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Socioeconomic Status, Energy Cost, and Nutrient Content of Supermarket Food Purchases

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Abstract

Background—The relative affordability of energy-dense versus nutrient-rich foods may promote socioeconomic disparities in dietary quality and obesity. Although supermarkets are the largest food source in the American diet, the associations between SES and the cost and nutrient content of freely chosen food purchases have not been described.

Purpose—To investigate relationships of SES with the energy cost (\$/1000 kcal) and nutrient content of freely chosen supermarket purchases.

Methods—Supermarket shoppers ($n=69$) were recruited at a Phoenix AZ supermarket in 2009. The energy cost and nutrient content of participants' purchases were calculated from photographs of food packaging and nutrition labels using dietary analysis software. Data were analyzed in 2010–2011.

Results—Two SES indicators, education and household income as a percentage of the federal poverty guideline (FPG), were associated with the energy cost of purchased foods. Adjusting for covariates, the amount spent on 1000 kcal of food was \$0.26 greater for every multiple of the FPG, and those with a baccalaureate or postbaccalaureate degree spent an additional \$1.05 for every 1000 kcal of food compared to those with no college education. Lower energy cost was associated with higher total fat and less protein, dietary fiber, and vegetables per 1000 kcal purchased.

Conclusions—Low-SES supermarket shoppers purchase calories in inexpensive forms that are higher in fat and less nutrient-rich.

Introduction

Socioeconomic differences in food purchasing,^{1–6} dietary intake,⁷ and obesity^{8–11} may stem from the high cost of nutrient-rich foods relative to less-nutritious, energy-dense foods.^{12,13} Individual foods and total diets with the lowest energy cost (i.e., dollars per 1000 kcal) are denser in energy and fat and less rich in micronutrients.^{14–22} Given that American families obtain two thirds to three quarters of their food from supermarkets,^{23–26} they are promising settings in which to implement pricing interventions aimed at reducing socioeconomic disparities in health. Yet, current understanding of the associations of SES, energy cost, and nutrition stems from analyses of overall dietary intake assessed through food frequency questionnaires or hypothetical diets based on healthy food plans, neither of which may reflect actual supermarket purchasing patterns. The present study tested two hypotheses: (1) the energy cost of freely chosen supermarket purchases is positively associated with socioeconomic indicators, and (2) food purchases with a lower energy cost are less healthful in terms of nutrient content.

Methods

The current study involved cross-sectional analyses of data collected during a pilot study of a supermarket point-of-purchase intervention.²⁷ Only data from the participants who received no intervention were analyzed. Data were collected on both weekdays and weekends between 10:00AM and 7:00PM from August to November 2009.

Participants

Shoppers at an urban, chain supermarket were recruited by researchers stationed near the store entrance. The supermarket was located in a ZIP code with a median annual household income of \$36,150, with 30.1% of adults holding a baccalaureate degree, and a 23.8% ethnic minority population. Eligible participants were aged ≥ 18 years, reported making the majority of household food purchases, planned to purchase at least 15 different food items, and had access to transportation and a refrigerator because of the potential impact of these resources on purchasing patterns. The study received IRB approval from the University of Arizona and Arizona State University. Approximately 500 shoppers inquired about the study, 164 met eligibility criteria, and 69 control group participants provided complete data.

Procedure

Researchers photographed the packaging and nutrition labels of food and beverage purchases, except bottled water. Field notes documented food items lacking packaging or a nutrition label. Duplicate register receipts were collected. After purchasing their groceries, participants completed a survey assessing age, gender, race/ethnicity, marital status, education, household income, number of children and adults in the household, and frequency of food shopping and fast-food intake.

Analysis

Percentage of the 2009 U.S. federal poverty guideline²⁸ was calculated from household income and size. For example, a family of two adults and two children with an income of \$50,000 would be at 226% of the federal poverty guideline. BMI was calculated from self-reported height and weight.

Nutrient analysis of food purchases was performed using Nutrition Data System for Research (Nutrition Coordinating Center, Minneapolis MN). Ten nutritional variables were calculated based on their relevance to health and inclusion in the Dietary Guidelines for Americans²⁹: energy density (kcal/g); protein, carbohydrate, total fat, saturated fat, *trans* fat,

and total dietary fiber (g/1000 kcal); sodium (mg/1000 kcal); and fruit and vegetables (cups/1000 kcal). The energy cost (\$/1000 kcal) of purchased foods was calculated using pre-tax food expenditures.

The fruit, vegetable, and dietary fiber variables were logarithmically transformed to correct for skew. An outlying case for sodium was corrected by excluding an extreme value. Linear regression tested univariate and multivariate associations of income, education, and energy cost with nutrient content.

Results

Participants (Appendix A, available online at www.ajpmonline.org) were predominantly female (75%) and non-Hispanic white (79.7%). Mean age was 43.7 (SD=12.5) years, and mean BMI was 28.4 (SD=4.7). Households averaged 3.4 individuals (SD=1.5), with 59% including one or more children. Mean household income was 355.7% of the federal poverty guideline (SD=158.6%), which corresponds to \$78,830 for a family of two adults and two children. Forty-three percent had a baccalaureate degree or higher, and 78% were married or living with a partner. The costs and nutrient content of food purchases are presented in Appendix B (available online at www.ajpmonline.org).

Household income was associated with energy cost in univariate and multivariate models; for each multiple of the federal poverty guideline, the adjusted energy cost was about \$0.26 greater per 1000 kcal of food (Table 1; Appendix C [available online at www.ajpmonline.org]). Individuals with a baccalaureate degree spent an additional \$1.05 per 1000 kcal compared to those with a high school diploma or lower in multivariate models. Energy cost did not differ between individuals with some college/technical degree and those without any college education. No covariates reached significance in either model.

Purchased foods with a higher energy cost were lower in total fat, and higher in protein, vegetables, and fiber (Table 2). Income demonstrated a modest positive association with purchasing of saturated fat, and individuals with a baccalaureate degree purchased 26.5 additional grams of carbohydrate per 1000 kcal than those without any college education (Table 2).

Discussion

Socioeconomic indicators were positively associated with the energy cost of freely chosen supermarket food purchases. Assuming a daily energy intake of about 2000 kcal/day per person, a family of two adults and two children with an annual income of \$88,200 (quadruple the federal poverty level) would spend an additional \$1518 on food per year compared to a similar family with an annual income of about \$44,100 (twice the federal poverty guideline). A college-educated shopper in a four-member household would spend approximately \$3066 more on food annually than a similar shopper with a high school diploma. These additional food expenditures would have implications for diet quality and health; higher energy cost was associated with lower total fat and higher proportions of protein, dietary fiber, and vegetables. This is the first study, to our knowledge, to analyze the energy cost and nutritional content of actual, freely chosen supermarket purchases.

Interestingly, education and household income were not directly related to most nutrient measures. Larger studies have also failed to support direct links between SES indicators and the nutrient content of food purchases in the presence of significant associations between SES and energy cost, and energy cost and nutrient content.¹⁷ One possibility is that low-SES households are able to purchase less-expensive alternatives without sacrificing diet quality, at least to some extent. More research into this possibility is needed, as the current findings

provide only partial support for an economic model in which the affordability of energy-dense and nutrient-poor foods promotes weight gain and chronic disease risk in low-income populations.

Several study limitations are noted. Data were collected at a single supermarket over a period of 4 months. Therefore, findings may have been affected by seasonal changes in dietary intake,³⁰ and may not generalize to other settings. The study's eligibility criteria may have disproportionately excluded low-SES participants who did not plan to purchase at least 15 different food items or have access to transportation and a refrigerator. The small sample size precluded the possibility of detecting small-magnitude associations or exploring interactions between SES and other factors. Finally, knowing in advance that food purchases would be documented may have led participants to alter their food-purchasing patterns.

The current findings suggest that previously documented associations of SES, diet cost, and the nutrient content of one's diet are reflected only partially in supermarket food-purchasing patterns. Future research should determine the extent to which low-SES shoppers may purchase affordable foods without sacrificing nutrition and explore pricing interventions to reduce socioeconomic disparities in diet quality and obesity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix. Supplementary data

Supplementary material accompanying this article can be found in the online version at doi: 10.1016/j.amepre.2011.12.007.

Table 1

Univariate and multivariate linear regression models predicting the energy cost (\$/1000 kcal) of supermarket purchases

	Estimate (95% CI)	p-value
Income (% FPG)		
Unadjusted model ($R^2=0.19$)	0.0035 (0.0016, 0.0053)	<0.001
Adjusted model ($R^2=0.18$) ^a	0.0026 (0.0005, 0.0048)	0.02
EDUCATION		
Unadjusted model ($R^2=0.12$)		
High school, GED, or lower	Ref	
Some college/technical degree	0.57 (−0.23, 1.36)	0.16
Baccalaureate/postbaccalaureate degree	1.13 (0.36, 1.89)	<0.01
Adjusted model ($R^2=0.18$)^a		
High school, GED, or lower	Ref	
Some college/technical degree	0.48 (−0.30, 1.26)	0.22
Baccalaureate/postbaccalaureate degree	1.05 (0.29, 1.81)	<0.01

^a Adjusted models included gender, race/ethnicity, marital status, number of children in the household, and number of adults in the household. None of these covariates was significant.

FPG, federal poverty guideline; GED, General Educational Development test

Table 2

Relationships of income, education, and energy cost with the overall nutrient content of supermarket food purchases, estimate (95% CI)^a

Variable	Income (% of FPG)	p-value	Education ^b	p-value	Energy cost (\$/1000 kcal)	p-value
Energy density (kcal/g)	0.0001 (−0.0009, 0.0010)	0.87	0.11 (−0.25, 0.46) −0.05 (−0.39, 0.30)	0.55 0.79	−0.09 (−0.20, 0.01)	0.09
Total fat	0.02 (−0.01, 0.04)	0.20	−6.60 (−15.36, 2.16) −7.87 (−16.36, 0.61)	0.14 0.07	−3.00 (−5.66, −0.34)	0.03
Saturated fat	0.012 (0.003, 0.021)	<0.01	−3.05 (−6.52, 0.42) −3.02 (−6.38, 0.34)	0.08 0.08	−0.72 (−1.80, 0.36)	0.19
Trans fat	0.001 (−0.001, 0.002)	0.24	−0.06 (−0.65, 0.53) −0.23 (−0.80, 0.34)	0.84 0.42	−0.16 (−0.34, 0.02)	0.08
Carbohydrate	−0.03 (−0.08, 0.02)	0.25	18.18 (−1.15, 37.50) 26.47 (7.76, 45.19)	0.07 0.01	1.39 (−4.91, 7.70)	0.66
Protein	−0.01, (−0.04, 0.02)	0.58	−7.86 (−18.50, 2.78) −8.85 (−19.16, 1.45)	0.15 0.09	4.49 (1.34, 7.64)	<0.01
Sodium (mg/1000 kcal)	−0.32 (−1.19, 0.55)	0.47	−7.46 (−329.63, 314.72) 143.30 (−168.72, 455.32)	0.96 0.36	94.98 (−2.11, 192.07)	0.06
Total fiber ^c	−0.0004 (−0.0014, 0.0006)	0.43	−0.23 (−0.61, 0.15) 0.03 (−0.35, 0.40)	0.23 0.89	0.16 (0.05, 0.28)	<0.01
Fruit (cups/1000 kcal) ^c	−0.0013 (−0.0030, 0.0003)	0.12	−0.34 (−95, 0.28) −0.25 (−0.84, 0.35)	0.28 0.41	0.05 (−0.14, 0.24)	0.59
Vegetables (cups/1000 kcal) ⁵	0.0011 (−0.0004, 0.0026)	0.16	−0.17 (−0.73, 0.39) −0.29 (−0.25, 0.83)	0.55 0.29	0.30 (0.14, 0.46)	<0.001

Note: Data are from multivariate linear regression models. Variables are given in g/1000 kcal, unless otherwise noted.

^a Models controlled for participant race/ethnicity, marital status, gender, and the number of adults and children in the household. Bottled water was not included in any calculations.

^b Compares <Bac and Bac/post to high school, GED, or lower; first line shows <Bac, second line shows Bac/post.

^c Variable was transformed to correct for skew; see Methods section.

<Bac, some college or technical degree; Bac/post, baccalaureate or postbaccalaureate degree; FPG, federal poverty guideline