

Review of the Multi-Level Factors Contributing to Fruit and Vegetable Consumption in the US

Qi Zhang, PhD;* Liulu Fu, BS

School of Community and Environmental Health, Old Dominion University, Norfolk, Virginia

The consumption of fruits and vegetables (F&V) has a significant protective effect in reducing various cardiometabolic diseases. In recent years, the U.S. government has made a lot of effort to promote F&V consumption through different projects and programs, including the *MyPyramid* food guidance system supported by the USDA's Center for Nutrition Policy and Promotion, and the *Fruits & Veggies More Matters* program (previously called the 5-A-Day for Better Health program), supported by the Centers for Disease Control and Prevention (CDC) and other public and private agencies. However, modest success has been achieved in promoting healthy diets among the American public. Only 40% of Americans eat five or more servings of F&V daily. Using a higher-level F&V consumption standard, less than 10% of American adults meet the *MyPyramid* recommendations. In order to understand the factors affecting F&V consumption and to summarize the factors from different perspectives into a coherent framework, we look at previous research regarding these various factors and their relationship to F&V consumption. The factors coalesce in three main levels: individual factors, household factors and environmental factors. Individual factors include demographics, dietary habits, lifestyle, health status and sensory appeal; household factors are marital status, number of family members, number of children in the family and parenting practices; and environmental factors consist of food prices, food accessibility and availability, social interaction and seasonal factors. All of these factors may positively or negatively affect F&V consumption among different population groups. Our study will help future researchers and policy makers to gain a more comprehensive understanding of this complex issue and develop more effect ideas for addressing it.

[N A J Med Sci. 2011;4(4):232-237.]

Key Words: fruit, vegetable, consumption, food intake, US, healthy diet

INTRODUCTION

A diet high in fruits and vegetables (F&V) has a significant protective effect against the risk of various cardiometabolic diseases, including hypertension, stroke, diabetes and peripheral arterial diseases.¹⁻⁸ Due to the substantial health benefits to be gained from a diet high in F&V, promoting F&V consumption remains a top priority for U.S. federal agencies. Recently, the *MyPyramid* food guidance system,¹⁰ supported by the USDA's Center for Nutrition Policy and Promotion, published new dietary guidelines - "The Dietary Guidelines for Americans, 2010" - based on the most recent data from nutritional science, which recommends more than the traditional five servings a day of F&V.¹¹ Another exemplary effort is the *Fruits & Veggies More Matters* program (previously called the 5-A-Day for Better Health program), which is a national partnership between the Centers for Disease Control and Prevention (CDC) and other public and private agencies. The primary objective of this program is to increase public awareness of the health benefits of F&V consumption and provide specific instructions for consumers' daily diet decisions. With the help of these national initiatives to promote F&V consumption, there was a

149% increase in F&V consumption awareness among American adults within a period of six years.¹²

However, although numerous campaigns have promoted Americans' knowledge and awareness, only modest success has been achieved in promoting healthy diets. Only 40% of Americans eat five or more servings of F&V daily,¹³ and the percentage of children and adolescents that meet the USDA's recommendations is significantly lower: Only 1% of boys and 2% of girls aged 9-18 obtain the daily recommended servings of F&V. Using the higher level F&V consumption standard, less than 10% of American adults meet the *MyPyramid* recommendations.¹⁴ People with incomes below the poverty line are at greater risk of failure to meet the recommended levels. Casagrande et al.¹⁵ analyzed data from the National Health and Nutrition Examination Survey (NHANES) III (1988-94) and found that individuals with incomes 2.5 times above the poverty line were significantly more likely to meet the USDA's F&V recommendations compared with individuals below the poverty line ($p < 0.05$). Based on an analysis of the CDC's BRFSS (Behavioral Risk Factor Surveillance System) data, Blanck et al.¹⁶ concluded that overall there was little change in F&V consumption from 1994 through 2005. This finding was consistent with Stables et al.'s result,¹² which indicated a higher F&V consumption

awareness from 1991 through 1997, while, on the other hand, the actual F&V consumption level did not significantly increase after adjustment.

It is therefore important to understand the factors that contribute to F&V consumption patterns. The existing systematic reviews are either outdated¹⁷ or else focus only on the relationship between F&V and certain diseases or targeted population groups.^{8,18} Actually, F&V consumption is governed by a complicated decision-making process that is influenced by individual, household and environmental factors. In this paper, we reviewed the multi-level factors contributing to F&V consumption in the U.S. Although this study is not a strict systematic review, we still hope to provide an up-to-date multi-level perspective on F&V consumption. Policy makers and researchers can design more effective interventions to promote healthy diets and thereby to reduce the incidence of cardiometabolic disorders.

INDIVIDUAL FACTORS

Sociodemographics: Previous research suggests that age, gender, race/ethnicity, urban/rural residency, and socioeconomic status are important demographic factors affecting F&V consumption.^{19,20} Older adults, women and individuals with higher socioeconomic status consume more F&V than younger people, men or those with lower socioeconomic status. Race/ethnicity can also affect dietary behavior because of cultural differences, group norms and psychological factors.²¹ Asian and Hispanic households are more likely to eat vegetables,²²⁻²⁴ while black households have lower F&V intakes.^{13,15,23,25,26}

Dietary habits: Food/dietary habits are complex constructs reflecting numerous cultural, traditional and psychosocial factors affecting food choices.²⁷ Distinct dietary differences exist around the world among different countries and cultures. For example, the norm in Chinese traditional cooking is to prepare dishes from fresh material every day. A combination of meat, vegetables and soup must be included. The Chinese meal is considered to be healthier than the western ones.²⁸ The research by Satia et al. showed that Chinese women living in the U.S. and Canada were still influenced by their cultural food preferences for F&V intake.²⁸ Self-efficacy, which prevents overeating and promotes healthy dietary habits, has also been found to be an important psychosocial factor affecting F&V intake.^{29,30}

Lifestyle: The primary lifestyle factors affecting food choices in the west are time constraints on food shopping and preparation, given the perishable nature of F&V. Unlike processed foods, such as canned food, dry food, frozen food and other foods that have a long shelf life, fresh fruits and vegetables have a more limited storage time and thus require more frequent shopping to replenish supplies. One study determined that individuals believed that more visits to grocery stores were necessary to increase F&V consumption.³¹ However, low-income people facing the pressure of working two or three minimum wage jobs to survive do not have the luxury of shopping several times per

week. Another barrier to increased consumption is preparation time. Although fruit was viewed as convenient to consume, vegetable preparation time was seen as a barrier.³² As a result, more prepackaged and prepared vegetables have been marketed and sold in supermarkets.³³ The increasing supply of processed vegetables may meet the increasing demand for convenient fruits and vegetables.³⁴

Health status: Smoking, Body Mass Index (BMI), and self-rated health status are related to the food choices people make. An individual's health status can be a consequence of his/her lifestyle, which also influences his/her food preferences. For example, people with lower awareness of hypertension take less FV than those have higher awareness, thus have higher risk of hypertension.³⁵ Female smokers consumed less F&V,^{36,37} which may indicate that they place less value on their long-term health status. Healthy people try to eat more nutritious foods, which encourages F&V consumption.³⁸ Obese people tend to underestimate their food intake, including F&V consumption.³⁹ However, optimistic bias - people believing they are less at risk than others for overeating - can also result in overestimation of F&V consumption.⁴⁰

Sensory appeal: Properties of F&V, such as taste, smell and appearance, provide an important way to satisfy consumers,⁴¹ and these were among the most important factors that influenced consumers' food choices.^{42,43} While the taste of fruits is generally perceived as pleasurable, the taste of certain vegetables, such as broccoli and spinach, is considered to be a barrier to their consumption.^{32, 44} These appeal-related factors are especially important for young children,⁴⁵ who are more likely to be affected by the appearance and taste of food and less aware of its nutritional value. Coulthard and Blissett⁴⁶ found that children's sensitivity to food taste and smell moderated the positive relationship between a mother's influence and children's F&V consumption. In other words, children who are more sensitive to food taste and smell rely more on their own preferences rather than parents' eating arrangements for them.

HOUSEHOLD FACTORS

Limited studies have investigated the impact of family structure on F&V consumption, especially how household factors affect children's F&V intake. Generally, married individuals with more family members, especially children, consumed significantly more F&V.^{34,47} Family influence is a key factor in children's F&V consumption.⁴⁸ More than half of the variations in F&V consumption among children could be attributed to family and home environment. Parenting, especially by non-working mothers, could make F&V more available and accessible to children at home. Moreover, parenting practices are recommended as a significant way to increase the F&V consumption of younger children, such as preschoolers.²⁴ Such parenting practices include telling the children taking F&V will make them strong and involving children in food preparation. In summary, household factors mainly contribute to children's F&V intake.

Table 1. Selected Literature on the Associations between Multi-Level Factors and F&V Consumption.

		Selected Factors	References
Individual factors	Demographics	Age (+) * Gender: Women (+) SES (+) Race: Asian and Hispanic (+)	Johansson & Andersen(1998); McClelland et al.(1998); Stewart et al.(2004); Guenther et al.(2006); Casagrande et al.(2007); Kant et al.(2007); Wolf et al.(2008); Quadir and Akhtar-Danesh(2010); O'Connor et al.(2010)
	Dietary habits	Cultures (+/-) Traditions (+/-)	Rozin et al.(1986); Satia et al.(2002); Richert et al.(2010); Bruening et al.(2010); Kiviniemi et al. (2011)
	Life style	Time for food shopping and preparation (+) Frequency of shopping (+)	Heimendinger et al.(1995); Anderson et al.(2000); Mintel (2001); Pollard et al.(2001); Pollack(2001)
	Health status	Smoking (-) BMI (-)	Heitmann et al.(1995); Lennernas et al.(1997); Cox et al.(1998); Baer and Nietert(2002)
	Sensory appeal	Taste, smell and appearance of F&V (+/-) Tastes of fruits (+) Tastes of certain vegetables such as broccoli/spinach (-)	Heimendinger et al.(1995);Drewnowski(1997); Clark(1998); Glanz et al.(1998); French (2003); Brug et al.(2008); Coulthard and Blissett (2009)
Household factors		Married (+) Number of family members (+) Family member with children (+) Parenting practice (+/-)	Devine et al.(1999); Pollard et al.(2001); Coulthard and Blissett(2009); O'Connor et al.(2010)
Environmental factors	Food price	Food cost (-) Income level (+)	Glanz et al.(1998); Putnam et al.(1999); French(2003); Drewnowski et al.(2004, 2005); Pearson et al.(2005); Powell et al.(2009);
	Accessibility and availability	Distance to reach grocery (-) Availability of F&V (+)	Leather(1995); Morland et al.(2002); Pearson et al.(2005);Zenk et al.(2005);Bodor et al.(2008);Backman et al.(2011)
	Social interaction	The dietary habits and fitness of surrounded friends (+/-) Neighborhood socioeconomic status (+) Media / advertisements (+)	Anderson et al.(1994); Lindstrom et al.(2001); Eisenberg et al.(2005); Kamphuis et al.(2006); Sorensen et al.(2007); Dubowitz et al.(2008); Litt et al.(2011)
	Seasonal factors	Summer (+)	Ziegler et al.(1987); Willett(1990); Joachim(1997); Uetrecht et al.(1999); Givens et al.(2007); Locke et al.(2009)

*(+)/(-) indicates the specific factor is positively/negatively related with the F&V consumption

ENVIRONMENTAL FACTORS

Food price: Food cost is a major factor, second only to taste, in determining food choices, especially for income-constrained groups.^{42,43,49} Lower energy density foods, which is to say healthier foods such as F&V, are associated with higher costs.⁵⁰ The relative cost disparity between F&V and energy-dense foods has led to a higher percentage of low-income populations purchasing high density foods that are high in fat and sugar.⁵¹ Poverty combined with the high cost of F&V may explain the disparity in obesity, as well as other

health disparities across socioeconomic status in the US.⁵² Because of the strong relationship between food price and F&V consumption, consumers are quite responsive to

changes in F&V prices, as reflected by French's study,⁴³ which found that a 50% reduction in price resulted in a four-fold increase in fruit sales and a two-fold increase in vegetable sales. Price sensitivity also varies by socioeconomic status. Young adults with lower income or education or with lower family socioeconomic status as measured by their mothers' education and parental income were more sensitive to the price of F&V than their peers with higher socioeconomic status.⁴⁹

Accessibility and availability: Location, access and food availability of grocery stores are all related to F&V consumption. Low-income populations that lack adequate transportation are more likely to utilize high-cost

convenience stores instead of accessing supermarkets that are further away but offer more choices and lower-priced F&V.⁵³ This is consistent with the research by Zenk et al,⁵⁴ who investigated a low-income African American community in the Detroit area and found that women shopping at supermarkets consumed more F&V than the ones choosing other types of grocery stores. Research indicated that additional supermarkets in a census tract increased F&V consumption by 32% among local residents.⁵⁵ However, the supermarket effect may not be found in all metropolitan areas. Bodor et al⁵⁶ examined household data from New Orleans and found an insignificant effect of supermarket availability on F&V consumption. Possible explanations for this result include low supermarket penetration in New Orleans. With the absence of supermarkets, F&V availability in neighborhood food stores was positively associated with F&V consumption. New efforts have been proposed to increase F&V availability and accessibility in workplaces, especially for low-income populations. When employers provided an available fruit supply in workplaces, the F&V intake increased for the low-income employees.⁵⁷

Social interaction: Social norms are considered to be significant factors in F&V consumption because of how they affect people's behavior patterns.⁵⁸ People are influenced by the surrounding environment through social pressures, social norms and fashions. These social interaction factors affect individuals' food preferences directly (e.g., the 5-A-Day project) or indirectly. In general, students who participate in school meal programs are more likely to intake healthy food include fruits and vegetables than those who don't participate.⁵⁹ Furthermore, in a school community environment girls are more likely affected by their friends in terms of dietary habit and fitness, which will potentially affect their F&V intake.⁶⁰ More specifically, an individual's F&V consumption is positively affected by positive social capital in high-SES neighborhoods.⁶¹ On the other hand, residents in disadvantaged neighborhoods consumed fewer F&V.^{62, 63} This negative effect is partly because the social pressure to increase F&V was low in those neighborhoods.⁶⁴ Litt et al.⁶⁵ suggest that there was a significant relationship between social factors and F&V consumption if there was a community garden for F&V instead of home gardens. Another barrier to F&V consumption is the lack of high branding of F&Vs in media and advertisements, leading some consumers to perceive F&V as "boring" or "old fashioned".⁶⁶

Seasons: The seasonal factor in F&V consumption is especially influential in agricultural communities.⁶⁷ The amount of fruit and vegetable supply, the quality of produce available and prices vary in different seasons, therefore F&V consumption also changes seasonally. Most customers consumed comparatively greater amounts of F&V during summer, while consuming less in the winter.⁶⁸ Several studies have assessed seasonal consumption of F&V. One cohort-study of 888 white men in New Jersey⁶⁹ found that consumers could be categorized into two groups: year-round versus seasonal consumers. For seasonal consumers, median servings of F&V per month (out of season) were nearly 0 for

the most common F&V. For year-round consumers, median frequency of F&V consumption in season was up to 200% greater than out-of-season consumption. A longitudinal study of children in Washington State suggested a 50% increase in fruit intake in the summer ($p < 0.001$), as assessed by evaluation of food diaries maintained every 7 to 15 days for a year.⁷⁰ Seasonal variations in F&V intake could greatly affect reported F&V consumption, if such information is collected at different times of the year.^{67,71-73} For example, when a specific food is seasonally not available, measuring the intake of that food at that time would yield biased results, since the answer reflects this availability rather than the intent to purchase.

CONCLUSION

The consumption of F&V, which has been widely accepted to be related with healthy life and lower diseases, is comprehensively influenced by factors of different levels. The individual factors, household factors and environmental factors all play important role for F&V intake. Current F&V consumption in the US is low compared to the recommended levels. In order to encourage a healthier diet style and higher F&V intake among Americans, individual, household or environmental factors should be considered. In other words, all social forces should work together to raise the awareness of the importance of eating F&V, creating the availability of low-priced F&V and eventually increase the assumption of F&V in the US. More research is needed to find the effective interventions to promote F&V consumptions among Americans.

CONFLICT OF INTEREST

None.

REFERENCES

1. Appel LJ, Moore TJ, Obarzanek E, et al. A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med.* 1997;336(16):1117-1124.
2. Joshipura KJ, Ascherio A, Manson JAE, et al. Fruit and vegetable intake in relation to risk of ischemic stroke. *J Am Med Assoc.* 1999;282(13):1233-1239.
3. Joshipura KJ, Hu FB, Manson JAE, et al. The effect of fruit and vegetable intake on risk for coronary heart disease. *Ann Intern Med.* 2001;134(12):1106-1114.
4. Merchant AT, Hu FB, Spiegelman D, et al. Dietary fiber reduces peripheral arterial disease risk in men. *J Nutr.* 2003;133(11):3658-3663.
5. Liu S, Serdula M, Janket SJ, et al. A prospective study of fruit and vegetable intake and the risk of type 2 diabetes in women. *Diabetes Care.* 2004;27(12):2993-2996.
6. Dauchet L, Amouyel P, Dallongeville J. Fruit and vegetable consumption and risk of stroke. *Neurology.* 2005;65(8):1193-1197.
7. Dauchet L, Amouyel P, Hercberg S, et al. Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohort studies. *J Nutr.* 2006;136(10):2588-2593.
8. He FJ, Nowson CA, MacGregor GA. Fruit and vegetable consumption and stroke: meta-analysis of cohort studies. *Lancet.* 2006;367(9507):320-326.
9. Griep LMO, Verschuren W, Kromhout D, et al. Raw and processed fruit and vegetable consumption and 10-year stroke incidence in a population-based cohort study in the Netherlands. *Eur J Clin Nutr.* 2011;65(7):791-799.
10. USDA. MyPyramid. <http://www.mypyramid.gov/index.html>. Accessed on January 15, 2009.
11. US DHHS, US Department of Agriculture. Dietary Guidelines for Americans. <http://www.health.gov/dietaryguidelines/>. Accessed on October 20, 2011.

12. Stables GJ, Subar AF, Patterson BH, et al. Changes in vegetable and fruit consumption and awareness among US adults: results of the 1991 and 1997 5-A-Day for Better Health Program surveys. *J Am Diet Assoc.* 2002;102(6): 809-817.
13. Guenther PM, Dodd KW, Reedy J, et al. Most Americans eat much less than recommended amounts of fruits and vegetables. *J Am Diet Assoc.* 2006;106(9): 1371-1379.
14. Kimmons J, Gillespie C, Seymour J, et al. Fruit and vegetable intake among adolescents and adults in the United States: percentage meeting individualized recommendations. *Medscape J Med.* 2009;11(1): 26.
15. Casagrande SS, Wang Y, Anderson C, et al. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. *Am J Prev Med.* 2007;32(4): 257-263.
16. Blanck HM, Gillespie C, Kimmons JE, et al. Trends in fruit and vegetable consumption among US men and women, 1994–2005. *Prev Chronic Dis.* 2008;5(2): A35.
17. Ness AR, Powles JW. Fruit and vegetables, and cardiovascular disease: a review. *Int J Epidemiol.* 1997;26(1): 1-13.
18. Knai C, Pomerleau J, Lock K, et al. Getting children to eat more fruit and vegetables: a systematic review. *Prev Med.* 2006;42(2): 85-95.
19. Johansson L, Andersen LF. Who eats 5 a day? Intake of fruits and vegetables among Norwegians in relation to gender and lifestyle. *J Am Diet Assoc.* 1998;98(6):689-691.
20. McClelland JW, Demark-Wahnefried W, Mustian RD, et al. Fruit and vegetable consumption of rural African Americans: baseline survey results of the black churches united for better health 5-A-Day project. *Nutr Can.* 1998;30(2):148-157.
21. Kiviniemi MT, Orom H, Giovino GA. Race/ethnicity, psychological distress, and fruit/vegetable consumption. The nature of the distress-behavior relation differs by race/ethnicity. *Appetite.* 2011;56(3):737-740.
22. Stewart H, Harris JM, Guthrie J. What determines the variety of a household's vegetable purchases? 2004; Agriculture Information Bulletin Number 792–793, Economic Research Service, U.S. Department of Agriculture, Washington, DC.
23. Qadir T, Akhtar-Danesh N. Fruit and vegetable intake In Canadian Ethnic Populations. *Can J Diet Pract Res.* 2010;71(1):11-16.
24. O'Connor TM, Hughes SO, Watson KB, et al. Parenting practices are associated with fruit and vegetable consumption in pre-school children. *Public Health Nutr.* 2010;13(1): 91-101.
25. Kant AK, Graubard BI, & Kumanyika SK. Trends in black-white differentials in dietary intakes of US adults, 1971-2002. *Am J Prev Med.* 2007;32(4): 264-272.
26. Wolf RL, Lepore SJ, Vandergrift JL, et al. Knowledge, barriers, and stage of change as correlates of fruit and vegetable consumption among urban and mostly immigrant black men. *J Am Diet Assoc.* 2008; 108(8):1315-1322.
27. Rozin P, Vollmecke TA. Food likes and dislikes. *Ann Rev Nutr.* 1986;6(1):433-456.
28. Satia JA, Kristal AR, Patterson RE, et al. Psychosocial factors and dietary habits associated with vegetable consumption. *Nutrition.* 2002;18(3):247-254.
29. Richert J, Reuter T, Wiedemann AU, et al. Differential effects of planning and self-efficacy on fruit and vegetable consumption. *Appetite.* 2010;54(3):611-614.
30. Bruening M, Kubik MY, Kenyon D, et al. Perceived barriers mediate the association between self-efficacy and fruit and vegetable consumption among students attending alternative high schools. *J Am Diet Assoc.* 2010;110(10):1542-1546.
31. Anderson AS, Cox D. Five a day—challenges and achievements. *Nutr Food Sci.* 2000;30(1):30-34.
32. Heimendinger J, Van Duyn M. Dietary behavior change: the challenge of recasting the role of fruit and vegetables in the American diet. *Am J Clin Nutr.* 1995;61(6):1397S-1401S.
33. Mintel. Fresh Fruit and Vegetables - UK - May 2007. London: Mintel International Group Ltd.
34. Pollack SL. Consumer demand for fruit and vegetables: the US example. In: *Changing Structure of Global Food Consumption and Trade.* 2001. 49-54.
35. Dickson BK, Blackledge J, Hajjar IM. The impact of lifestyle behavior on hypertension awareness, treatment, and control in a southeastern population. *Am J Med Sci.* 2006;332(4):211-215.
36. Pollard J, Greenwood D, Kirk S, et al. Lifestyle factors affecting fruit and vegetable consumption in the UK women's cohort study. *Appetite.* 2001;37(1):71-79.
37. Baer D, Nietert PJ. Patterns of fruit, vegetable, and milk consumption among smoking and nonsmoking female teens. *Am J Prev Med.* 2002;22(4):240-246.
38. Lennernäs M, Fjellström C, Becker W, et al. Influences on food choice perceived to be important by nationally-representative samples of adults in the European Union. *Eur J Clin Nutr.* 1997;51: S8-S15.
39. Heitmann BL, Lissner L. Dietary underreporting by obese individuals - is it specific or non-specific? *Brit Med J.* 1995; 311(7011):986-989.
40. Cox DN, Anderson AS, Lean MEJ, et al. UK consumer attitudes, beliefs and barriers to increasing fruit and vegetable consumption. *Public Health Nutr.* 1998;1(1): 61-68.
41. Clark JE. Taste and flavour: their importance in food choice and acceptance. *Proc Nutr Soc.* 1998;57(4): 639-643.
42. Glanz K, Basil M, Maibach E, et al. Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. *J Sm Diet Assoc.* 1998;98(10):1118-1126.
43. French SA. Pricing effects on food choices. *J Nitr.* 2003;133(3):841S-843S.
44. Drewnowski A. Taste preferences and food intake. *Annual Review of Nutrition.* 1997;17(1):237-253.
45. Brug J, Tak NI, Velde S, et al. Taste preferences, liking and other factors related to fruit and vegetable intakes among schoolchildren: results from observational studies. *Brit J Nutr.* 2008;99(Suppl 1):S7-S14.
46. Coulthard H, Blissett J. Fruit and vegetable consumption in children and their mothers. Moderating effects of child sensory sensitivity. *Appetite.* 2009;52(2): 410-415.
47. Devine CM, Wolfe WS, Frongillo E. A. Life-course events and experiences: association with fruit and vegetable consumption in 3 ethnic groups. *J Am Diet Assoc.* 1999;99(3): 309-314.
48. Gross SM, Pollock ED, Braun B. Family influence: Key to fruit and vegetable consumption among fourth- and fifth-grade students. *J Nutr Educ Behav.* 2010;42(4): 235-241.
49. Powell LM, Zhao Z, & Wang Y. Food prices and fruit and vegetable consumption among young American adults. *Health Place.* 2009; 15(4):1064-1070.
50. Drewnowski A, Darmon N. The economics of obesity: dietary energy density and energy cost. *Am J Clin Nutr.* 2005;82(1): 265S-273S.
51. Putnam J, Allshouse J. Food Consumption, Prices, and Expenditure, 1970-97. Economic Research Services, Washington, DC: Food and rural and economic division, USDA Statistical Bulletin 965; 1999.
52. Drewnowski A, Specter S. Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr.* 2004;79(1):6-16.
53. Leather S. Fruit and vegetables: consumption patterns and health consequences. *Brit Food J.* 1995;97(7):10-17.
54. Zenk SN, Schulz AJ, Hollis-Neely T, et al. Fruit and vegetable intake in African Americans: income and store characteristics. *Am J Prev Med.* 2005;29(1):1-9.
55. Morland K, Wing S, Roux AD. The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. *Am J Public Health.* 2002;92(11): 1761-1767.
56. Bodor JN, Rose D, Farley TA, et al. Neighborhood fruit and vegetable availability and consumption: the role of small food stores in an urban environment. *Public Health Nutr.* 2008;11(4): 413-420.
57. Backman D, Gonzaga G, Sugerman S, et al. Effect of fresh fruit availability at worksites on the fruit and vegetable consumption of low-wage employees. *J Nutr Educ Behav.* 2011;43(4):S113-S121.
58. Sorensen G, Stoddard AM, Dubowitz T, et al. The influence of social context on changes in fruit and vegetable consumption: results of the healthy directions studies. *Am J Public Health.* 2007;97(7):1216-1227.
59. Condon EM, Crepinsek MK, Fox MK. School meals: types of foods offered to and consumed by children at lunch and breakfast. *J Am Diet Assoc.* 2009;109(2):S67-S78.
60. Eisenberg ME, Neumark-Sztainer D, Story M, et al. The role of social norms and friends' influences on unhealthy weight-control behaviors among adolescent girls. *Soc Sci Med.* 2005;60(6):1165-1173.
61. Dubowitz T, Heron M, Bird CE, et al. Neighborhood socioeconomic status and fruit and vegetable intake among whites, blacks, and Mexican Americans in the United States. *Am J Clin Nutr.* 2008;87(6): 1883-1891.
62. Kamphuis CB, Giskes K, De Bruijn GJ, et al. Environmental determinants of fruit and vegetable consumption among adults: a systematic review. *Br J Nutr.* 2006;96(4):620-635.

63. Kamphuis C, van Lenthe FJ, Giskes K, et al. Perceived environmental determinants of physical activity and fruit and vegetable consumption among high and low socioeconomic groups in the Netherlands. *Health Place*. 2007;13(2):493-503.
64. Lindström M, Hanson BS, Wirfält E, et al. Socioeconomic differences in the consumption of vegetables, fruit and fruit juices. *Eur J Public Health*. 2001;11(1):51-59.
65. Litt JS, Soobader MJ, Turbin MS, et al. The influence of social involvement, neighborhood aesthetics, and community garden participation on fruit and vegetable consumption. *Am J Public Health*. 2011;101(8):1466-1473.
66. Anderson AS, Marshall D, Lean M, et al. Five a day? Factors affecting fruit and vegetable consumption in Scotland. *Nutrition & Food Science*. 1994;94(5):14-16.
67. Locke E, Coronado GD, Thompson B, et al. Seasonal variation in fruit and vegetable consumption in a rural agricultural community. *J Am Diet Assoc*. 2009;109(1):45-51.
68. Uetrecht CL, Greenberg M, Dwyer JJM, et al. Factors influencing vegetable and fruit use: implications for promotion. *Am J Health Behav*. 1999;23(3):172-181.
69. Ziegler R, Wilcox H, Mason T, et al. Seasonal variation in intake of carotenoids and vegetables and fruits among white men in New Jersey. *Am J Health Behav*. 1987;45(1): 107-114.
70. Givens ML, Lu C, Bartell SM, Pearson MA. Estimating dietary consumption patterns among children: a comparison between cross-sectional and longitudinal study designs. *Environ Res*. 2007;103(3):325-330.
71. Willett WC. Nature and variation in diet. In *Nutritional Epidemiology Monographs*. In: *Epidemiology and Biostatistics*. London: Oxford University Press;1990.
72. Joachim G. The influence of time on dietary data: differences in reported summer and winter food consumption. *Nutr Health*. 1997; 12(1):33-43.
73. Joachim G. Supply and demand: a framework for explaining variability in dietary intake and its impact on data. *Nutr Health*. 1997;11(4):289-299.