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Perceived Social Ecological Factors Associated with Fruit and Vegetable Purchasing, Preparation, and Consumption among Young Adults

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Abstract

Most young adults do not consume recommended levels of fruits and vegetables (FV), and interventions to increase FV-related behaviors among this understudied population are needed. Therefore, it is important to identify correlates of FV intake among young adults to guide intervention development. This cross-sectional study utilized data from an online survey to identify factors related to young adults' FV purchasing, preparation, and consumption, and to explore between-factor relationships using mediation analysis. In 2010, 1201 college students in Minnesota completed questionnaires assessing FV behaviors, as well as perceptions of FV-related individual, social, and environmental factors. Factor analysis identified questionnaire items assessing similar constructs. Seven factors were identified (personal barriers, FV knowledge, family, friends, neighborhood, access barriers, and campus) and evaluated for relationships with FV purchasing, preparation, and consumption using linear regression. Results revealed that perceived personal barriers (e.g., lacking cooking skills) were inversely related to all FV outcomes. Perception that family and friends eat healthfully and neighborhood access to FV were positively related to all outcomes. Individual-, social-, and environmental-level perceptions were related to purchasing, preparation, and consumption, and the effects of these factors were similar when accounting for mediated effects. Factors at all three levels and the ways in which these

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various factors operate together may be important to consider in future efforts to improve FV behaviors among young adults.

Keywords

fruit and vegetable; young adult; correlates; factor analysis

INTRODUCTION

Fruit and vegetable (FV) consumption is positively related to many health outcomes; individuals who consume FV at recommended levels have lower risk of chronic health conditions including diabetes,^{1–3} hypertension,^{4–6} obesity,^{7,8} cardiovascular disease,^{9–14} and cancers.^{15–19} Despite the benefits of a FV-rich diet, only ~10% of U.S. young adults (aged 19–30) consume the recommended two cups of fruit and two to three cups of vegetables daily.²⁰

The present study was guided by the social-ecological premise that individuals interact with multiple, nested levels of influence (e.g., individuals exist within social networks which exist within surrounding environments) that affect their health behaviors.^{21,22} A social-ecological framework posits that individual, social, and environmental factors are associated with FV intake. Research has supported this contention, identifying the following factors as related to FV consumption: taste,^{23–26} knowledge of dietary recommendations, social support,^{27,28} behavior modeling,^{29,30} price,³¹ and both home and neighborhood availability of FV.^{24,32–36}

Most of the existing research on FV behaviors comes from data on children, adolescents, and adults, with very little research on individuals transitioning from adolescence to adulthood.³⁷ Eating behaviors during this transition period are important to understand, as national data indicate the late teens/early twenties as a time when obesity and poor dietary practices develop.³⁸ Little is known about the factors influencing young adult FV intake and whether they resemble factors influencing adolescent or adult intake, or a hybrid. Despite this, young adult dietary patterns have recently received increasing attention.^{39–43} For example, Larson et al. found that individual and socioenvironmental factors, including food preferences and home food availability, longitudinally predict young adults' FV intake.⁴⁴

The present study's purpose was to identify key factors associated with young adult FV purchasing, preparation, and consumption and the inter-relationships among these factors. This work contributes to the literature by examining the multifaceted correlates of three FV-related outcomes and simultaneously considering participants' perceptions of multiple levels of influence (i.e., individual, social, environmental) on FV behaviors. It was hypothesized that young adults reporting fewer FV-related barriers and more positive social norms for FV consumption would purchase, prepare, and consume more FV than those perceiving more barriers and less-positive social norms. Consistent with social-ecological theory and previous research,^{45,46} we hypothesized that the most-proximal, individual-level factors would demonstrate stronger direct relationships with the outcomes, followed by social factors, and finally by the most-distal, environmental factors. It was additionally hypothesized that more distal factors would display indirect effects on the outcomes that would be partially mediated by more-proximal factors.⁴⁷

METHODS

Participants

Recruitment for this cross-sectional study occurred during 2010 in Minneapolis/St. Paul Minnesota on two college campuses. Trained data collectors stationed on campus invited a diverse convenience sample of 1201 students (598 two-year community college and 603 four-year public university students) to participate and complete an online survey.

Procedures

Students were offered a \$50 gift card and entry into a drawing for a mobile digital device for completing a 30–35 minute survey on nutrition and weight-related issues and having their height and weight measured. Participants provided online consent before the survey, and were required to enter their student ID numbers to begin the survey. Upon survey completion, trained data collectors checked students' photo IDs before weighing and measuring participants, and before providing them with gift cards for participating. This process minimized the risk that students had a different person complete the survey on their behalf. An expert team developed the survey, which contained questions related to students' health behaviors, as well as those of their friends and family, and included items adapted from previous studies and formative work with young adults. Before data collection, several young adults piloted the survey by completing it in full and providing feedback on wording, length, ease of use, and interpretability of survey items. Study procedures were approved by the University of Minnesota Institutional Review Board.

Measures

Outcomes: FV Purchasing, Preparation, and Consumption—Participants were asked two questions about previous-month FV purchasing (one each about fruits and vegetables). Responses were summed, creating a composite “purchasing” variable. One item assessed participants' preparation of meals that included vegetables, adapted from an item used in Project EAT (Eating Among Teens and Young Adults), a large, 10-year longitudinal study of adolescents transitioning to adulthood.⁴⁸ Participants reported previous-month FV consumption using the Five Factor Screener from the 2005 National Health Interview Survey Cancer Control Supplement;⁴⁹ a summary variable (FV servings per day) was created based on this validated scale.⁵⁰

Predictors: Individual, Social, and Environmental Factors—Individual-level variables included: perceived personal barriers regarding FV purchasing, preparation, and consumption (See Table 1, Factor 1), perceived need for FV (Table 1, Factor 2), and confidence in ability to locate and select high-quality FV at the store (Table 1, Factor 3). Social variables (adapted from previous work)⁵¹ assessed dietary behaviors of family and friends (Table 1, Factors 3 and 4). Respondents who indicated that they “did not know” their family/friends' dietary behaviors were not included in analyses using these variables. Environmental variables addressed participants' perceptions of availability, quality, and affordability of FV in their neighborhood (Factor 5), in nearby stores (Factor 6), and on campus (Factor 7).^{52,53}

Demographics

Participants self-reported sex, age, race, ethnicity, and living arrangement.

Factor Analysis

A principal components factor analysis with Varimax rotation⁵⁴ and 25 iterations informed creation of composite variables representing unique correlates of FV purchasing,

preparation, and consumption. The factor analysis was exploratory; the number of factors that might underlie the scale was not specified a priori, in order to determine the factor structure best supported by the data. A data-driven approach was employed to identify the factors, but it was subsequently verified that these factors were largely in line with the pattern predicted by social-ecological theory. Eighteen items listed in Table 1 and described above were entered separately, producing a seven factor solution. Based on the factor loadings obtained via factor analysis (Table 2), composite variables were created in which all items loading most highly on the same factor were standardized and their mean became the score. This strategy produced seven composite factors (1. personal barriers – such as lacking preparation skills; 2. knowledge of FV recommendations – hereafter called FV knowledge; 3. family eating habits – hereafter family; 4. friends' diet – hereafter friends; 5. neighborhood access to affordable FV – hereafter neighborhood; 6. access barriers – such as quality and variety of FV; and 7. on-campus access to affordable FV – hereafter campus) from items grouping together statistically.⁵⁵ Because the factor analysis was data-driven, some of the items that loaded most heavily on a particular factor were grouped together in ways that may appear inconsistent (e.g., “Selection Confidence” and “In-Store Availability” loaded most heavily on family); these items were not placed into other factors because the pattern of results indicated that the factor analysis had largely identified seven theoretically appropriate dimensions.

Statistical Analyses

Primary analyses were linear regression and Sobel's partial mediation tests.⁵⁶ Prior to analysis, each outcome variable (i.e., purchasing, preparation, consumption; see Table 3) was square-root transformed to adjust for positive skew. A *p*-value of <.05 was considered statistically significant.

The seven composite variables and control variables (sex, age, race and ethnicity) were the independent variables in linear regression analyses separately modeling each FV outcome. To test whether more-distal factors were related to the outcomes in part through their relationships with more-proximal factors (potentially resulting in underestimating the more-distal factors' total effects), Sobel's partial mediation tests were conducted for each more-distal factor through each more-proximal factor. For example, the association between neighborhood factors and the three FV outcomes was examined for mediation by family, friends, personal barriers, and FV knowledge; the percent of the distal factor's effect found to be mediated by one or more of the more-proximal variables is reported in Table 3. All analyses were conducted in 2012 using SPSS version 19.0.0.1 (2011, SPSS Inc., Chicago, IL).

RESULTS

Participant mean age was 21.5 ± 5.0 years (range 17–51); racial/ethnic composition was 41% White, 19% Black, 27% Asian, and 13% other (including Hispanic); and 53% of participants were females. Compared to the overall student populations at the recruited schools, study participants were younger and more representative of racial and ethnic minorities, but gender distributions were similar; additional participant information was published previously.⁴⁹ Of study participants, 11% lived on campus, 47% lived off campus with a parent/guardian, 7% lived off campus with other (non-parent/guardian) family members, and 35% lived off campus independently (with friends, significant others, their own children, or alone). In addition, 74% of participants who lived with their parents or other family members reported purchasing food from a supermarket, convenience store, superstore, or cooperative grocery store at least once per week, and 68% reported preparing a meal at home at least once per week.

Regression results indicated that the direct effects of personal barriers, friends, family, and neighborhood were significantly related to all three outcomes (Table 3). All of these relationships were in the expected direction; those who perceived fewer barriers, more-healthy family and friend dietary behaviors, and greater neighborhood FV accessibility were more likely to purchase, prepare, and consume FV. In addition, FV knowledge was positively related to preparation. Counterintuitively, perceived access barriers were positively related to all three outcome variables, although this relationship reached statistical significance for consumption only ($p < .05$).

Sobel's tests indicated statistically significant partial mediation of the relationships between three more-distal factors (family, neighborhood, and access barriers) and each outcome. Recommended procedures were employed to determine the total effect of these partially-mediated variables on the FV outcomes, and the proportion of effects mediated through one or more of the more-proximal variable(s)^{57,58} (see Table 3). The total effects of two factors, access barriers and family, on all three outcomes were mediated by personal barriers. The total effects of the neighborhood environment were mediated by family, friends, and personal barriers.

The seven derived factors explained 8%, 17%, and 6% of the variance in FV purchasing, preparation, and consumption, respectively (Table 3). When assessed together with demographic covariates, these variables explained 11%, 18%, and 11% of the variance in purchasing, preparation and consumption.

DISCUSSION

Findings in this study suggest perceptions of individual, social, and environmental factors are related to FV purchasing, preparation, and consumption. Results partially supported the hypothesis that factors at more-proximal levels of influence would demonstrate stronger relationships with FV behaviors compared to less-proximal factors. Personal barriers to FV behaviors were indeed among the strongest correlates of all three outcomes; however, the other individual-level composite variable, FV knowledge, was not a consistent correlate of FV outcomes. More-distal social and environmental factors displayed consistent relationships with the outcomes. Specifically, the calculations of total effect size indicated that the effects of friends, family, neighborhood, and access barriers on FV-related behaviors were often comparable to the effects of more-proximal, individual-level factors.

The influence of friends' diet on each of the three FV outcomes exceeded the influence of the family factor. These results are consistent with previous research^{44,59} suggesting that it is important to consider the unique life circumstances and important social influences of young adults in understanding their FV-related behaviors. Although parents' early-life influence persists into young adulthood, perceptions of friends' diets, as opposed to family, may relate more strongly or to a greater variety of young adult FV behaviors.^{60,61} The greater influence of friends over family may emerge in young adults due to the relatively larger amount of time spent with friends. The present results also suggest that the family influence on FV-related behaviors may manifest in indirect ways, such as through perceptions of personal barriers like lack of meal preparation skills. The findings indicating that perceived neighborhood barriers to accessing FV (e.g., FV price), are negatively related to FV consumption correspond with previous research⁶² Likewise, with regard to meal preparation skills, the present results fit with previous research indicating that perceived lack of cooking skills relates to poorer dietary quality among young adults.⁶³

Consistent with previous work,⁴³ associations between environmental factors and the FV-related outcomes in this study suggest that young adults' food environments are complex,

and that the areas in which students live, attend classes, and shop for foods may have unique relationships with dietary outcomes. For example, a previous study found that students' frequency of purchasing foods/beverages on campus was negatively associated with dietary quality, but was not associated with perceived healthfulness of the campus environment;⁶¹ this finding suggests that factors other than perceived healthfulness, such as convenience, taste, or cost, influence students' decisions about where to purchase food. Similarly, the seemingly counterintuitive finding of greater FV consumption among participants reporting poorer access to high-quality and affordable FV could derive from the increased salience of issues of price, variety, and quality among frequent FV purchasers. An analogous finding has been reported in the physical activity literature, wherein highly active individuals are more likely to perceive and report barriers to activity in their neighborhood environment.⁶⁴

Practitioners applying these results should consider the combined effects of environmental perceptions and personal barriers on FV behaviors. For example, combining education about where to find inexpensive FV with skill-building activities for FV preparation may improve FV-related behaviors. In addition, practitioners may benefit from directing individuals to take note of family and friends' FV consumption. Psychological research suggests that individuals are more likely to notice and recall phenomena they are actively looking for;⁶⁵ thus, by looking out for FV consumption around them, individuals are more likely to note and recall this behavior, increasing their perceptions of friends' and family members' FV consumption, which was shown here to increase the target individual's FV behaviors. This strategy of harnessing selective attention to increase perceptions of friends' and family members' FV consumption is attractive because even if the FV consumption of friends and family members in question does not increase objectively, young adults' may perceive an increase simply because they are paying greater attention to this behavior.

Another important implication of these results, particularly given that young adults may not seek out dietary advice from dietitians and other health professionals, is that environmental modifications may influence young adults' FV-related behaviors. Increasing availability and visibility of FV in campus and workplace cafeterias and the places young adults shop for food could increase the perceived availability of FV. In addition, shifting social norms about FV consumption among this population is also likely important; possible means of shifting norms around healthy eating may include targeted social marketing campaigns and/or campus campaigns promoting placing and consuming FV in conspicuous containers and in locations easily seen by young adults.^{66–68} Environmental modifications could impact young adults' FV consumption directly (e.g., by serving FV at meals) and indirectly (e.g., by influencing the perceptions young adults hold about availability and normative consumption of FV).

This study contributes to the literature on FV behavior by examining perceptions of multiple levels of influence together; by assessing a young adult population; and by considering three separate FV-related outcomes. The inclusion of multiple outcomes, rather than only consumption, allows for a better understanding of the potential roadblocks inhibiting young adult FV behavior. For example, identifying personal barriers as a key direct and indirect factor in FV preparation has intervention implications (e.g., that skills training for young adults may be a fruitful way to increase FV preparation). Further, lack of knowledge regarding FV intake may be less of an impediment to purchasing and consumption for students than perceived barriers such as believing vegetables taste bad or spoil quickly. Using previously validated measures (e.g., to assess FV consumption)⁴⁹ was a study strength. In addition, by analyzing direct and mediated relationships between these factors and outcomes, this study underscores the importance of understanding connections between factors often treated as separate influences on FV behaviors.

Despite these strengths, this study is limited by the cross-sectional study design, prohibiting statements regarding temporality of relationships. Also, the study relied on self-reported data that are vulnerable to reporting biases. While some measures used were previously validated, others were not. The measure of FV preparation was a single item; thus it could not be identified which specific fruits and vegetables were prepared. In addition, although college campuses represent important venues for reaching large, diverse populations of young adults, these results may not generalize to those not attending college or those attending schools in other geographic areas. Furthermore, factors other than those assessed may explain variation in FV purchasing, preparation, and consumption. Indeed, the proportions of variance explained (5 – 16%), though consistent with those seen in other work,⁴⁴ indicate that important factors were missing. Finally, survey items provided data on participants' perceptions of their social and physical environments; although these perceptions relate more closely to health behaviors than objective measures of the environment,⁶⁹ more objective environmental information could help paint a fuller picture of the influences on young adult FV-related behaviors.

Future research into predictors of FV purchasing, preparation, and consumption among young adults could benefit from longitudinally sampling both individuals enrolled in college and those not attending college. In addition, including multiple measures of individual-, social-, and environmental-level factors could help identify key targets for interventions to promote greater FV intake. To date, most interventions targeting young adults have focused primarily on individual-level factors and delivery;⁷⁰ results from this and other research⁴⁴ suggest that multilevel interventions designed to change individual, social and environmental factors related to FV-related behaviors may be more successful. This could include messaging tailored to common barriers, targeting peer and social networks rather than individuals, and/or making environmental changes such as providing point-of-purchase food labeling or changing the layout of stores to more prominently display FV.

CONCLUSIONS

Young adults' perceptions of individual-, social-, and environmental-level factors are related to their FV purchasing, preparation, and consumption. Consistent with social-ecological theory, perceptions of various levels of influence are inter-related and effects of more-distal levels are partially mediated through more-proximal factors. When direct and indirect effects are taken together, the relative magnitudes of relationships between FV behaviors and perceptions of certain individual, social, and environmental factors (i.e., personal barriers, family, friends' diet, neighborhood, and access barriers) are quite similar. Future work attempting to improve FV behaviors should consider factors at all three levels and the ways in which these factors operate together.

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References

1. Carter P, Gray LJ, Troughton J, Khunti K, Davies MJ. Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis. *BMJ*. 2010; 341:c4229. [PubMed: 20724400]

2. Ford ES, Mokdad AH. Fruit vegetable consumption and diabetes mellitus incidence among U.S adults. *Prev Med.* 2001; 32(1):33–39. [PubMed: 11162324]
3. Harding AH, Wareham NJ, Bingham SA, et al. Plasma vitamin C level, fruit and vegetable consumption, and the risk of new-onset type 2 diabetes mellitus: the European prospective investigation of cancer--Norfolk prospective study. *Arch Intern Med.* 2008; 168(14):1493–1499. [PubMed: 18663161]
4. Appel LJ, Champagne CM, Harsha DW, et al. Effects of comprehensive lifestyle modification on blood pressure control: main results of the PREMIER clinical trial. *J Am Med Assoc.* 2003; 289(16):2083–2093.
5. Utsugi MT, Ohkubo T, Kikuya M, et al. Fruit and vegetable consumption and the risk of hypertension determined by self measurement of blood pressure at home: the Ohasama study. *Hypertens Res.* 2008; 31(7):1435–1443. [PubMed: 18957815]
6. Elmer PJ, Obarzanek E, Vollmer WM, et al. Effects of comprehensive lifestyle modification on diet, weight, physical fitness, and blood pressure control: 18-month results of a randomized trial. *Ann Intern Med.* 2006; 144(7):485–495. [PubMed: 16585662]
7. Buijsse B, Feskens EJ, Schulze MB, et al. Fruit and vegetable intakes and subsequent changes in body weight in European populations: results from the project on Diet, Obesity, and Genes (DiOGenes). *Am J Clin Nutr.* 2009; 90(1):202–209. [PubMed: 19458016]
8. Epstein LH, Gordy CC, Raynor HA, et al. Increasing fruit and vegetable intake and decreasing fat and sugar intake in families at risk for childhood obesity. *Obes Res.* 2001; 9(3):171–178. [PubMed: 11323442]
9. Crowe FL, Roddam AW, Key TJ, et al. Fruit and vegetable intake and mortality from ischaemic heart disease: results from the European Prospective Investigation into Cancer and Nutrition (EPIC)-Heart study. *Eur Heart J.* 2011; 32(10):1235–1243. [PubMed: 21245490]
10. Dauchet L, Amouyel P, Hercberg S, Dallongeville J. Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohort studies. *J Nutr.* 2006 Oct; 136(10):2588–2593. [PubMed: 16988131]
11. Joshipura KJ, Hu FB, Manson JE, et al. The effect of fruit and vegetable intake on risk for coronary heart disease. *Ann Intern Med.* 2001; 134(12):1106–1114. [PubMed: 11412050]
12. Nikolic M, Nikic D, Petrovic B. Fruit and vegetable intake and the risk for developing coronary heart disease. *Cent Eur J Public Health.* 2008; 16(1):17–20. [PubMed: 18459474]
13. Oude Griep LM, Geleijnse JM, Kromhout D, Ocke MC, Verschuren WM. Raw and processed fruit and vegetable consumption and 10-year coronary heart disease incidence in a population-based cohort study in the Netherlands. *PLoS One.* 2010; 5(10):e13609. [PubMed: 21049053]
14. Bazzano LA, He J, Ogden LG, et al. Fruit and vegetable intake and risk of cardiovascular disease in US adults: the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *Am J Clin Nutr.* 2002; 76(1):93–99. [PubMed: 12081821]
15. Aune D, Lau R, Chan DS, et al. Nonlinear Reduction in Risk for Colorectal Cancer by Fruit and Vegetable Intake Based on Meta-analysis of Prospective Studies. *Gastroenterology.* 2011; 141(1): 106–118. [PubMed: 21600207]
16. Boggs DA, Palmer JR, Wise LA, et al. Fruit and vegetable intake in relation to risk of breast cancer in the Black Women's Health Study. *Am J Epidemiol.* 2010; 172(11):1268–1279. [PubMed: 20937636]
17. Buchner FL, Bueno-de-Mesquita HB, Ros MM, et al. Variety in fruit and vegetable consumption and the risk of lung cancer in the European prospective investigation into cancer and nutrition. *Cancer Epidemiol Biomarkers Prev.* 2010; 19(9):2278–2286. [PubMed: 20807832]
18. Freedman ND, Park Y, Subar AF, et al. Fruit and vegetable intake and head and neck cancer risk in a large United States prospective cohort study. *Int J Cancer.* 2008; 122(10):2330–2336. [PubMed: 18092323]
19. Millen AE, Subar AF, Graubard BI, et al. Fruit and vegetable intake and prevalence of colorectal adenoma in a cancer screening trial. *Am J Clin Nutr.* 2007; 86(6):1754–1764. [PubMed: 18065596]
20. Krebs-Smith SM, Guenther PM, Subar AF, Kirkpatrick SI, Dodd KW. Americans do not meet federal dietary recommendations. *J Nutr.* 2010; 140(10):1832–1838. [PubMed: 20702750]

21. Sallis, JF.; Owen, N.; Fisher, EB. Ecological models of health behavior. In: Glanz, K.; Rimer, BK.; Viswanath, K., editors. Health behavior and health education. 4 ed.. San Francisco, CA: Jossey-Bass; 2008. p. 465-485.
22. Stokols D. Establishing maintaining healthy environments Toward a social ecology of health promotion. *Am Psychol.* 1992; 47(1):6–22. [PubMed: 1539925]
23. Brug J, Tak NI, te Velde SJ, Bere E, de Bourdeaudhuij I. Taste preferences, liking and other factors related to fruit and vegetable intakes among schoolchildren: results from observational studies. *Br J Nutr.* 2008; 99(Suppl 1):S7–S14. [PubMed: 18257952]
24. Williams L, Ball K, Crawford D. Why do some socioeconomically disadvantaged women eat better than others? An investigation of the personal, social and environmental correlates of fruit and vegetable consumption. *Appetite.* 2010; 55(3):441–446. [PubMed: 20728488]
25. Lucan SC, Barg FK, Long JA. Promoters and barriers to fruit, vegetable, and fast-food consumption among urban, low-income African Americans--a qualitative approach. *Am J Public Health.* 2010; 100(4):631–635. [PubMed: 20167885]
26. Schatzler M, Rust P, Elmadfa I. Fruit and vegetable intake in Austrian adults: intake frequency, serving sizes, reasons for and barriers to consumption, and potential for increasing consumption. *Public Health Nutr.* 2010; 13(4):480–487. [PubMed: 19807933]
27. Baranowski T, Watson K, Missaghian M, et al. Social support is a primary influence on home fruit, 100% juice, and vegetable availability. *J Am Diet Assoc.* 2008; 108(7):1231–1235. [PubMed: 18589035]
28. Shaikh AR, Yaroch AL, Nebeling L, Yeh MC, Resnicow K. Psychosocial predictors of fruit and vegetable consumption in adults a review of the literature. *Am J Prev Med.* 2008; 34(6):535–543. [PubMed: 18471592]
29. Pearson N, Biddle SJ, Gorely T. Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. *Public Health Nutr.* 2009; 12(2):267–283. [PubMed: 18559129]
30. Gregory JE, Paxton SJ, Brozovic AM. Maternal feeding practices predict fruit and vegetable consumption in young children Results of a 12-month longitudinal study. *Appetite.* 2011; 57(1): 167–172. [PubMed: 21569809]
31. Cassady D, Jetter KM, Culp J. Is price a barrier to eating more fruits and vegetables for low-income families. *J Am Diet Assoc.* 2007; 107(11):1909–1915. [PubMed: 17964310]
32. Backman D, Gonzaga G, Sugerman S, Francis D, Cook S. Effect of fresh fruit availability at worksites on the fruit and vegetable consumption of low-wage employees. *J Nutr Educ Behav.* 2011; 43(4 Suppl 2):S113–121. [PubMed: 21683280]
33. Di Noia J, Contento IR. Fruit and vegetable availability enables adolescent consumption that exceeds national average. *Nutr Res.* 2010; 30(6):396–402. [PubMed: 20650347]
34. Jago R, Baranowski T, Baranowski JC. Fruit and vegetable availability: a micro environmental mediating variable. *Public Health Nutr.* 2007; 10(7):681–689. [PubMed: 17381953]
35. Kouli E, Jago R. Associations between self-reported fruit and vegetable consumption and home availability of fruit and vegetables among Greek primary-school children. *Public Health Nutr.* 2008; 11(11):1142–1148. [PubMed: 18167168]
36. Bodor JN, Rose D, Farley TA, Swalm C, Scott SK. Neighbourhood fruit and vegetable availability and consumption: the role of small food stores in an urban environment. *Public Health Nutr.* 2008; 11(4):413–420. [PubMed: 17617930]
37. Larson NI, Neumark-Sztainer D, Hannan PJ, Story M. Trends in adolescent fruit and vegetable consumption, 1999–2004: project EAT. *Am J Prev Med.* 2007; 32(2):147–150. [PubMed: 17234489]
38. Nelson MC, Story M, Larson NI, Neumark-Sztainer D, Lytle LA. Emerging adulthood and college-aged youth: an overlooked age for weight-related behavior change. *Obesity.* 2008; 16(10): 2205–2211. [PubMed: 18719665]
39. Larson NI, Neumark-Sztainer D, Story M. Weight control behaviors and dietary intake among adolescents and young adults: longitudinal findings from Project EAT. *J Am Diet Assoc.* 2009; 109(11):1869–1877. [PubMed: 19857628]

40. Phelan S, Wing RR, Loria CM, Kim Y, Lewis CE. Prevalence and predictors of weight-loss maintenance in a biracial cohort: results from the coronary artery risk development in young adults study. *Am J Prev Med.* 2010; 39(6):546–554. [PubMed: 21084075]
41. Deshmukh-Taskar PR, O'Neil CE, Nicklas TA, et al. Dietary patterns associated with metabolic syndrome, sociodemographic and lifestyle factors in young adults: the Bogalusa Heart Study. *Public Health Nutr.* 2009; 12(12):2493–2503. [PubMed: 19744354]
42. Laska MN, Graham D, Moe SG, Lytle L, Fulkerson J. Situational characteristics of young adults' eating occasions: a real-time data collection using Personal Digital Assistants. *Public Health Nutr.* 2010;1–8. [PubMed: 20015421]
43. Laska MN, Graham DJ, Moe SG, Van Riper D. Young adult eating and food-purchasing patterns food store location and residential proximity. *Am J Prev Med.* 2010; 39(5):464–467. [PubMed: 20965385]
44. Larson N, Laska MN, Story M, Neumark-Sztainer D. Predictors of fruit and vegetable intake in young adulthood. *J Acad Nutr Diet.* 2012; 112(8):1216–1222. [PubMed: 22698924]
45. De Bourdeaudhuij I, te Velde S, Brug J, et al. Personal, social and environmental predictors of daily fruit and vegetable intake in 11-year-old children in nine European countries. *Eur J Clin Nutr.* 2008; 62(7):834–841. [PubMed: 17522608]
46. Klein EG, Lytle LA, Chen V. Social ecological predictors of the transition to overweight in youth: results from the Teens Eating for Energy and Nutrition at Schools (TEENS) study. *J Am Diet Assoc.* 2008; 108(7):1163–1169. [PubMed: 18589024]
47. Bauman AE, Sallis JF, Dzewaltowski DA, Owen N. Toward a better understanding of the influences on physical activity: the role of determinants, correlates, causal variables, mediators, moderators, and confounders. *Am J Prev Med.* 2002; 23(2):5–14. [PubMed: 12133733]
48. Laska MN, Larson NI, Neumark-Sztainer D, Story M. Does involvement in food preparation track from adolescence to young adulthood and is it associated with better dietary quality? Findings from a 10-year longitudinal study. *Public Health Nutr.* 2011:1–9. [PubMed: 21211099]
49. National Cancer Institute. [Accessed Jan 10, 2012] Short dietary assessment instruments. <http://riskfactor.cancer.gov/diet/screeners/>. Updated Nov. 2009
50. Thompson FE, Subar AF, Smith AF, et al. Fruit and vegetable assessment: performance of 2 new short instruments and a food frequency questionnaire. *J Am Diet Assoc.* 2002; 102(12):1764–1772. [PubMed: 12487538]
51. Neumark-Sztainer D, Story M, Hannan PJ, Perry CL, Irving LM. Weight-related concerns and behaviors among overweight and nonoverweight adolescents: implications for preventing weight-related disorders. *Arch Pediatr Adolesc Med.* 2002; 156(2):171–178. [PubMed: 11814380]
52. Mujahid MS, Diez Roux AV, Morenoff JD, Raghunathan T. Assessing the measurement properties of neighborhood scales: from psychometrics to econometrics. *Am J Epidemiol.* 2007; 165(8):858–867. [PubMed: 17329713]
53. Echeverria SE, Diez-Roux AV, Link BG. Reliability of self-reported neighborhood characteristics. *J Urban Health.* 2004; 81(4):682–701. [PubMed: 15466849]
54. Kaiser HF. The varimax criterion for analytic rotation in factor analysis. *Psychometrika.* 1958; 23(3):187–200.
55. Fabrigar LR, Wegener DT, MacCallum RC, Strahan EJ. Evaluating the use of exploratory factor analysis in psychological research. *Psychol Methods.* 1999; 4(3):272–299.
56. Sobel ME. Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological Methodology.* 1982; 13:290–312.
57. MacKinnon DP, Dwyer JH. Estimating mediated effects in prevention studies. *Eval Rev.* 1993; 17(2):144–158.
58. Cohen, J.; Cohen, P.; West, SS.; Aiken, L. *Applied multiple regression/correlation analysis for the behavioral sciences.* Hillsdale, NJ: Lawrence Erlbaum Associates; 2003.
59. Lau RR, Quadrel MJ, Hartman KA. Development and change of young adults' preventive health beliefs and behavior: influence from parents and peers. *J Health Soc Behav.* 1990; 31(3):240–259. [PubMed: 2133479]
60. Pelletier J, Graham DJ, Laska MN. Links between young adults' dietary behaviors and dietary behaviors of social network members. *Am J Health Behav.* In Press.

61. Pelletier JE, Laska MN. Campus food and beverage purchases are associated with indicators of diet quality in college students living off campus. *Am J Health Promot.* In Press
62. Powell LM, Zhenxiang Z, Youfa W. Food prices and fruit and vegetable consumption among young American adults. *Health Place.* 2009; 15(4):1064–1070. [PubMed: 19523869]
63. Larson NI, Perry CL, Story M, Neumark-Sztainer D. Food preparation by young adults is associated with better diet quality. *J Am Diet Assoc.* 2006; 106(12):2001–2007. [PubMed: 17126631]
64. Humpel N, Owen N, Leslie E. Environmental factors associated with adults' participation in physical activity. *Am J Prev Med.* 2002; 22(3):188–199. [PubMed: 11897464]
65. Most SB, Astur RS. Feature-based attentional set as a cause of traffic accidents. *Vis Cogn.* 2007; 15(2):125–132.
66. Boon B, Stroebe W, Schut H, Jansen A. Food for thought: cognitive regulation of food intake. *Br J Health Psychol.* 1998; 3:27–40.
67. Cornell CE, Rodin J, Weingarten H. Stimulus-induced eating when satiated. *Physiol. Behav.* 1989; 45:695–704. [PubMed: 2780836]
68. Wansink B, Painter JE, Lee YK. The office candy dish: Proximity's influence on estimated and actual consumption. *Int J Obes.* 2006; 30(5):871–875.
69. Gebel K, Bauman A, Owen N. Correlates of non-concordance between perceived and objective measures of walkability. *Ann Behav Med.* 2009; 37(2):228–238. [PubMed: 19396503]
70. Laska MN, Pelletier JE, Larson NI, Story M. Interventions for weight gain prevention during the transition to young adulthood: a review of the literature. *J Adolesc Health.* 2012; 50(4):324–333. [PubMed: 22443834]

Table 1

Derived Factor Names and Fruit and Vegetable Components of online survey, for Student Health and Wellness Study, 2010 (n=1201)

Factor	Name	Number of Items	Item Descriptions
1	Personal Barriers	3	Lack Skills^a : I don't have the skills to prepare vegetables Dislike Taste^a : If I were to prepare more vegetables, I probably wouldn't like the way that they taste Likely Spoil^a : If I purchased more fruits and vegetables, they would likely spoil (or "go bad") before I could eat them
2	FV Knowledge	2	Fruit Need^b : About how many servings of fruit do you think you should consume per day in order to be healthy? Vegetable Need^b : About how many servings of vegetables do you think you should consume per day in order to be healthy?
3	Family	4	Family FV Consumption^c : To what extent does your family eat fruits and vegetables Family Eat Healthy^c : To what extent does your family generally eat healthy food Selection Confidence^a : I feel confident in my ability to select high quality fruits and vegetables in the grocery store In-Store Availability^a : At the stores where I usually buy my food fruits and vegetables are available
4	Friends	2	Friends FV Consumption^c : To what extent do your friends eat fruits and vegetables Friends Eat Healthy^c : To what extent do your friends generally eat healthy food
5	Neighborhood	2	Neighborhood Access^a : In the neighborhood where I currently live, there are places to buy fruits and vegetables Neighborhood Price^a : In the neighborhood where I currently live, there are stores that have reasonably priced fruits and vegetables
6	Access Barriers	3	Too Expensive^a : At the stores where I usually buy my food fruits and vegetables cost too much to buy Limited Variety^a : At the stores where I usually buy my food the variety of fresh fruits and vegetables is limited Poor Quality^a : At the stores where I usually buy my food the condition of fresh fruits and vegetables is poor
7	Campus	2	Campus Access^d : Fruits and vegetables are readily available on or near campus Campus Price^d : Fruits and vegetables are reasonably priced on or near campus

^aResponse Options: strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree

^bResponse Options: no options provided - numeric responses were required and analyzed as continuous variables

^cResponse Options: not at all, a little bit, somewhat, very much, I don't know

^dResponse Options: strongly disagree, disagree, agree, strongly agree

Table 2

Factor Loadings from Principal Components Factor Analysis: Student Health and Wellness Study, 2010 (n = 1201)

	Factor 1: Personal Barriers	Factor 2: Fruit and Vegetable Knowledge	Factor 3: Family	Factor 4: Friends	Factor 5: Neighborhood	Factor 6: Access Barriers	Factor 7: Campus
Lack Skills	.760	.008	.136	.037	.034	.076	-.026
Dislike Taste	.786	.050	.170	.030	-.094	.066	-.056
Likely Spoil	.760	.009	-.081	.083	.046	.060	.080
Fruit Need	-.008	.915	-.024	-.013	.046	-.051	.004
Vegetable Need	.068	.912	-.026	.015	-.022	-.010	-.021
Family FV Consumption	.013	.005	.603	.446	-.129	.120	.165
Family Eat Healthy	.016	.026	.624	.500	-.156	.080	.121
Selection Confidence	.270	-.051	.585	.032	.262	-.044	-.043
In-Store Availability	.057	-.037	.726	-.058	.283	-.067	-.069
Friends FV Consumption	.054	.003	.000	.844	.138	-.008	-.001
Friends Eat Healthy	.095	-.008	.140	.816	.103	.020	-.001
Neighborhood Access	.006	.035	.164	.061	.874	.069	.096
Neighborhood Price	-.023	-.004	.075	.139	.868	.111	.173
Too Expensive	.178	-.003	-.307	.082	.003	.656	.099
Limited Variety	.020	-.042	.079	-.034	.039	.864	-.028
Poor Quality	.053	-.019	.114	-.013	.120	.828	-.018
Campus Access	.022	.000	.139	-.052	.182	.025	.837
Campus Price	-.021	-.017	-.102	.095	.062	-.001	.861

Notes: Numbers refer to factor loadings from Principal Components Analysis. Higher numbers indicate the item loads more heavily on a given factor. Shaded items in each column indicate the items grouped together for each composite variable.

Table 3

Predictors of Fruit and Vegetable (FV) Purchasing, Preparation, and Consumption by College Students: Student Health and Wellness Study, 2010 (n = 1201)^a

Level	FACTOR	Purchase Fruits and Vegetables ^b (n=1074)			Prepare Fruits and Vegetables ^c (n=1067)			Consume Fruits and Vegetables ^d (n=1038)		
		Direct Effect ^e b(95%CI)	Total Effect ^f b	Percent Mediated ^g	Direct Effect ^e b(95%CI)	Total Effect ^f b	Percent Mediated ^g	Direct Effect ^e b(95%CI)	Total Effect ^f b	Percent Mediated ^g
Individual	Personal Barriers	-0.047*** (-.066, -.028)	-0.047	--	-0.219*** (-.265, -.173)	-0.219	--	-0.074*** (-.107, -.042)	-0.074	--
	FV Knowledge	0.009 (-.009, .027)	0.009	--	0.064** (.021, .106)	0.064	--	0.022 (-.009, .052)	0.022	--
Social	Family	0.027* (.004, .049)	0.032	15%	0.056* (.002, .109)	0.066	15%	0.044* (.006, .081)	0.052	15%
	Friends	0.049*** (.030, .069)	0.049	--	0.121*** (.074, .168)	0.121	--	0.084*** (.051, .117)	0.184	--
Environmental	Neighborhood	0.022* (.001, .043)	0.039	43%	0.096*** (.045, .146)	0.134	28%	0.041* (.005, .076)	0.069	40%
	Access Barriers	0.020 (-.004, .044)	0.030	33%	-0.003 (-.060, .054)	0.048	94%	0.050* (.010, .091)	0.065	23%
	Campus	0.002 (-.020, .023)	0.002	--	-0.020 (-.072, .031)	-0.020	--	0.001 (-.036, .037)	0.001	--
	R ² (Full Model) ^h	0.114			0.175			0.107		
	R ² (Factors Only)	0.075			0.166			0.060		

* p<.05

** p<.01

*** p<.001

^a Analyses excluded participants with any missing data; due to differences in number of participants missing outcome data, the analytic sample sizes for the regression equations were 1074 for the equation predicting FV purchasing, 1067 predicting FV preparation, and 1038 predicting FV consumption.

^b Purchase Fruits and Vegetables (2 items): During the past 30 days, about how often have you purchased a fresh vegetable?; During the past 30 days, about how often have you purchased a fresh fruit? (Never, 1–2 times, 3–4 times, 5–6 times, 7 or more times).

^c Prepare Fruits and Vegetables (1 item): During the past 7 days, how many times did you prepare a meal that included vegetables? (never, 1–2 times, 3–4 times, 5–6 times, 7 times or more)

- ^d Consume Fruits and Vegetables (calculated from 9 items): servings of daily fruits and vegetables (excluding French fries) calculated from NCI 5-Factor screener
- ^e Direct Effect refers to the predicted value of the factor for the outcome from multivariate regression analyses including all other predictors.
- ^f Total Effect includes direct effect (from multivariate regression analyses including all other predictors) and indirect effects mediated by more-proximal factors in the model (i.e., those at the individual level (personal barriers and FV knowledge) would be more proximal to the individual than would the social factors (family and friends), which, in turn, are more proximal than the environmental factors (neighborhood, access barriers, and campus)). For example, the association between neighborhood factors and the three FV outcomes was examined for mediation by family, friends, personal barriers, and FV knowledge."
- ^g Percent of total effect mediated by more proximal factors is presented only for those more distal factors for which Sobel's tests indicated that at least one more-proximal factor partially mediated its effect.
- ^h Full model included all factors shown in table plus gender, race, ethnicity, and age.