

FOOD OPTIONS WITH A MORE NUTRIENT FAVORABLE PROFILE IN GROCERY
STORES: BUYING HEALTHIER FOODS WITHOUT PAYING MORE.

By: Sarah Mammarella

April 2010

Chair: Sarah Colby, Ph.D., R.D.

Major Department: Nutrition and Dietetics

Obesity is more prevalent in people of lower-socioeconomic status. Since over half of meals consumed are prepared in the home, grocery store purchases may be playing an important role in the obesity epidemic. The objective of this study was to assess the price differences between more nutrient favorable (MNF; i.e. low in fat, low in sodium, low in sugar, low in calories and whole grain) foods and less nutrient favorable (LNF; i.e. high in fat, high in sodium, high in sugar, high in calories, and refined) food option pairs (n=126; 63 MNF, 63 LNF) in all grocery stores in Greenville, NC (n=13) in the summer of 2009. Anovas, independent t tests and post-hoc analyses were used to produce means for each food item across the 13 grocery stores. LNF food items never cost more than MNF food items. Of the MNF and LNF food pairs assessed, 14 (22.2%) of foods had statistically significant differences in price ($P<0.01$). When looked at for cent-for-cent differences, 33 (52.4%) of the food pairs assessed had no differences in price. The findings of this study show that consumers can largely reduce calorie, fat, sugar, and sodium content of grocery store food purchases without increasing cost.

FOOD OPTION WITH A MORE NUTRIENT FAVORABLE PROFILE IN GROCERY
STORES: BUYING HEALTHIER FOODS WITHOUT PAYING MORE

A Thesis

Presented to

The Faculty of the Department of Nutrition and Dietetics

East Carolina University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Sarah Mammarella

April 2010

© Copyright

Sarah Mammarella

FOOD OPTIONS WITH A MORE NUTRIENT FAVORABLE PROFILE IN GROCERY
STORES: BUYING HEALTHIER FOODS WITHOUT PAYING

By

Sarah Mammarella

APPROVED BY:

DIRECTOR OF

DISSERTATION/THESIS: _____

Sarah E. Colby, Ph.D., R.D.

COMMITTEE MEMBER: _____

Roman Pawlak, Ph.D., R.D.

COMMITTEE MEMBER: _____

David Rivera, Ph.D.

COMMITTEE MEMBER: _____

Elizabeth Wall-Bassett, Ph.D., R.D.

COMMITTEE MEMBER: _____

Kevin H. Gross, Ph.D.

CHAIR OF THE DEPARTMENT OF

NUTRITION AND DIETETICS: _____

William Forsythe, Ph.D., R.D.

DEAN OF THE GRADUATE

SCHOOL: _____

Paul Gemperline, Ph.D.

TABLE OF CONTENTS

LIST OF TABLES.....	iii
CHAPTER1: BACKGROUND.....	1
CHAPTER 2: METHODS.....	4
Survey Tool.....	4
Variables.....	4
Sample.....	6
Statistical Analysis.....	6
CHAPTER 3: RESULTS AND DISCUSSION.....	8
CHAPTER 4: CONCLUSIONS.....	11
CHAPTER 5: LIMITATIONS.....	12
CHAPTER 6: FUTURE RESEARCH.....	13
REFERENCES.....	18

LIST OF TABLES

1. Food item pairs with statistically significant price differences.....	14
2. Food item pairs found to have no price differences.....	16
3. Food item pairs without statistically significant price differences, but with cent-for-cent price differences.....	17

CHAPTER ONE: BACKGROUND

Obesity is an epidemic in the United States. Over 1/3 of American adults are obese (Body Mass Index ≥ 30 kg/m²) and 16% of children are overweight (above the 95th percentile based on gender-specific BMI charts) (1-2). Furthermore, since 1980 obesity rates have doubled for adults and overweight incidence has tripled for children (2). These rising rates of obesity have been associated with increased consumption of energy dense foods, decreased physical activity and increased availability of refined grains, fats and sweets (3-5). Although nearly half of all meals are eaten outside the home, 51.1% of food is still prepared and consumed inside the home (6). Purchases made in grocery stores may be playing an important role in the obesity epidemic; thus, interventions targeting grocery store purchasing behaviors may be needed.

To develop obesity prevention interventions targeting grocery store purchasing behaviors, it is important to understand why people purchase certain food items. It has been shown that grocery store food purchases are primarily based on taste, cost and convenience (7- 8). Of these factors, there is considerable evidence that food purchases in grocery stores are mostly influenced by cost (9-12). Studies have shown that, in an effort to save money, those who have a lower income often select low-cost, energy-dense foods that are high in refined grains, and added sugar and fats (13-14). Furthermore, cost may be playing an important role in food purchase decisions in recent years due to the increased number of people living below the poverty line and/or being food insecure (“limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire acceptable food in socially acceptable ways”) (15).

In 2007, over 31 million people in America (12.5%) were considered to be living in poverty (making less than \$10,991 in a one-person household) (15). In 2009, 11.1% of people were considered food insecure (16). Low income, food insecure individuals are more susceptible to health disparities. Studies have shown that individuals with lower income and higher levels of food insecurity have higher rates of obesity, diabetes, cardiovascular disease, osteoporosis, and certain cancers (17- 26).

Increased consumption of less nutrient favorable (LNF) foods (e.g. high fat, sodium, sugar, calorie, and refined foods) is associated with the development of chronic disease. Individuals with lower income status have been found to consume more LNF foods. For example, lower income individuals eat less fruits and vegetables (that are often higher priced items) (17). Lower fruit and vegetable intakes may make these individuals more susceptible to certain cancers (17). Furthermore, lower income individuals consume more saturated fat (often prevalent in lower cost food items) than higher income individuals, possibly making the lower income individuals more susceptible to cardiovascular disease (18). The higher cost of more nutrient favorable (MNF) foods (e.g. low fat, sodium, sugar, calorie, and less refined) may play a role in the development of obesity among low-income and/or food insecure individuals.

Research has indicated that LNF foods cost less than foods with a more nutrient favorable profile (MNF; i.e. low fat, low sodium, low sugar, low calorie, and whole grain) (13, 29-30). Foods with added fats and sugars represent the lowest cost food groups; whereas fruits, vegetables, whole grains and meats represent the highest cost food groups. (5, 13, and 29).

However, it is possible that some MNF foods may not cost more than similar, LNF food

options in the grocery store. The identification of specific MNF foods that are cost equivalent to similar LNF food options in grocery stores would be useful for dietitians to use when counseling low income patients. With information on cost-equivalent, MNF food options, dietitians could more effectively advise low income consumers how to make healthy selections in grocery stores without increasing cost. The purpose of this study was to identify cost-equivalent MNF foods in grocery stores.

CHAPTER TWO: METHODS

A trained researcher used a modified Nutrition Environment Measures Survey (NEMS) to measure price differences of 63 matched foods (126 total foods assessed).

Survey Tool

The original NEMS was developed and validated by Glanz et al at Rollins School of Public Health at Emory University in Atlanta, Georgia. Originally, the NEMS tool was intended to measure food environments and only identified fifteen food pairs. We wanted to identify all MNF and LNF food pair options; therefore we made observations in three grocery stores. Upon searching these grocery stores for more MNF and LNF food pairs, we found forty-nine additional food pair items that had MNF and LNF food pairs and could be added to the survey. Therefore, we modified the NEMS tool to include the additional forty-nine food pairs (MNF and LNF). Furthermore, foods that did not have a MNF counterpart were removed from the original NEMS survey. All other NEMS data collection formats were retained in the modified NEMS.

Variables

To make sure all possible foods that had a MNF counterpart were compared; researchers went into 13 grocery stores and made lists of all possible food pairs. Four food item pairs were removed from the survey because they were available in only two grocery stores. The food pairs removed include: ramen noodles, hamburgers, hotdog buns and hamburger buns. Forty-nine food pairs were added to the existing 15 food pairs in the NEMS survey (N=64 food pairs). The food pairs were categorized into ten food groups: dairy, condiments, snacks, eggs, fruit, vegetables, meats, packaged meals, starches, and beverages. The foods categorized in each food group included: dairy (milk, yogurt, sour cream, cottage cheese, ice cream and cheese),

condiments (mayonnaise, margarine, chocolate sauce, ketchup, jelly, peanut butter, cool whip, syrup, frosting and salad dressing), snacks (cookies, popcorn, saltine crackers, peanuts, peanut butter crackers, pop-tarts, ice cream, Jello™, pudding and chips), eggs, fruits (canned fruits and applesauce), vegetables (canned vegetables), meats (ground beef, deli meats, bacon, ground sausage, sausage links, sausage patties, kielbasa, spam and hot dogs), prepackaged meals (frozen dinners, breakfast meals, hot pockets, cheese shells, frozen waffles and soups), starches (English muffins, bagels, bread, rice, flour, pancake mix, muffin mix, croissants, cinnamon rolls, biscuits, rice, cereals, flavored oatmeal and pasta) and beverages (sodas, beer, hot chocolate mix and other packaged non-carbonated drinks) and represent a total of 63 food pairs. The price differences were assessed for the 63 MNF and 63 LNF paired food items.

The price and the package size of each food item were recorded. Food items were compared by price per ounce and adjusted to an average package size in ounces. To adjust for package size the price was divided by the amount of ounces in the package for each food item. Frozen dinners and cereals were the only two food items that had specific criteria established in the original NEMS protocols that had to be met in order to be considered MNF foods. Frozen dinners were considered MNF if they had ≤ 9 grams of total fat per serving. Cereals were considered MNF if they had < 7 grams of sugar or if they have ≥ 4 grams of fiber. All other foods were paired by MNF and LNF nutrient compositions (e.g. low fat vs. regular fat, low sodium vs. regular sodium, etc.).

Sample

All grocery stores within the city limits of Greenville, NC were surveyed (n=13). To be included in the survey, grocery stores had to offer a full range of foods, including dairy and meat. Stores that did not offer a full range of food were not included in the survey. In addition, gas, drug, health food, specialty and convenience stores were not included in this survey. Grocery stores were assessed within a two-week time period in the summer of 2009.

Statistical Analysis

All statistical analyses were conducted using Microsoft Office Excel (2007). Prices of each of the 63 food item pairs (e.g. skim milk) were gathered from each grocery store. The prices were then assessed, summed, averaged and used in statistical comparison. Food prices were adjusted by package size (to one ounce servings) and averaged across all 13 grocery stores in Greenville, NC to allow for statistical comparisons between items. Independent t tests and one-way ANOVA tests were used to determine if there were statistically significant differences between mean prices within food pairs. Independent t tests were used to analyze any statistically significant difference in means of different food pairs with two food samples. One-way ANOVA tests were used to analyze any statistically significant means of different food pairs with three food samples. If there were statistically significant differences between means, Post-Hoc analyses were done to see which food pairs, out of the three food samples, had statistically significant means. A hypothesis testing of $p < .01$ was used. We used the Bonferroni method of adjustment to account for multiple comparisons between food items that had three food samples ($.01/3 = .003$) (32). Also, one-tailed probabilities were used since it was hypothesized that MNF

foods would cost more than LNF food counterparts.

We further analyzed the results for practical application. The actual price difference (cent for cent) between paired items was calculated. All items with no actual difference were put into one list. The average package size for every food item that had a statistical difference and an actual difference was multiplied by each mean price per ounce to produce an average price per package. A percentage price difference was also calculated for each food item pair found to be statistically or actually different in price.

CHAPTER THREE: RESULTS AND DISCUSSION

Of the 64 food item pairs assessed in 13 grocery stores, no LNF food item cost more than its MNF counterpart. Of the food item pairs assessed, only 14 (22.2%) were statistically different in price (ground beef, flavored oatmeal, hot chocolate mix, pasta, bacon, peanut butter crackers, deli meat, ketchup, ground sausage, eggs, chips, bread, jelly and cheese) (Table 1).

Both cheese and hot chocolate each had three different options and were found to be statistically significantly different using one-way ANOVAs. Statistical differences in both hot chocolate and cheese were individually found, post-hoc analyses were conducted to determine where the statistical difference occurred between the three means. There was no statistical difference between prices of low fat and fat free cheese (Table 2); but, there were statistically significant differences in prices between regular vs. low fat and regular vs. fat free cheese options (Table 1). There was no statistically significant difference between low fat and sugar free hot chocolate (Table 2); however, there were statistically significant differences between regular vs. low fat hot chocolate and regular vs. sugar free hot chocolate (Table 1).

Of the total 64 food item pairs assessed, 49 (77.8%) were not statistically different in mean prices (Table 2). Some food pairs were shown to not be statistically different in price, but were also exactly the same in price, cent for cent. Thirty-three (52.4%) food item pairs were found to have no cent for cent difference in price. Food pairs that were not statistically difference in price, but had slight price differences, cent for cent, were also found (Table 3).

Cost has been shown to be the primary factor in product selection for low-income consumers when grocery shopping (9-12). The higher cost of healthy foods has been indicated by some people as a reason for not buying healthier items at the grocery store (9-12). Results of

the present study show that roughly 78% of MNF food options in grocery stores, in Greenville, NC did not cost statistically more than their LNF counterparts. Results also show that 52.4% of food item pairs had absolutely no cent-for-cent difference in price. Other studies have found that MNF foods were always more expensive than LNF foods (13, 29-30). Those observed differences in price may have been because the studies compared non-paired MNF and LNF items. For example, if spinach was compared to cookies, in weight equivalencies or per 100 calories, spinach would most likely cost more than cookies. However, when comparing a food pair, such as low-fat cookies and regular cookies, there was no price difference. Another explanation could be that these studies looked at overall dietary patterns. For instance, studies could have compared at a diet high in whole grains, fruits, vegetables and lean meats to a diet high in processed, fatty and sugary foods. In this study, food items (such as Fruit Roll-Ups™) that did not have a same-brand MNF paired option available were not compared. If Fruit Roll-Ups™ had been compared to 100% fruit snacks (of a different brand), there would likely have been nutrient profile and price differences.

People who are food insecure have been found to have higher BMIs and are at a higher risk for health disparities (17-26). The results of this study show that consumers can reduce calorie, fat, sugar, and sodium content of grocery store food purchases without increasing cost. The results of this research were presented in categories that align with nutrients of interest for health promotion and chronic disease prevention (e.g. fat, sodium, added sugar, and whole grains). The practical results shown in this study will be important for those low income individuals who want to eat healthy but have no additional money to spend.

Health professionals can use the results of this study to promote the intake or restriction of nutrients found in specific foods without increasing grocery costs. For example, if a health professional is working with an individual who needs a low-fat diet, the health professional may want to encourage the purchase of the MNF foods listed in Table 2 in the fat category. If a health professional is seeking to promote whole grain intake, using this research health professionals will be aware that whole wheat pasta and bread are higher cost MNF options, but whole wheat bagels, English muffins, frozen waffles, pancake mix and muffin mix do not cost more. Health professionals can also consider a client's specific diet patterns and financial situation to decide when it would be most effective to encourage selection of MNF food options that cost more and when to encourage moderation with LNF lower cost options.

CHAPTER FOUR: CONCLUSIONS AND IMPLICATIONS

The findings of this study suggest that most of the time, MNF food options can be purchased in grocery stores without increased cost to consumers. Knowing which MNF food options can be purchased at equivalent costs can help dietitians inform food insecure and/or lower socio-economic status consumers which specific food items they can buy without “putting a dent” in their budgets. Since cost plays such an important role in food selections of individuals with low income, awareness of MNF foods that do not cost more than LNF foods may help these individuals to decrease their fat, sodium, sugar and calorie consumption and increase their whole grain consumption. For instance, the results of this study show that if a client wants to decrease their fat intake he/she can purchase low-fat ice cream, hot dogs, breakfast meals, popcorn, frosting, soup and saltine crackers without increasing cost. Small, achievable dietary changes are encouraged. With small achievable dietary changes may come a decreased risk for various chronic health conditions including obesity.

CHAPTER FIVE: LIMITATIONS

The present results were based on the analyses of 13 grocery stores in Greenville, NC, and thus cannot be generalized to other areas. Also, we did not assess food pairs in side-marts, convenience stores, gas stations or corner shops there were not within the city limits of Greenville, NC; therefore, these findings cannot be generalized to low-income individuals located in rural areas. In addition, a larger sample size may have revealed different results.

CHAPTER SIX: FUTURE RESEARCH

Future research should evaluate and assess prices of MNF and LNF food pairs in stores that are frequented more often by low-income individuals; such as convenience stores, side-marts, gas stations and corner shops. Knowing the price difference in food pairs in these settings may further improve the diet quality of low-income individuals. Also, it may be interesting to assess the perceived cost barrier to eating healthy in such populations using a validated survey method.

Table 1. Food item pairs with price differences.

Nutrient	Food Item	Paired Food Items	Average Price per Package (USD)	Mean	SD	P-value	Percentage difference (%)
Fat	Bacon	Regular	2.66	0.19	0.03	0.000	41.15
		Low-Fat	4.06	0.29	0.04		
	Peanut butter crackers	Regular	2.40	0.24	0.00	0.000	19.98
		Low-fat	2.90	0.29	0.01		
	Deli meats	Regular	2.32	0.29	0.04	0.000	19.44
		Low-fat	2.80	0.35	0.04		
Ground beef	Regular	2.16	0.18	0.02	0.000	32.03	
	Low-fat	3.00	0.25	0.02			
Ground sausage	Regular	3.22	0.23	0.02	0.000	28.73	
	Low-fat	4.02	0.30	0.02			
Chips	Regular	3.50	0.35	0.03	0.000	15.70	
	Baked	4.10	0.41	0.04			
Fat (cont.)	Cheese	Regular	1.92	0.17	0.02	0.000	47.20
		Low-fat	3.06	0.27	0.08		
	Cheese	Regular	1.96	0.17	0.02	0.004	41.25
Fat free		2.95	0.26	0.10			
Hot Chocolate Mix	Regular	1.38	0.19	0.03	0.000	104.64	
	Low-fat	4.27	0.59	0.08			
Sodium	Ketchup	Regular	1.65	0.11	0.01	0.000	43.04
		Low-sodium	2.40	0.16	0.02		

Added Sugar	Oatmeal (flavored)	Regular	3.38	0.25	0.00	0.001	20.87
		Low-sugar	4.05	0.30	0.00		
	Hot Chocolate Mix	Regular	1.38	0.19	0.03	0.000	85.99
		Sugar-free	2.02	0.46	0.19		
Other	Egg	Regular	0.96	0.08	0.04	0.000	90.50
		Enhanced	2.52	0.21	0.02		
Whole Grain	Pasta	Regular	1.12	0.08	0.02	0.000	54.06
		Whole Wheat	1.96	0.14	0.01		
	Bread	Regular	1.18	0.06	0.01	0.000	49.97
		Whole wheat	2.03	0.09	0.00		

Table 2. Food item pairs found to have no difference in price.

Nutrient	Paired Items	Food Item(s)
Sugar	Regular vs. Sugar Free	Applesauce, Jello™, Pudding, Soda, Syrup
	Regular vs. Low-sugar	Pop tart
Whole Grains	White vs. Wheat	Bagel, English muffin, Muffin Mix
	Regular vs. Brown	Rice
Fat	Regular vs. Low-fat	Peanut butter, Biscuit, Canned meals, Cheese shells, Cinnamon rolls, Cookies, Cottage cheese, Croissant, Hot pocket, Kielbasa, Margarine, Sausage links, Tuna, Muffin Mix, Cool whip, Salad dressing, Milk, Sour cream, Spam, Yogurt
	Low-fat vs. Fat-free	Cool whip, Salad dressing, Milk, Sour cream, Spam, Yogurt
Salt	Regular vs. No added Sodium	Canned vegetables
	Regular vs. Unsalted	Peanuts
Calories	Regular vs. Light	Beer

Table 3. Food item pairs without statistically significant price differences, but with cent-for-cent differences.

Nutrient	Food Item	Paired Food Item	Mean	SD	P-value	Percent Difference (%)
Fat	Ice Cream	Regular Low-Fat	0.14 0.16	0.22 0.21	0.378	18.27
	Hot dogs	Regular Low-Fat	0.26 0.29	0.04 0.02	0.040	9.55
	Breakfast Meals	Regular Low-Fat	0.31 0.32	0.03 0.01	0.425	.58
	Popcorn	Regular Low-Fat	0.33 0.36	0.08 0.02	0.170	8.69
	Popcorn	Regular Fat-free	0.33 0.40	0.08 0.09	0.056	21.08
	Frosting	Regular Low-Fat	0.11 0.13	0.01 0.01	0.043	13.64
	Soup	Regular Low-Fat	0.11 0.13	0.03 0.02	0.012	19.55
	Saltine Crackers	Regular Low-Fat	0.13 0.13	0.03 0.03	0.281	5.51
Added Sugar	Ice cream	Regular Sugar-free	0.16 0.10	0.21 0.02	0.206	47.74
	Fruit	Regular Sugar-free	0.10 0.14	0.01 0.14	0.144	36.58
	Chocolate Sauce	Regular Sugar-free	0.08 0.11	0.02 0.02	0.047	27.92
Whole Wheat	Flour	Regular Whole wheat	0.06 0.06	0.02 0.02	0.332	6.05
	Frozen Waffles	Regular Whole wheat	0.21 0.24	0.07 0.04	0.133	12.72
	Pancake Mix	Regular Whole wheat	0.07 0.08	0.01 0.01	0.065	11.27
Other	Juice	Juice drink 100% juice	0.05 0.06	0.00 0.11	0.329	14.70
	Cereals	Regular “Healthy”	0.29 0.32	0.00 0.00	0.050	10.82

REFERENCES

1. QuickStats: Prevalence of overweight among children and teenagers, by age group and selected period---United State, 1963-2002. *MMWR Weekly*. **54** (2005), pp. 203.
2. Obesity: Halting the epidemic by making health easier. National Center for Chronic Disease Prevention and Health Promotion. 2009.
Available:<http://www.cdc.gov/nccdphp/dnpa>. Accessed on December 14, 2008.
3. J. Putnam, J. Allshouse, L. Kantor. U.S. per capita food supply trends: more calories, refined carbohydrates, and fats. *Food Review*. **25** (2002), pp. 2-15.
4. S. Nielsen, A. Siega-Riz, B. Popkin. Trends in energy intake in U.S. between 1977 and 1996; similar shifts seen across age groups. *Obesity Research*. **10** (2002), pp. 370-378.
5. A. Drewnowski & S. Specter. Poverty and obesity: the role of energy density and energy costs. *American Journal of Clinical Nutrition*. **79** (2004), pp.6-16.
6. US Department of Agriculture, Economic Research Service, Briefing room. 2008.
Available at: www.ers.usda.gov/Briefing/CPIFoodAndExpenditures/. Accessed on December 14, 2008.
7. K. Glanz, M. Basil, E. Maibach, J. Goldberg, D. Snyder. Why Americans eat what they do: Taste, nutrition, cost, convenience and weight control concerns as influences on food consumption. *Journal of the American Dietetic Association*. **98** (1997), pp. 1118-1126.
8. M. Lennernas, C. Fjellstrom, W. Becker, I. Giachetti, A. Schmitt et al. Influences on food choice perceived to be important by nationally-representative samples of adults in the European Union. *European Journal of Clinical Nutrition*. **51** (1998), pp. S8-S15.

9. T. Quan, J. Salomon, S. Nitzke, M. Reicks. Behaviors of low-income mothers related to fruit and vegetable consumption. *Journal of the American Dietetic Association*. **2** (2000), pp. 505-512.
10. M. Riecks, J. Randall, B. Haynes. Factors affecting vegetable consumption in low-income households. *Journal of the American Dietetic Association*. **94** (1994), pp. 1309-1311.
11. D. Cox, A. Anderson, M. Lean, D. Mela. UK consumer attitudes beliefs and barriers to increasing fruit and vegetable consumption. *Publ. Health Nutr.* **1** (1998), pp. 61-68.
12. K. Dittus, V. Hillers, K. Beerman. Benefits and barriers to fruit and vegetable intake: relationship between attitudes and consumption. *Journal of Nutrition Education*. **27** (1995), pp. 120-126.
13. N. Darmon, E. Ferguson, A. Briend. A cost constraint alone has adverse effects on food selection and nutrient density: an analysis of human diets by linear programming. *Journal of Nutrition*. **132** (2002), pp. 3764-3771.
14. N. Darmon, A. Briend, A. Drewnowski. Energy-dense diets are associated with lower diet costs: a community study of French adults. *Publ. Health Nutr.* **7** (2004), pp.21-27.
15. U.S. Census Bureau, Current Population Survey: Annual Social and Economic Supplement. 2008.
16. S. A. Anderson. Core indicators of nutritional state for difficult-to-sample populations. *Journal of Nutrition*. **120** (1990), pp. 1559-1600.

17. M. Melchior, M. Goldberg, N. Krieger. Occupational class, occupational mobility and cancer incidence among middle-aged men and women: a prospective study of the French GAZEL cohort. *Cancer Causes Control*. **16** (2005), pp. 515-524.
18. A. Molarius, J.C. Seidell, S. Sans, J. Tuomilehto, K. Kuulasmaa. Education level, relative body weight and changes in their association over 10 years: an international perspective from the WHO MONICA Project. *American Journal of Public Health*. **90** (2000), pp. 1260-1268.
19. P.M. Lantz, J.S. House, J.M. Lepowski, D.R. Williams, R.P. Mero, J. Chen. Socioeconomic factors, health behaviors and mortality: results from a nationally representative prospective study of US adults. *JAMA*. **279** (1998), pp. 1703-1708.
20. E.J. Brunner, M.G. Marmot, K. Nanchahal et al. Social inequality in coronary risk: central obesity and the metabolic syndrome. Evidence from the Whitehall II study. *Diabetologia*. **40** (1997), pp. 1341-1349.
21. J.M. Evans, R.W. Newton, D.A. Ruta, T.M. MacDonald, A.D. Morris. Socioeconomic status, obesity and prevalence of type 1 and type 2 diabetes mellitus. *Diabet Med*. **17** (2000), pp. 478-480.
22. M. Tang, Y. Chen, D. Krewski. Gender-related differences in the association between socioeconomic status and self-reported diabetes. *International Journal of Epidemiology*. **32** (2003), pp. 381-385.

23. T. Lang, P. Ducimetiere. Premature cardiovascular mortality in France: divergent evolution between social categories from 1970 to 1990. *International Journal of Epidemiology*. **24** (1999), pp. 331-339.
24. D. Pearson, R. Taylor, T. Masud. The relationship between social deprivation, osteoporosis, and falls. *Osteoporos International*. **15** (2004), pp. 132-138.
25. B.L. del Rio, B.M. Romera, S.J. Pavia et al. Bone mineral density in two different socioeconomic population groups. *Bone Miner*. **18** (1992), pp. 159-168.
26. S.T. Reisine, W. Psoter. Socioeconomic status and selected behavioral determinants as risk factors for dental caries. *J Dent Educ*. **65** (2001), pp. 1009-1016.
27. Department for Environment. National Food Survey, 2000. Food and Rural Affairs, (2001).
28. Department of Health. Nutritional aspects of cardiovascular disease (1994).
29. P. Monsivais & A. Drewnowski. The rising cost of low-energy-density foods. *Journal of the American Dietetic Association*. **107** (2007), pp. 2071-2076.
30. A. Drewnowski, & N. Darmon. The economics of obesity: dietary energy density and energy cost. *American Journal of Clinical Nutrition*. **82** (2005), pp. 265S-273S.
31. A. Drewnowski & N. Darmon. Food choices and diet costs: an economic analysis. *The Journal of Nutrition*. **135** (2005), pp. 900-904.

32. D. Moore, G. McCabe & B. Craig. *Introduction to the Practice of Statistics* (6th ed.).
(2009). W.H. Freeman and Company: New York.

