than less healthful alternatives such as energy-dense foods made from refined grains, sugars, and fats.<sup>19,20</sup> Another article used the dataset from France to demonstrate how those spending the least money on food

had diets higher in energy-density and lower in micronutrients.<sup>21</sup> Between 1980 and 2000, childhood obesity more than doubled in the USA as relative prices of all food fell 14%, with even greater drops in cost of energy-dense foods.<sup>22</sup> These findings support contentions that food costs partly explain consumption patterns and obesity rates as the obesigenic foods are less expensive.

**Government and Business Policies:** The pricing of food is a result of government and business policies that determine the costs and profits associated with production, distribution, and marketing- see Nestle for a full review.<sup>23</sup> Drewnowski and Darmon posited that a broader problem lies with the economics of food production, importation, and trade, along with poverty, employment, and minimum-wage policy.<sup>20</sup> Agricultural subsidies and trade practices affect the quantity and types of crops grown, resulting in imbalances and price differences for certain commodities. Businesses make use of inexpensive commodities by processing and adding value to create and market profitable, palatable energy-dense foods.<sup>23</sup> Families are targeted through marketing, and often ignore long-term health implications when purchasing food. Several European governments have banned advertising directed at children, but the American food industry has resisted similar efforts here.<sup>24</sup> While some research has shown connections between advertising and obesity,<sup>25</sup> there is no good evidence that advertising bans, by themselves, can prevent or reduce obesity.<sup>26</sup> Drewnowski and Darmon called for cooperation between governments, businesses, and academia, to address growingly unequal distributions of wealth and an economic slant toward consumption of obesigenic foods.<sup>19,20</sup>

**Federal & Community Food Programs:** In the USA, federal special assistance food programs are available to bolster the dietary adequacy of low-income families, including WIC, food stamps, school meals, child and adult care, and other programs. Many communities also

have food banks or support programs available to the needy. Such programs can impact nutritional outcomes of participants, even more than equivalent increases in earned income.<sup>27</sup> The Food Stamp Program and WIC are structured to improve participants' home food environments by directly providing foods to be stored, prepared, and consumed at home. Other programs may not directly influence the home food environment (e.g., the National School Lunch Program), but can have impact through food exposure, shaping preferences, and offsetting total food costs. Beyond just participants, federal programs have ripple effects by shaping institutional policy in schools and after-school programs. Federal programs also help shape the national food supply through financial support and outlet mechanisms for excess commodities, though sometimes to the detriment of other food sources.<sup>23</sup> Federal agencies have responded to some criticisms by making efforts to provide more fresh fruits and vegetables, and by using local farmers markets. (<http://www.fns.usda.gov>, accessed January 1, 2007).

**National & Community Economic Conditions:** Worldwide, the link between diet and economics is clearly visible. As wealth rises and the population becomes less rural, societies undergo a nutrition transition, wherein diets high in unrefined carbohydrates and fiber are replaced by varied diets higher in fats, saturated fats, and sugars.<sup>28</sup> Within developed countries and at the community level, economic conditions are related to employment, wages, health, and nutrition.<sup>29</sup> Economic recessions, depressions, layoffs, and unemployment are likely to affect families' home food environments by altering socioeconomic status, relative food costs, and food insecurity at the micro-level.

## Micro-level

**Family Socio-Economic Status:** Socio-economic status (often measured by income, education, occupation, food-program eligibility, or the like) is a well-established influence on dietary habits, nutritional outcomes, and obesity.<sup>19-22</sup> The potential influence of socio-economic status on the home food environment is pervasive enough that nutrition-related studies usually measure and account for its contribution or confounding potential in relationships between other observed variables.<sup>30-32</sup> Strauss and Knight conducted a prospective study of children to determine home environmental risks for obesity.<sup>30</sup> These authors found that family income and home cognitive stimulation were significantly related to obesity in children at follow-up, controlling for other socio-economic factors, marital status, race, ethnicity and baseline BMI of mother and child.

**Family Food Insecurity:** Food insecurity is the limited or uncertain availability of nutritionally adequate foods, and is strongly related to financial insecurity and poverty.<sup>33</sup> Food insufficiency, a term used by some authors, is an inadequate amount of food intake due to a lack of money or resources. In the U.S., more than 14 million children under age 18 live in a home where they sometimes don't get enough to eat.<sup>34</sup> These children have significantly greater likelihood of poor health, lower quality of life, poorer physical function, and school difficulties.<sup>34,35</sup> Food insecurity can often be characterized by alternating patterns of "feast and famine" wherein family members over-eat at times when food is available, and under-eat at times when little food is available. Food insecurity may be associated with lower intakes of fruits and vegetables and higher intakes of energy-dense foods (when available).<sup>33,36</sup> Such dietary patterns may lead to a net positive energy balance and result in obesity. A large nationally representative sample using NHANES III data revealed that poverty and food



insecurity were unrelated to nutritional outcomes and obesity among schoolchildren, and that poverty was a suitable predictor for nutritional outcomes in preschoolers.<sup>37</sup> The authors offered the possibility that food stamps and national school lunch programs could explain the null result. This finding suggests caution with regard to connections between food insecurity and nutritional outcomes. However, a more recent study, based on NHANES III data, found that household and child food insecurity were related to risk for obesity among certain demographic categories of children.<sup>38</sup> Food-insecure adolescents, young children, Mexican-American children, and youth living below poverty were more likely to be above the 85<sup>th</sup> percentile of BMI. Another study demonstrated a potential moderating effect of the food stamp program on health-related outcomes of food-insecure households.<sup>39</sup> Thus, child food insecurity may be independently related to childhood obesity.

**Food Program Participation:** Less than 75% of those eligible actually use federal assistance programs, and three related explanations for lack of participation have been offered: stigma, transactions costs, and lack of information.<sup>40</sup> Despite eligibility, family decision-makers may not participate due to barriers of required documentation, perceived enrollment difficulties, guilt and shame from taking handouts, or ignorance of the program, process, or benefits.<sup>40</sup> Among the eligible, immigrants (especially Hispanics) are less likely to participate in assistance programs.<sup>40</sup> Those who do participate in food programs are likely to have better food security and nutritional intakes,<sup>27</sup> possibly improving home food environments and decreasing risk for obesity, though little evidence is available. Cook and colleagues found that children in food stamp program-participating, food-insecure households had lower adjusted odds of fair/poor health than children in similar non-program households.<sup>39</sup> In a study of participating families

with preschool children, Rose and colleagues found that the WIC program positively influenced the intakes of ten nutrients, while the food stamp program positively influenced five nutrients.<sup>27</sup>

### **Socio-Cultural Environments**

Children are socialized from birth by the social forces and cultures that surround them. Early on, parents and caretakers provide the bulk of influence. As children age, other individuals, institutions, and media increasingly add to the socio-cultural environmental influences on children.

#### Macro-level

**Race, Ethnicity, & Cultural Identity:** Callery noted the importance of recognizing how diets differ across and within societies and how food patterns are part of cultural expression.<sup>41</sup> Dettwyler posited that cultural ideas of child feeding may influence nutritional intake to a similar extent as availability and household income.<sup>42</sup> Two major determinants of culture are race and ethnicity, both with important impacts on home food environments. Though certain groups of people purchase and prepare specific foods in certain ways, cultural impact can be confounded by education and economics. Race and ethnicity appear to work through assorted mechanisms to influence the home food environment, and this influence can vary by time, place, and food.<sup>43</sup>

Racial and ethnic influences may stem from cultural and genetic differences, affecting food selection and nutritional outcomes of children and adults.<sup>44,45</sup> Children from ethnically diverse groups are at increased risk for obesity and are more likely to have diets failing to meet nutritional recommendations.<sup>44</sup> In a study of adolescent meal patterns, Blacks were about four times as likely as whites to eat less than two meals per day, indicative of food insufficiency, meal

skipping, or a predominance of snacking- all of which raise concerns for health, weight status and nutritional adequacy.<sup>46</sup> Children of Mexican Americans may be held to culturally specific standards, as their parents are more inclined to push food, expect hearty appetites, and have differing ideals of child body weight.<sup>47</sup> One cross-cultural study showed ethnic differences for child feeding responsibility, child weight concern, and perceived child weight were moderated by parent education and child BMI.<sup>31</sup>

**Media Advertising & Marketing Exposure:** Innovative strategies continue to emerge via schools, endorsements, internet, and movies, but television remains the pinnacle of food marketing targeting children and families.<sup>48</sup> A review of television and consumption patterns revealed that food is the most frequently advertised product category on kid's TV, with sugary products and fast food predominating.<sup>49</sup> Market segments are apparent as analyses of TV ads appearing during African-American program content showed greater likelihood of fast food, candy, soda, and meat, with less likelihood of cereals, grains, pasta, fruits, vegetables, desserts or alcohol compared to general program content.<sup>50</sup> Children exposed to TV advertisements are more likely to prefer the advertised product, to request such products from parents, and to consume these products.<sup>51</sup> Because advertising is effective,<sup>51</sup> and currently directs children and families disproportionately toward less nutritious foods, legislated regulations or bans have been used in some countries and proposed in many more<sup>48</sup> though the impact of such legislation has not been determined.

**Consumption Trends:** Recent data show that the availability of food calories has increased dramatically since 1980,<sup>52,53</sup> and consumption patterns have also changed (figures 3,4).<sup>54-56</sup> Over the past few decades, soda consumption, snacking, and food portion sizes of in and out of the home have shifted in an obesigenic direction.<sup>57</sup> Portion sizes, which predict food

consumption, have increased over recent decades, and are implicated in overeating and obesity.<sup>58-61</sup> U.S. children get approximately 20% of their daily calories through snacks, compared to Chinese kids who get only 1% of daily calories from snacks.<sup>9</sup> There has been an increased prevalence, across all age groups of youth for frequent snacking and for deriving a large proportion of one's total daily calories from energy-dense snacks, and some evidence exists linking opportunities for snacking with youth obesity.<sup>62-64</sup>

Overall caloric consumption may have increased slightly in recent years (figure 5), though perhaps not among children.<sup>54-57</sup> A nationally representative sample revealed no increased consumption for children aged 6-11, but significant increases for adolescent boys and girls.<sup>55,56</sup> Whether caloric intake has changed among children requires further study, but solid data show that source of calories has shifted remarkably over the past few decades.<sup>58,62,65</sup> Sweetened beverage consumption increased from the 1970s to the beginning of the 21<sup>st</sup> century.<sup>57</sup> Prevalence of soft drink consumption among children aged 6-17 has increased 48% during roughly the same time period.<sup>66</sup> Nielson reported increases in the proportion of calories from salty snacks, soda, cheeseburgers and pizza, with decreases in milk, desserts, beef, and pork consumption.<sup>54,62</sup> While milk has dropped in consumption, cheese has more than doubled.<sup>18</sup>

A nationally representative sample of children consumed about 33% of their calories in food prepared away from home, with about 20% in the form of fast food.<sup>9</sup> Foods prepared away from home find their way to the home food environment via takeout, carry out, and delivery. In a study of Australian parents, over 70% reported purchasing carry-out foods for the evening meal.<sup>67</sup> Food preferences and exposures outside the home help shape the home food environment. Among foods consumed at home, modern times have brought an increasing variety of prepackaged convenience foods<sup>23</sup> (added value to food through preparation,

processing, and packaging) requiring minimal preparation time or effort.<sup>18,68</sup> Portion sizes have increased for most foods consumed in or out of the home between 1977 and 1996.<sup>18,58</sup>

Unfortunately, many convenience foods sacrifice nutritional quality (loss of fiber, vitamins, minerals, & phytonutrients; addition of sugars, fillers, preservatives, hydrogenated or saturated fats, sodium, artificial colors and flavors), come in large portion sizes, have high energy density, and may promote obesity.<sup>19,23,69</sup> With these consumption trends, poor nutritional outcomes are predictable.

### Micro-level

**Customs & Traditions:** The home food environmental impact of traditions, culture, religious practices, ethnicity, race, and related social influences is important to consider as many customs and traditions involve food as a central focus. In a study of familial aggregation of dietary intake, cultural inheritance accounted for 30-40% of the dietary intake variance for children.<sup>70</sup> Correlations in energy intake and macronutrients were higher between spouses and between siblings than between parents and children, suggesting a stronger contribution from culture and shared environment than from genetics. The study also found that families who shared meals together more often had more similar dietary intakes.

**Family Structure, Stress, & Schedules:** Secular trends have revealed an increase in dual earner and single-parent families and more women in the workforce.<sup>18,71</sup> Working mothers are more likely to have reduced participation in meal planning, shopping and food preparation.<sup>72</sup> Mothers who work may opt for greater convenience in food choices, as time pressures influence the foods in their home environment.<sup>18</sup> Demographic shifts have resulted in less time available for food preparation, with significant effects on the home food environment.<sup>73</sup> Children who

lived with a single mother were shown to have higher saturated fat intake.<sup>74</sup> In another study, children of single mothers were more likely to become obese in a six-year prospective study, though this effect appeared to be mediated by other socioeconomic factors.<sup>30</sup> Teens from a single-parent household were more than twice as likely as those from a dual-parent household to have inconsistent meal patterns (placing them at risk for poor nutritional outcomes and obesity).<sup>46</sup> The makeup and size of families may influence the impact of the home food environment on children's risk for overweight, but few data are available in the literature. Households having more than one adult may have more family income and opportunities for monitoring or socialization. Family size may be associated with financial security, time constraints, and opportunities for the modeling of desirable or undesirable eating habits.

Family stress may be partially determined by socio-economics, race, ethnicity, employment, and health. Data have shown that food-insufficient households are much more likely than food-sufficient households to have experienced recent events that stress household budgets, such as losing a job, gaining a household member or losing food stamps.<sup>75</sup> Stress may have a reciprocally determined relationship with the environment.<sup>10</sup> Relationship stress could mediate the effect of other influences of the home food environment. For instance, stress could decrease the quality and frequency of family meals, or alter the degree to which parents monitor and regulate the types of foods purchased and consumed. Children in a stressful home environment may eat and behave in ways that exacerbate their exposure to stress and further shape their home food environments.

**Parenting: Practices, Styles, & Rules:** Golan and colleagues have consistently argued that parents can and should play the primary role in controlling the obesigenic environment at home.<sup>76-79</sup> Other researchers have acknowledged the importance of parents while focusing

interventions on prevention and treatment of weight problems in children.<sup>80-83</sup> However, children and parents may not perceive the home food environment in the same way.<sup>84,85</sup>

The home food environment typically has one nutritional gatekeeper, often the mother, who controls a majority of the food eaten.<sup>86</sup> According to parental surveys, parents believe that they control an average of 83% of the food that children eat at home, with the proportion remaining high regardless of parental body mass, sex, age, cooking ability, and food type.<sup>86</sup> Mothers are often presumed to be nutritional gatekeepers, but studies have attested to the fact that fathers are also influential<sup>80,87-89</sup>

Parenting style provides the emotional context of the parent-child relationship, reflecting attitudes and creating an emotional climate wherein parenting practices and behavior are enacted.<sup>90</sup> Too often, studies have enmeshed general parenting styles within more specific domains, such as child feeding practices.<sup>91,92</sup> Specific parenting practices always take place within a greater parenting style context, and outcomes of individual practices may vary as a function of parenting style. In the parenting literature, typically three parenting styles are discussed: Permissive, Authoritarian, and Authoritative.

Permissive parents are warm but not firm, allowing their children great freedoms in behavior and decision-making.<sup>90</sup> Typically, permissive parents are less likely to set limits or control the food choices of their children.<sup>93</sup> Authoritarian parents are firm but not warm.<sup>90</sup> They are likely to set rigid limits for children, and to employ punitive and forceful actions of enforcement.<sup>94</sup> In contrast, authoritative parents are warm, firm, and accepting of the child's needs for autonomy.<sup>95</sup> Authoritative parents are likely to set limits for children based on reasoning, and to enforce limits through persuasion, rather than intimidation.<sup>94</sup> In research on parenting style and obesity-related behavior, parental permissiveness has been significantly

related to soda consumption while fruit consumption and fruit-specific cognitions were best among adolescents who reported that their parents were authoritative, followed by those with permissive and authoritarian parents.<sup>32,96</sup>

Parenting practices are specific actions, but may be categorized similarly to style. Parents with authoritative-type feeding practices provided better availability of fruits and vegetables, made more attempts to get children to eat dairy, fruit and vegetables, and had children with better consumption of dairy and vegetables.<sup>91</sup> Authoritarian-type feeding practices were negatively related to vegetable consumption and fruit/vegetable availability. Maternal child feeding practices and perceptions of daughters' risk for obesity have been shown to predict girls' eating and weight status.<sup>87</sup> A review of the literature, discussed the development of food preferences as a function of exposure to foods and parenting practices.<sup>97</sup> This review highlighted how genetic predispositions to like foods with high-energy density, sweet and salty flavors, and to dislike sour and bitter tastes are modified with experience and exposure. Repeated exposure to foods can increase children's liking for that food.

Using food as a reward is associated with nutritional problems for children, and parents practicing this had children with higher regular sweet consumption.<sup>32,98</sup> Less-educated and lower-income mothers are more likely to reward good behavior with food, but obese mothers were no more likely than non-obese mothers to do so.<sup>99,100</sup> In contrast, parental support and verbal praise have been positively associated with children's fruit and vegetable consumption.<sup>32,101</sup>

Research on control in the context of the home food environment has frequently failed to distinguish different types of control. Authoritative and authoritarian parents both employ behavioral control, but psychological control reflects restrictive practices and is associated only



with authoritarian parenting style.<sup>102</sup> Ogden and colleagues further differentiated control as either covert (undetectable), or overt (detectable). Lighter parents and those with heavier children were more likely to use covert control, while parents of higher social status were more likely to use overt control. Some studies have shown a positive relationship between controlling practices and child overweight, while others have not.<sup>89,103</sup> Restricting access to palatable foods has backfired in laboratory studies, such that children showed increased interest for restricted foods.<sup>104</sup> Overweight parents, those concerned with their child's weight, and those having difficulty with self-control are more likely to use control, which may interact with genetics to foster child eating and weight problems.<sup>10,92</sup>

Overfeeding and pressure to eat have been shown to be associated with undesirable nutritional outcomes in most studies.<sup>47,91</sup> Some studies have also focused on family rules such as eating with the TV or snacking between meals.<sup>78</sup> In an Australian sample, about one-third of families reported watching television more than four times per week while eating the evening meal, and only 11% had a rule against using the phone during dinner.<sup>67</sup> More research is needed to illustrate influences of family rules on children's dietary behavior.

**Parental Eating/Dieting:** Similarity exists in the dietary habits of people living together, irrespective of genetic relationships.<sup>70</sup> In children, food preferences are strong predictors of consumption, and those for fruits and vegetables are influenced by availability, variety, and exposure, likely stemming from foods mom and dad eat.<sup>105</sup> Siblings, peers, and parents can act as role models to encourage tasting of novel foods.<sup>97</sup> In a sample of middle-school students, parental modeling predicted adolescent fruit and vegetable consumption.<sup>101</sup> Separating out potential genetic effects, parental overweight is frequently cited as a predictor of child overweight but parents can also model positive food attitudes and intake, and practice

appropriate socialization techniques.<sup>10,87</sup> Home social influences may impact eating behaviors consciously or unconsciously via attitudes, subjective norms, mimicry, awareness, and involvement.<sup>13</sup> Parental reluctance to meet nutritional recommendations in their own dietary practices may serve to undermine attempts to ensure healthful dietary practices of their children.<sup>106</sup> If this is true, modeled eating and availability of obesigenic foods in the home food environment will prove a stronger influence on child consumption patterns than parental encouragement or instructions. Several studies have focused on parental dietary practices, including disinhibition and dietary restraint, with a majority finding dietary restrictive practices a risk factor for children.<sup>10,107,108</sup>

**Family Eating Patterns:** The family mealtime aspect of the home food environment has great potential to affect the eating behaviors of youth in the family.<sup>85,109</sup> Among adolescents, those eating six or more family dinners per week had significantly better dietary outcomes, being less likely to: skip breakfast; eat fewer than two servings of fruit; eat fewer than two servings of vegetables; consume fewer than two servings of dairy products.<sup>110</sup> Eating family dinner has been associated with healthful dietary patterns, better fruit/vegetable intake, lower intake of fried food and soda.<sup>111</sup> Children without regular family dinners ate sweets and fast foods more often, and had more behavioral problems than those having regular family dinners.<sup>112</sup> In a longitudinal study of television and food intake, the frequency of family dinners was inversely related to overweight prevalence at baseline, but not with likelihood of becoming overweight at follow-up.<sup>113</sup> The frequency of meals eaten at home was shown to influence the success of 10-year family treatment outcomes of obesity.<sup>114</sup> Overall, there is ample cross-sectional evidence showing positive associations from family meals, though further work is necessary to determine whether family meals have potential to prevent obesity.

Eating a breakfast meal has been associated with positive outcomes for both school performance and protection from obesity.<sup>115-118</sup> Among preschoolers, lack of daily breakfast consumption nearly doubled the odds of being overweight.<sup>119</sup> Unfortunately, research has demonstrated a documented decline over past decades in breakfast consumption among both boys and girls.<sup>120</sup> Eating breakfast also tends to decline as children age.<sup>117</sup> Studies show female adolescents are more likely to skip breakfast than are males.<sup>110,118,120</sup> Meal skipping is more prevalent among children of working mothers, and urban versus rural or suburban children<sup>72,121</sup>

**Education & Nutrition Knowledge:** In parents, general education level contributes to socio-economic status, and is thought to have far-reaching effects on many health outcomes. Parent education may impact the home food environment via financial income, money management, priority for nutrition, nutritional knowledge, parenting skills, general resources, or in other ways. Education level of mothers has been associated with child and mother consumption of fruits, vegetables, soft drinks, use of restrictions, verbal praise, negotiation, discouragement of sweets and restraining from negative modeling behavior.<sup>32</sup> In a population study, better maternal nutritional knowledge was associated with better diets in children, although the influence decreased with child age.<sup>122</sup> Conversely, a study of adolescents found a significant association between nutrition knowledge and food choices for seventh and eighth grade boys and girls, but not for sixth graders.<sup>123</sup> These findings depict shifts in knowledge-related influence from parent to child as the child ages and develops more autonomy. However, environmental availability may moderate the impact of knowledge, and self-efficacy or parental support may mediate the knowledge-behavior relationship.<sup>101,124</sup>

**Food preparation skills:** By using interviews, focus groups, and surveys, Wansink and Park showed how nutritional gatekeepers vary in cooking skill, food usage, motivations, and

personality, suggesting that interventions should consider such factors when targeting dietary change in the home.<sup>125</sup> A recent study of young adults showed that although they had positive attitudes toward food preparation, they overestimated their food preparation ability and held negative views of from-scratch preparation.<sup>126</sup> This highlights how limited skill may prevent adults from making improvements to the home food environment. According to another study in England, most people learn food preparation skills from their mothers, though cooking classes in schools also served an important role.<sup>127</sup> This study's data suggests that socio-economic status and education are associated with the sources of people's knowledge about cooking, and that that knowledge may be an important factor in dietary choices and health.

### **Built & Natural Environments**

According to Sobal and Wansink, certain aspects of the built environment are able to influence perceptions and cognitions regarding food consumption, to provide distractions or disruptions to self-regulation processes, or to increase awareness and promote convenience toward facilitation of eating.<sup>128</sup> Built environments exert influence on what and how much is eaten, when and where it is eaten, and who is eating. In describing the physical environment in relation to obesity, Wells suggested that a full spectrum, from small-scale design elements to large-scale community infrastructure, should be considered.<sup>129</sup> Food acquisition is a function of numerous influences both inside and outside the home as outlined above. Once food is available within the home, it becomes part of the physical makeup of the home food environment.

Postulating that behavior is simultaneously influenced consciously and unconsciously by the environment, the Environmental Research framework for weight Gain prevention (EnRG),

has been put forth as an attempt to describe the obesigenic environment.<sup>13</sup> This framework bears resemblance to the ecological model published by Egger and Swinburn in describing types and levels of the environment, but expands the areas related to moderators and cognitive mediators of the environment-behavior relationship.<sup>12</sup> In the EnRG framework, moderators include demographic, personality, awareness, involvement, habit strength and clustering, while mediators include attitudes, subjective norms, intention, and perceived behavioral control. The present paper's home food environment model (Figure 2) builds on the ideas put forth by those authors above in depicting the influence of moderators and mediators of the environment-behavior connection.

#### Macro-level

##### **Food Landscape- Institutionalized Food Production, Availability, and Accessibility:**

Food becomes available and accessible through a wide variety of ways, including grocery stores, convenience stores, restaurants, shops, markets, schools, and churches. Overall availability per capita (including children) in the USA increased from 3300 kilocalories in 1970 to 3800 kilocalories in 1994.<sup>53</sup> Caloric availability is a large overestimate of food consumption due to spoilage and waste, but micro-level studies show that availability is associated with consumption.<sup>18,105</sup>

Recently, studies have examined relationships between the food landscape, availability and intake. Low-income neighborhoods are less likely to have grocery stores or restaurants offering fruits and vegetables.<sup>130</sup> Wealthier neighborhoods have significantly more supermarkets than poor and ethnically diverse neighborhoods.<sup>131</sup> Edmonds used a sample of African-American Boy Scouts to assess the influence of food landscape, finding that census tract

methods were useful for determining fruit and vegetable availability from restaurants, but not grocery stores.<sup>130</sup> Among African-Americans, a nearby grocery store predicted increased likelihood of meeting dietary standards for fruit, vegetable, and saturated fat consumption. Massive increases in fruit and vegetable consumption were seen in local residents after the building of a supermarket in a “retail-poor” area.<sup>132</sup> The measurement of food deserts and other uses of geographic information systems are still in their infancy as tools of science. As these measurement tools continue to develop, so too will methods of analysis that may bolster our understanding of how the macro-level environment carries over to the home food environment.

**Information Infrastructure:** Considering the resources devoted to television, radio, cable, satellite, internet, newspapers, magazines, books, podcasts, billboards and related vehicles, a truly vast information transfer system exists in modern society. Among its many uses, this vast system is used to direct consumers to food purchase and consumption opportunities.

#### Micro-level

**Home Availability & Accessibility of Foods:** Children are unable to eat foods not available to them.<sup>133</sup> This simple point, however, has practical and theoretical implications for the home food environment. Less availability of obesity-protective foods such as fruits and vegetables predict lower consumption levels, while higher availability of obesity risk-factor foods predict higher consumption, each pathway leading toward obesity. Hearn and colleagues reported in two studies that children’s fruit and vegetable consumption was significantly related to availability of these foods.<sup>134</sup> In a review of the literature, Blanchette and Brug found that along with taste preferences, the availability and accessibility of fruit and vegetables were most consistently and most positively related to consumption.<sup>135</sup> Le Bigot Macaux found that

children's taste preferences for fruit are similar to those of candy, suggesting that the taste of fruit is more benefit than barrier for consumption, and that greater availability should promote consumption.<sup>84</sup> Availability moderates children's consumption such that homes with greater availability of fruits and vegetables have higher levels of motivating factors for children's consumption of fruits and vegetables.<sup>136</sup> Larson and colleagues studied eating habits of more than 4,000 teens in Minnesota, and found that calcium intakes of males and females were positively related to the availability of milk at meals.<sup>137</sup> A pilot intervention used nutrition information and media literacy to increase availability and parental social support, finding children were able to increase their consumption of fruits and vegetables.<sup>138</sup> The better the availability and accessibility of nutrient-dense foods in the home environment, the more likely it is that children will choose to eat these obesity-protective foods. Intervention programs should target availability and accessibility of healthful foods, such as the preparation of fruits and vegetables so that they are flavorful and ready to eat.<sup>139</sup>

For obesigenic foods, the home food environment is the largest source of sugar-sweetened beverages, as consumption increased from 5oz/day to 12oz/day from the mid-1970s to the late-1990s.<sup>66</sup> A review of the literature showed strong evidence for the role of such beverages in the development of obesity in children, accounting for eight to nine percent of children's daily calories.<sup>140</sup> Among high-fat foods, cheese consumption has increased in convenience foods such as pizza, tacos, nachos, and fast-food sandwiches.<sup>18</sup> Stockpiling of foods in the home may increase consumption for preferred and convenient products when food is visible and accessible, and when the family is frequently reminded of the food via marketing.<sup>141</sup> As nutritional gatekeepers, parents are capable of manipulating the availability of foods in the

home food environment through their purchases, which can influence children's eating patterns without undue control or restriction.

**Audiovisual Media Equipment:** Several years back, the average child in the U.S. lived in a home with three televisions, two VCR or DVD players, and a computer, though these numbers may have climbed even higher recently.<sup>142,143</sup> American homes have a TV on about 25% of each day, and TV watching begins at an early age, with many children exceeding recommended levels of viewing.<sup>144</sup> Research has tied television viewing to a host of nutrition-related outcomes including fast-food consumption, lower fruit and vegetable intake, higher intakes of fat and salty snacks, and obesity.<sup>49,113,145-148</sup>

Figure 6 illustrates how television may promote an obesigenic home food environment through three main avenues of influence: promotion of sedentary behavior, food advertising, and eating while watching television.<sup>11</sup> Sedentary behavior results in a lower energy expenditure, leading to weight gain unless caloric intake is proportionally reduced. Sedentary behavior inside the home allows opportunities for eating as food is nearby, and because being sedentary (as opposed to being vigorously active) is compatible with eating. Mindless eating can occur while watching TV, wherein a person is unlikely to be aware of how much is eaten, leading to higher energy intake and obesity.<sup>149</sup> Food is the most frequently advertised product type, often sugary snacks or fast-food products.<sup>49</sup> Children purchase and influence their parents to buy advertised foods, and parents respond directly to advertising from their own TV viewing.<sup>150</sup> Thus, advertising can lead to energy-dense foods being available at home, foster more eating opportunities, higher energy intake, and promotion of obesity, unless offset by physical activity.

Computer use can also promote sedentary behavior and lower energy expenditure, although its influence on energy intake is not likely as powerful, due to the more interactive



nature, occupation of one's hands, and currently lower levels of exposure to food advertising. Supplemental to the advertising influence, the internet has become one avenue for the direct purchase of food that may be delivered to the home. Presumably, advertising via internet or related media technologies could function in similar ways to TV. In the 1990s, numerous ethically questionable corporate data collection practices were revealed wherein food companies' kid-friendly websites used animated characters to gather personal information via interactive surveys.<sup>48</sup> Such information was then used to create targeted marketing for children. While this specific practice has subsided, the use of internet advertising overall is growing.<sup>48</sup>

Irrespective of advertising source, controlled studies have demonstrated the effectiveness of children's advertising in product recognition, selection, purchase requests, and parental acquiescence with resultant presence of advertised products at home.<sup>49</sup> Older children with access to money may purchase advertised food products themselves. Time-strapped parents are likely to let children watch TV, and to seek time-sparing methods of food provision through conveniently prepared foods.<sup>69</sup> Whatever the mechanism, television has shown larger effect sizes on obesity than either physical activity or nutritional intake alone.<sup>151</sup>

Saelens and colleagues longitudinally followed 169 families, finding that viewing, number of TVs, presence of VCRs, frequency of eating meals while watching TV, and percentage of children with a bedroom TV all increased from ages 6 to 12.<sup>152</sup> TV watching was related to weight status when children were younger and older, and watching more than 2 hours per day was a risk factor for higher weight. Some research suggests an increase of television viewing at mealtimes.<sup>84</sup> In one study of an ethnically diverse sample of children, about 20% of calories were consumed while watching television, and food fat content consumed with TV was related to BMI in the 3<sup>rd</sup> grade sample.<sup>153</sup> Other work has found that television viewing

predicted fat intake in Black and white adolescents.<sup>139</sup> Reducing the frequency of meals eaten while watching TV may be useful for reducing television exposure and obesity risk.<sup>152</sup>

Beyond television, modern food marketing impacts the home food environment via internet websites, movie product placement, movie or TV character toy tie-ins, sponsorship of sports teams and icons, postal mail advertisements, newspaper and magazine advertisements and inserts, and even with coupons or vouchers from school programs.<sup>48,154,155</sup> With such ubiquitous product pushing aimed at children, reducing television exposure or advertising may only partially stem the tide of influence on the home food environment. Various public health policies have been proposed to protect children by regulating food marketing to children, but the issue is politically charged. Many have called for food companies to self-regulate and to develop more healthful product lines, yet the feasibility of this approach remains unknown.<sup>155</sup>

**Kitchenscapes, Tablesapes, Platescapes, & Foodsapes:** Food intake is influenced by the physical setting and the objects therein.<sup>18</sup> The “microscale” built environment has become a substantial focus of research relating to obesity. A recent literature review described how small-scale elements of the built environment have an influence on food intake and obesity.<sup>128,149</sup> Rooms, furniture, containers, and the structure of food itself have been shown to modify consumption patterns. For instance, characteristics such as the visibility and accessibility of food, kitchen ambience and size, furniture characteristics, organization pattern of serving, size and shape of serving utensil, plate, and food all have been shown to influence eating habits. Preferred foods that are prominently visible and accessible, along with larger plates, bowls, cups, and serving utensils are all likely to promote greater food consumption.<sup>149</sup> Small kitchens with inefficient designs may discourage the preparation and consumption of less convenient and more healthful meals.<sup>128</sup> Kitchenscapes, tablesapes, platescapes, and foodsapes provide subtle, yet

pervasive influence in the home food environment, partially determining food choices, consumption, and obesity. Structural changes to the micro-scale built environment may offer an effective means to change food intake.<sup>128,149</sup> Some examples of structural changes to alter obesigenic micro-scale built environments may include the use of smaller tableware, increasing the accessibility of stored fresh fruits and vegetables, storing otherwise convenient energy-dense foods in hard-to-reach and out-of-sight areas, limiting the size of food storage areas, or keeping dining areas clear of clutter and set up for family meals at home.

**Kitchen Appliances & Cooking Equipment:** If the micro-scale built environment is intended to account for influences on eating behaviors in the home, it should also include food preparation and storage equipment such as refrigerators, freezers, microwave ovens, ranges, and conventional ovens, cooking utensils, pots and pans, and other such items. While literature is lacking, these aspects of the built environment could influence consumption patterns in the home food environment. One study in the UK, showed that those with unskilled occupations were significantly more likely to own a deep fat fryer and least likely to own a food processor, suggesting potential negative impacts on their diet.<sup>156</sup>

**Home & Community Gardens:** Before most Americans lived in cities, much of the food in the home was grown in gardens and farms nearby. More recently, gardening became more hobby than necessity, but garden-grown foods can positively impact the diet and budget of families.<sup>157</sup> Foods grown in the garden may be consumed in season, or canned, dried, and frozen for later use. An overabundance of certain foods ripening simultaneously may also result in sharing these foods with friends, neighbors, and relatives.<sup>158</sup> As many as one quarter of households in the USA have gardens, saving families hundreds of dollars in food cost each year.<sup>158</sup> Because the types of foods grown in home or community gardens are likely to be fruits,

vegetables, herbs, spices, and grains, the more that a family uses products from gardens, the less obesigenic their home food environment should be. Recently, interventions have focused on ways to involve youth in horticultural activities to promote physical activity, decrease sedentary activity, and increase fruit and vegetable preferences and consumption.<sup>159,160</sup>

### **Discussion and Conclusions**

The home food environment can be conceptualized as overlapping interactive domains composed of built and natural, socio-cultural, political and economic, micro-level and macro-level environments. Each type and level of environment uniquely contributes influence in a mosaic of determinants depicting the home food environment as a major behavior setting for child dietary behavior and the development of weight status. Obesity is a multi-factorial problem, and the home food environmental aspects described in the present paper represent a substantial part of the full environmental context in which a child grows, develops, eats, and behaves.

The epidemic levels of obesity now seen among children and nearly pandemic level in adults warrant grave concern due to decreased quality of life, potential tracking of weight and health behaviors from childhood to adulthood, and comorbid cardiovascular diseases, certain cancers, diabetes and others. If preventive measures are not taken, the negative outcomes of obesity are likely to result in great costs to society, not only in terms of health and quality of life, but also in fiscal impact on the healthcare system and national economy. Preventive changes are needed, spanning individual to national levels, and researchers have called for the development of family-based prevention programs for childhood obesity as a primary public health goal.<sup>10</sup>

Dufour cogently noted that the phenotypic development of obesity is only possible in an environment that permits overeating relative to energy expenditure.<sup>93</sup> Although the present paper does not address energy expenditure or physical activity, consideration of both sides of the energy balance equation is essential for the study of obesigenic environments and the development of obesity. These environments consist not only of physical structures, but also interlaced social, cultural, economic, and political components that create behavior settings for individuals and groups of people. In the present paper, we have made an attempt to draw upon ecological frameworks and extant literature to describe a comprehensive conceptual model of the home food environment that likely plays a strong role in the escalating problem of childhood obesity. It is hoped that this model will help to inform intervention efforts designed to alter the obesigenic qualities of the home food environment.

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Figure 1. U.S. Prevalence of Obesity by Age Group

(Data from Hedley et al.,<sup>6</sup> *JAMA*. 2004;291:2847-2850)

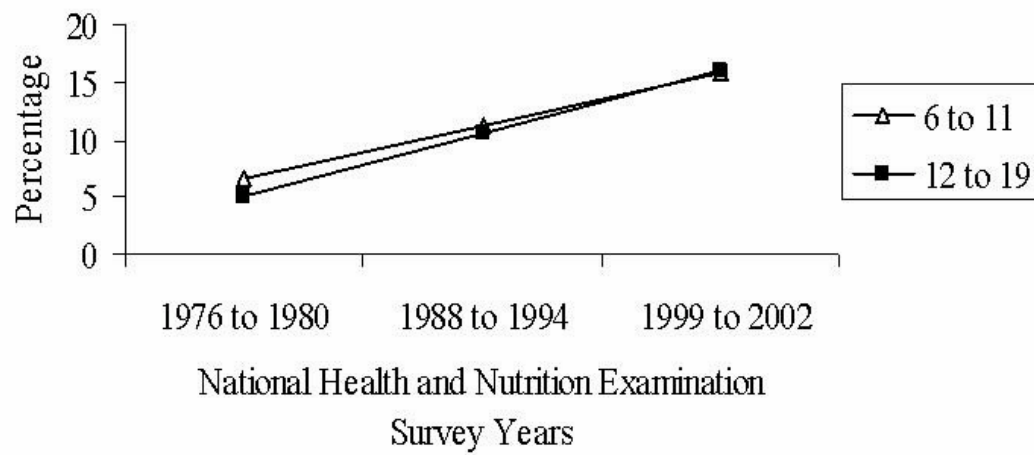


Figure 2: A Model of the Home Food Environment Pertaining to Childhood Obesity

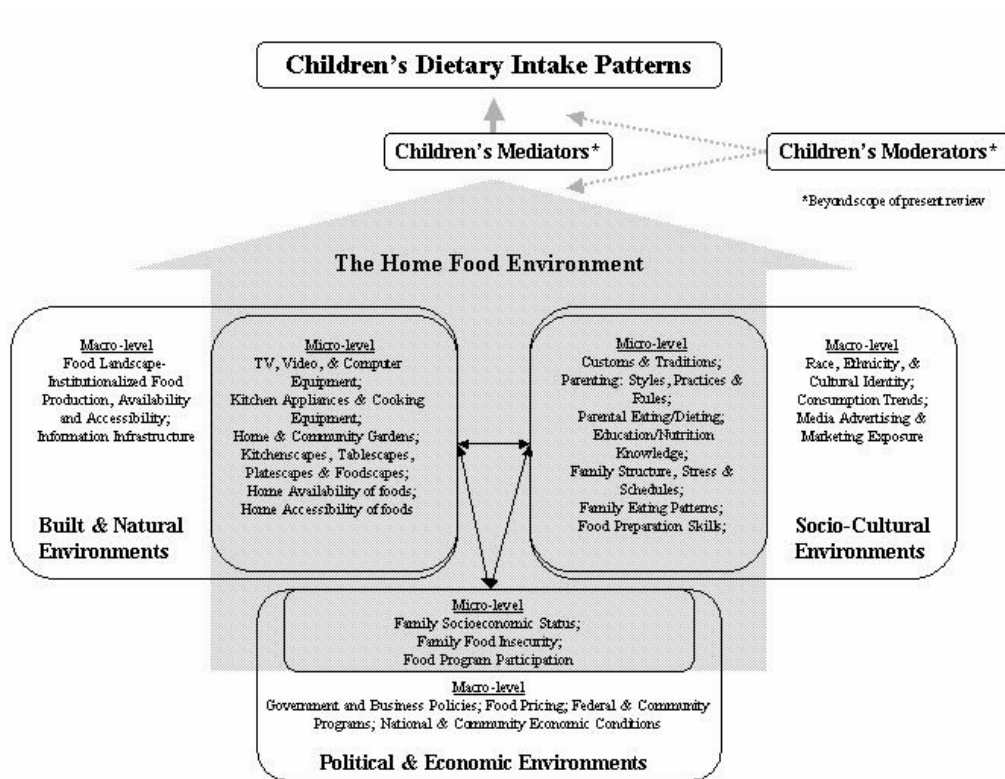


Figure 3. U.S. Dietary Consumption Trends for Girls Aged 6-11

(Data from Nielsen et al.,<sup>54</sup> *Obes Res.* 2002;10:370-378)

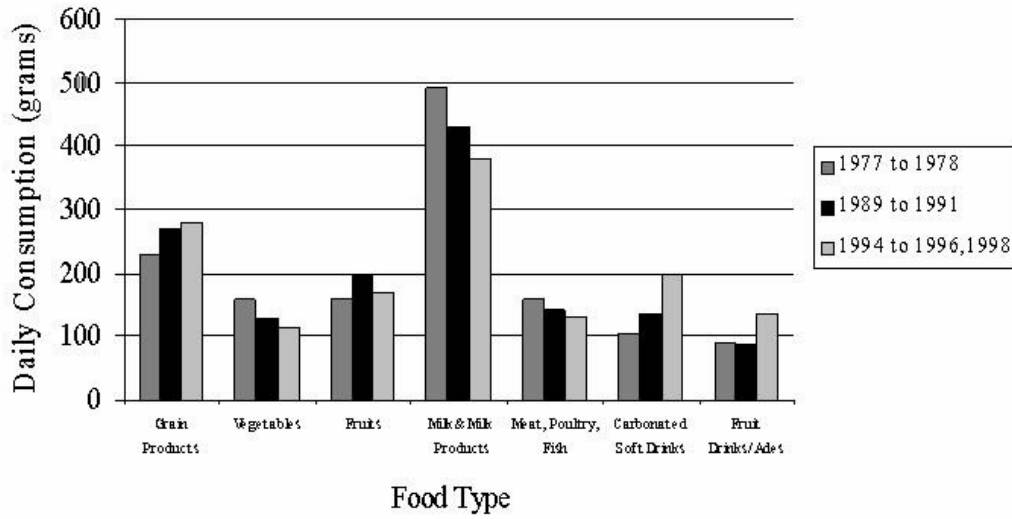


Figure 4. U.S. Dietary Consumption Trends for Boys Aged 6-11

(Data from Nielsen et al.,<sup>54</sup> *Obes Res.* 2002;10:370-378)

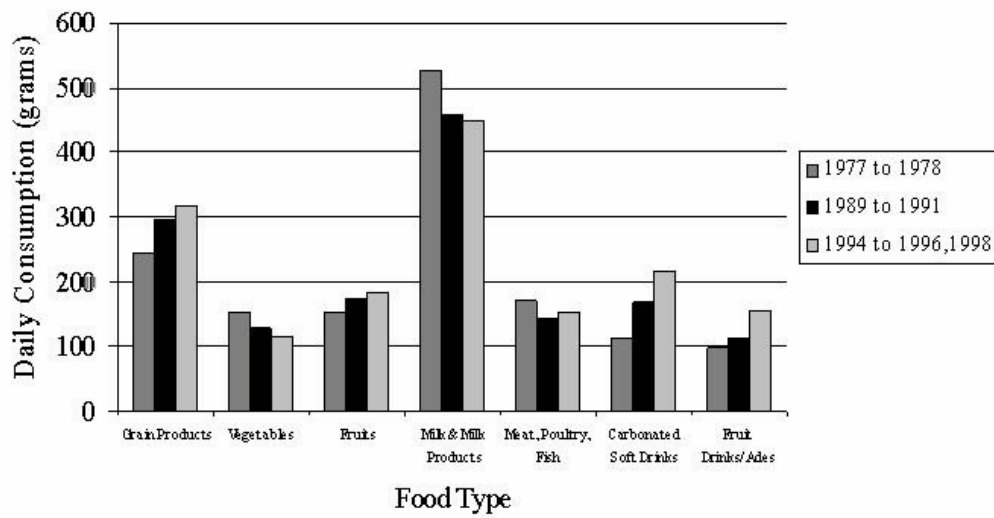


Figure 5. U.S. Caloric Intake Trends for Children and Adolescents

(Data from Enns et al.,<sup>55</sup> *Fam Econ Nutr Rev.* 2002;14:56-68  
and Enns et al.,<sup>56</sup> *Fam Econ Nutr Rev.* 2003;15:15-27)

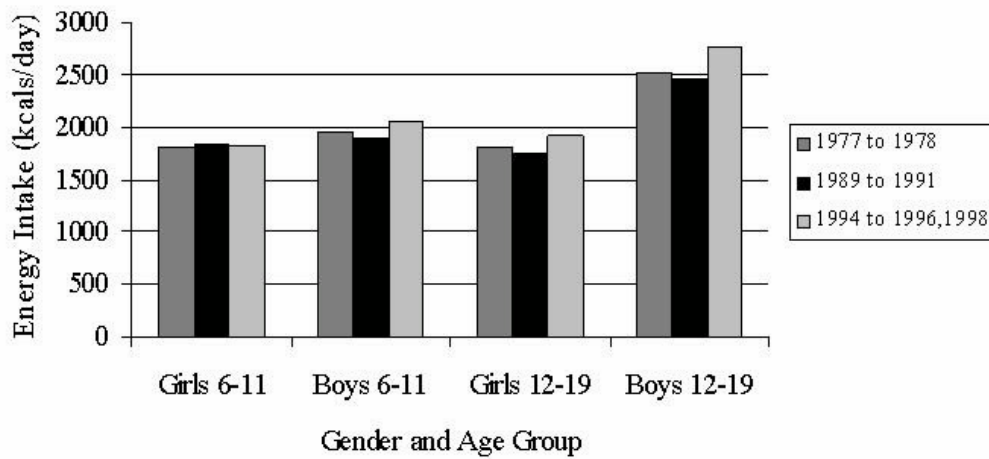
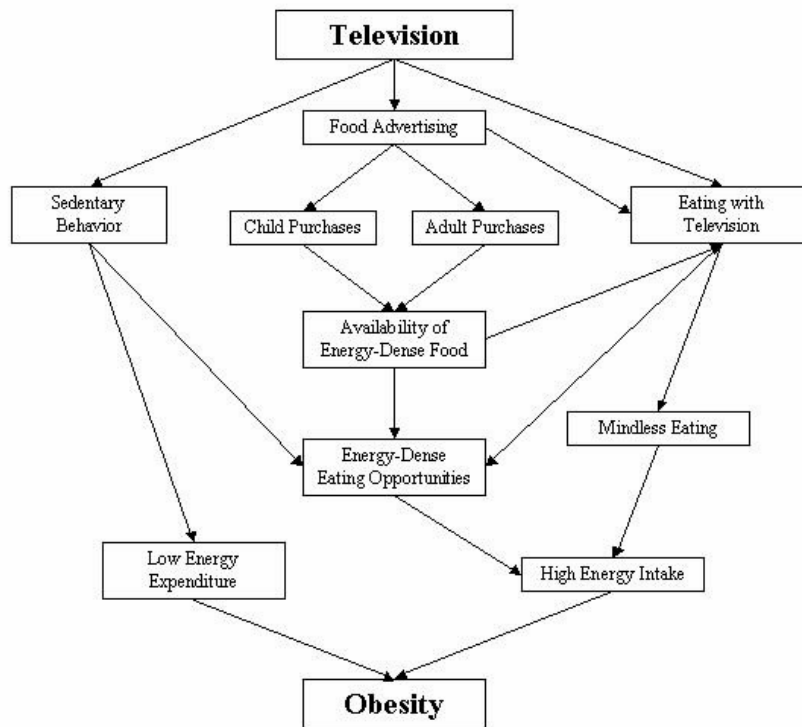


Figure 6: Conceptual Model of Television's Impact in a Permissive Home Food Environment



**Table 1.** Socio-Economic Status Influence on Nutritional Outcomes and the Home Food Environment

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Compared to their higher-SES counterparts, children from lower-SES families...

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- |  |  |
|--|--|
| ▶ Eat fewer family meals. <sup>110</sup>   | ▶ Are more likely to be food-insecure. <sup>33, 37</sup>           |
| ▶ Have parents with less authoritative feeding practices. <sup>32</sup>  | ▶ Are more likely to skip breakfast. <sup>119</sup>                |
| ▶ Have parents less concerned with child weight. <sup>31</sup>   | ▶ Are less likely to have healthful foods at home. <sup>18</sup>   |
| ▶ Have parents more likely to use food as a reward. <sup>99</sup>  | ▶ Have less healthy food habits. <sup>37, 161</sup>                |
| ▶ Get less parental discouragement from sweets. <sup>32</sup>  | ▶ Are more likely to eat fast food. <sup>20</sup>                  |
| ▶ Have parents who eat less fruits and vegetables. <sup>32</sup>   | ▶ Drink more sugar-sweetened beverages. <sup>161-163</sup>         |
| ▶ May live in neighborhoods without grocery stores or restaurants that provide fruits and vegetables. <sup>130</sup> | ▶ Have lower calcium intakes. <sup>137</sup>                       |
| ▶ Have less availability of fruits and vegetables. <sup>20</sup>   | ▶ Watch more television. <sup>48, 152, 161</sup>                   |
| ▶ Eat less fruits and vegetables. <sup>32, 161</sup>   | ▶ Are more likely to watch television while eating. <sup>152</sup> |
|  | ▶ Are more likely to be overweight. <sup>162, 164</sup>            |
|  | ▶ Are more likely to become overweight as adults. <sup>165</sup>   |
-