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Title: Assessing variety and pricing of selected foods in socioeconomic disparate districts of Berlin, Germany

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Abstract: Aim: The neighbourhood environment appears to influence people's food consumption. Access, variety and pricing of foods play a role in the socioeconomic difference of fruit and vegetable consumption. This study compared differences in number of grocery stores, variety of fresh fruits and vegetables and food prices in districts with different Social Index (SI) in Berlin, Germany.
Methods: The district with the lowest SIs was compared to the district with the highest SI. The number of grocery stores offering fresh produce, the variety of fresh fruits and vegetables, and prices of selected healthy and less healthy food items were assessed and compared.
Results: The low SI district had more grocery stores per residents than the high SI district. Variety and prices of fruits and vegetables did not differ between the two districts but milk and whole wheat bread were less expensive in the high SI district. For all grocery stores, selected foods with higher energy density had lower energy costs than low energy density foods.
Conclusion: Health inequalities in Germany might be less influenced by access to healthy foods than in other countries but nutrient rich foods such as fruits and vegetables have higher energy costs than high energy dense foods.

Response to Reviewers: Response to reviewer's comments:

The authors provide no explanation why cigarettes are included in the study, which deals with pricing of food. Cigarettes don't belong to any group of food, so it has to be explained why they are analysed in this context as well.

- The authors have decided to exclude the item "cigarettes" from the analysis and the manuscript. The authors agree with the reviewer that the topic of cigarette pricing and its relationship to socioeconomic differences does not belong in this manuscript.

p. 2, 1st paragraph: ". behaviour. ", should use similar terms as in the rest of the text.

- The British orthography was used and all words were changed accordingly.

p. 5, 1st paragraph: The two areas Kreuzberg and Steglitz-Lankwitz are compared, but the population density is given for the three areas: Kreuzberg, Steglitz and Lankwitz. This is confusing and should be clarified.

- Official data only provides population density separately for Steglitz and Lankwitz but the authors hopefully clarified this confusion by calculating the mean for both areas.

p. 5, 1st paragraph and p. 9, 3rd paragraph: information about the size of the two areas is inconsistent: p.5 ". roughly the same size. ", p. 9 ". size. differed."

- The information regarding the size of the areas chosen was clarified.

p. 5, 3rd paragraph: It should be explained in this paragraph why the variety of food items was determined only in non-organic food stores (compare p.6, 1st paragraph).

- A sentence explaining the reasons for choosing only non-organic food stores was added (p. 5, 3rd paragraph)

p. 6, 1st paragraph: Which established criteria for the popularity for the chosen food products in the German population were used?

- A reference was added.

p. 7, 1st paragraph: ". framers´ markets. ", should use similar terms as of the rest of the text.

- For all markets, the expression "farmers' markets" was chosen.

p. 8, 2nd paragraph: The relationship between energy density and energy costs should be explained shortly in the part "results", only referring to the figure would not be sufficient.

- The results presented in figure 1 were explained in more details (p. 8, 2nd paragraph).

p. 9, last paragraph and p. 11, 1st paragraph are identical.

- The last paragraph on page 9 was taken out.

*Title Page

Assessing variety and pricing of selected foods in socioeconomic disparate districts of Berlin, Germany.

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RUNNING HEAD: Environment, Food Variety and Pricing

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Abstract

Aim: The neighbourhood environment appears to influence people's food consumption. Access, variety and pricing of foods play a role in the socioeconomic difference of fruit and vegetable consumption. This study compared differences in number of grocery stores, variety of fresh fruits and vegetables and food prices in districts with different Social Index (SI) in Berlin, Germany.

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Results: The low SI district had more grocery stores per residents than the high SI district. Variety and prices of fruits and vegetables did not differ between the two districts but milk and whole wheat bread were less expensive in the high SI district. For all grocery stores, selected foods with higher energy density had lower energy costs than low energy density foods.

Conclusion: Health inequalities in Germany might be less influenced by access to healthy foods than in other countries but nutrient rich foods such as fruits and vegetables have higher energy costs than high energy dense foods.

Keywords: environment, fruit and vegetables, pricing, accessibility, variety

Introduction

Unhealthy dietary behaviour, in particular the consumption of fruits and vegetables has been shown to be particularly low among socioeconomically disadvantaged populations (Giskes et al. 2002; Hulshof et al. 2003). A systematic review revealed that household income appears to be consistently positively related to fruit and vegetable intake (Kamphuis et al. 2006) and lower socioeconomic groups seem to be less likely to follow existing dietary guidelines (Turrell et al. 2002).

Another factor that has been gaining attention recently is the possible influence of neighbourhood food environment. Recent studies from the U.S. suggest that residents of socioeconomically disadvantaged neighbourhoods have less access to affordable healthy food choices compared to high socioeconomic neighbourhoods (Jetter et al. 2006; Hendrickson et al. 2006; Chung et al. 1999; Moore et al. 2006; Powell et al. 2007; Zenk et al. 2009). Healthier food choices in deprived areas differ in their availability, variety and in price compared to healthier choices in less deprived areas. In deprived areas fewer variety of fresh fruits and vegetables is offered and fresh produce tend to be more expensive (Hosler et al. 2008; Zenk et al. 2005). However, other studies show few or no differences in food prices, availability or access between deprived and affluent areas (Cassady et al. 2007; Smith et al. 2009; Winkler et al. 2006a; Winkler et al. 2006b). Two recent systematic reviews examining the empirical evidence found only little evidence for the influence of environmental factors on fruit and vegetable consumption (Giskes et al. 2007;Kamphuis et al. 2007).

Another aspect of the food environment has been gaining attention in the public health sector; high energy dense foods, high fat foods and general convenience, processed foods including fast

food tend to be cheaper than healthy foods such as fresh fruits or vegetables (Drewnowski et al. 2004; Darmon et al. 2004). Research on dietary behaviour and social inequalities suggest that low income households rather purchase energy dense foods that are nutrient poorer but are at an affordable cost compared to more expensive nutrient rich foods such as fresh fruits and vegetables (Drewnowski et al. 2005; Drewnowski 2009). Data from the U.S. shows an inverse relationship between the energy density of foods and the energy costs measured in USD/1000kcal (Drewnowski et al. 2005). It is possible that lower food costs might be associated with higher energy dense diets which might lead to an increase in total energy intake. As a consequence, the higher prevalence of overweight and obesity in socio-economically disadvantaged groups could be explained by this imbalance of economics of food choice. Research in the area of food environment and social inequality in Germany is lacking. Although socioeconomic inequalities is less pronounced in Germany compared to other countries (van Doorslaer et al. 2004; Hernandez-Quevedo et al. 2006), prior research has shown that people of low economic standing in Germany have above average rates of malnutrition, eating disorders and obesity (Mackenbach et al. 2008; Robert Koch-Institut 2006). The capital city of Germany, Berlin, consists of a number of districts where inhabitants live under conditions differing widely by their socioeconomic situation such as income, unemployment rate, and ethnic background as well as in their health and disease status (Senatsverwaltung für Gesundheit 2009).

In this pilot study, we sought to determine if differences in the food neighbourhood environment are apparent in Berlin, Germany. We analyzed the two districts with the largest social economic disparity and studied their availability of stores, produce prices and fruit and vegetable variety.

Methods

This study investigated access to food within two districts in Berlin comparing the districts with the lowest and highest socioeconomic population. The study examined (1) the number of grocery stores offering fresh produce; (2) the variety of fresh fruits and vegetables available to the consumers; and (3) the prices of a series of food items defined as healthy and unhealthy. Healthy food items included a series of popular fresh fruits and vegetables, milk and whole-wheat bread. As unhealthy, energy dense food items, such as frozen pizza, chocolate, and potato chips were chosen.

Setting

Two areas in Berlin similar in size but with a widely different socioeconomic population were selected. The socioeconomic difference between the two areas was determined by a complex measuring tool called the Social Index (SI) created by the city of Berlin (Senatsverwaltung für Gesundheit 2009). The SI was developed to determine social differences between Berlin's neighbourhoods and to create a common ground for analysis and planning of social communities. Among other things, the index is based on unemployment rates, average per capita income, number of people on social welfare, and life span expectancy. We chose to study the area of Kreuzberg which lies within the community district of Kreuzberg-Friedrichshain and represents the neighborhood with one of lowest SI in Berlin based on the SI of 2008. The other area chosen was Steglitz and Lankwitz which is an area within the community district of Steglitz-Zehlendorf. Steglitz-Zehlendorf represents the neighborhood with the highest SI in Berlin in 2008. The net household income in Kreuzberg-Friedrichshain in 2006 was € 1,175 per months whereas the net household income in Steglitz-Zehlendorf was € 1,850. The areas are roughly of the same size

(10.4 km2 for Kreuzberg and 13.8 km^2 for Steglitz and Lankwitz) but population density is higher in Kreuzberg (14.239 residents/km^2) compared to Steglitz and Lankwitz (8.085 residents/km^2; Steglitz is 10.391 residents/km^2 and Lankwitz is 5.778 residents/km^2).

Availability

Within the districts the number of food stores including organic grocery stores and farmers' markets were counted. Food stores were identified through systematic investigation of each and every street within the established district borders. Farmers' markets were located through internet research. Food stores were defined as stores that offer at least one type of fresh vegetable and one type of fresh fruit (except lemons or limes). Food stores had to be open at least 5 days/week for 8 hours/day. Farmers' markets were included if they were open for at least 6 hours/week. Availability was defined as the number of food stores and farmers' markets per 10.000 residents.

Variety of fresh fruits and vegetables within food stores

Variety of food items was determined through the visual count of different kinds of fresh fruit and vegetables available at each store by a trained surveyor to all non-organic food stores during the months of May through July 2009. Given that organic food stores are still relatively rare as well as usually limited in their fruit and vegetable variety, only non-organic food stores and foods were assessed. The following fresh fruit and vegetable items were summarized into larger categories and counted as one: berries (strawberries, cranberries, raspberries, blackberries), lemon (lemon and limes), melons (watermelons, cantaloupes, honeydew), and cabbage (red cabbage, green cabbage, chinese cabbage). To control for seasonal variation and to increase

comparability, we collected data concurrently in both districts and completed data collection within 12 weeks.

Pricing

For the purpose of price comparison between stores and districts, the most economical price for a sample of 12 products was recorded. The 12 products were chosen because of their popularity among the German population (DFHV, 2009). Food prices of the following 12 food products were measured: apples, bananas, tomatoes, carrots, potatoes, whole wheat bread, fresh milk, frozen pizza, chocolate, potato chips, and beer. Since the most economical price for each food was often found in bulk quantities we calculated prices for predetermined amounts. Prices for fresh fruit and vegetable items were noted per one kilogram (1000 grams). Prices for whole wheat bread, chocolate and chips were recorded per 100 grams. Fresh milk prices were recorded as price per carton (1 liter), beer prices as the cost per 0.5 liter, and frozen pizza as price for one pizza (300 grams). Organic food stores were not entered to record prices or produce variety because high quality standards often cause costs to increase which makes sold items unaffordable to many people and high prices would result in distorted price averages.

Statistical Analysis

Analysis of variance was used to examine differences by district (low SI vs. high SI) in the mean number of fruits and vegetables and the mean lowest prices of the selected food items available in all stores. Using the average caloric content of selected food items (100g pizza = ca. 216kcal, 100g potato chips = ca. 547 kcal, 100g chocolate = ca. 536 kcal, 100g apples = ca. 49 kcal, 100g

bananas = ca. 95 kcal, 100g carrots = ca. 25 kcal), the relationship between energy costs (Euro €/1,000 kcal) and energy density (kcal/g) of each food item was calculated.

Results

The low SI district (Kreuzberg) had greater access to supermarkets compared to the district with high SI (Steglitz + Lankwitz). Per 10,000 residents, in the low SI district 5.88 food stores (including farmer markets and organic food stores; N = 87) were available compared to only 4.42 food stores in the high SI district (N = 46). More organic food stores and farmers' markets were available in the low SI area compared to the high SI area.

Number of types of fruits and vegetables in the low SI district did not differ significantly from the number of types of fruits and vegetables in the high SI district (table 1).

- insert table 1 -

In the low SI district, prices of the selected food items were assessed in 72 grocery stores including 13 supermarkets, 23 discounters, and 36 farmers' markets. In the high SI district only 45 grocery stores including 18 supermarkets, 18 discounters, and nine farmers' markets were found. Including all types of food stores (super markets, discounters and farmers' markets) fruits and vegetables did not differ in pricing between the two districts. No differences were found for apples, bananas, tomatoes, carrots and beer. Potatoes (F= 9,122, p= 0.003), whole-wheat bread (F= 9,527, p = 0.003), fresh milk (F= 56,179, p = 0.000), chocolate (F= 40,489, p = 0.000), potato chips (F= 32,655, p = 0.000), and frozen pizza (F= 5,819, p = 0.018) were significantly

cheaper in the high SI district compared to the low SI district (table 1). However, when the local farmers' markets which were more common in the low SI district were taken out of the analysis, the only four remaining items that were less expensive in the high SI district were whole-wheat bread (0,16 vs. 0,14; F=20,208, p = 0.000), fresh milk (0,50 vs. 0,48; F= 6,634, p= 0.012), and potato chips (0,29 vs. 0,28; F = 6,081, p = 0.016). Without the farmers' markets, bananas were cheaper in the low SI district compared to the high SI district (1,18 vs. 1,13; F= 10,589, p = 0.002).

To compare pricing of selected low and high energy dense foods, the mean prices of all grocery stores for the following food items were chosen: chocolate, potato chips, pizza, apples, bananas and carrots. Figure 1 shows the relationship between energy density (kcal/g) and energy costs (Euro€/1,000kcal) of a selection of low and high energy dense foods. It shows that energy costs for apples (3,26€/1,000kcal), bananas (4,10€/1,000kcal), and carrots (4,88€/1,000kcal) are higher than for pizza (2,16€/1,000kcal), potato chips (0,84€/1,000kcal), and chocolate (0,66€/1,000kcal) whereas energy density is higher for pizza (2,16kcal/g), potato chips (5,47kcal/g), and chocolate (5,36kcal/g) compared to apples (0,49kcal/g), bananas (0,95kcal/g) and carrots (0,25kcal/g).

- insert figure 1 -

Discussion

The variety and prices of the examined food items were similar in the high and low socioeconomic districts. More grocery stores per 10.000 residents were found in the low SI area compared to the high SI area. The variety of fruits and vegetables did not differ between the districts and no differences could be found in terms of fruit and vegetable prices. These findings

are in line with several other studies (Smith et al. 2009; Zenk et al. 2009; Cassady et al. 2007) . However, other food items such as fresh milk and whole wheat bread tended to be cheaper in the high SI district which in part supports the idea that healthy food choices tend to be more expensive in more disadvantaged neighbourhoods.

Looking at high-fat/energy-dense foods such as pizza, potato chips and chocolate significantly higher prices were observed in the low SI neighborhood. A possible explanation for the higher prices could be that grocery stores simply sell some of products at a higher price in neighbourhoods with a higher demand for these types of foods and products. Since this effect is mainly observed for unhealthy food items and not for fruits and vegetables it raises the question of the possibility of existing health inequity based on socio-economic standing.

In general, food pricing in Germany appears to be similar to food pricing in other nations with energy dense foods to be the lowest cost dietary options. For people with low SI, the financial aspect of foods most likely plays a crucial role in their purchase behaviour.

Limitations of this study

Several limitations of this study need to be mentioned. This was a pragmatic case-study approach with the focus on two geographically comparable areas in one particular city. Mainly the population density between the two districts differed. This approach does not allow the comparison of associations between neighbourhood deprivation and food accessibility for the full range of urban and rural settings across the world or even across Germany only.

The findings of this study can only be generalized to the study region and spatial inequality might exist in rural and small town settings in Germany. In addition, no information on

residents' shopping behaviours was obtained and food quality was also not addressed. Other food outlets such as convenience stores without fresh fruits and vegetables, restaurants, snack bars that might play a role in determining food item pricing were also not examined.

Possible Implications and future research

To our knowledge, this is the first study in Germany looking at neighbourhood food environments. The findings showed that the food environment in a socioeconomically disadvantaged area was as conducive to buying healthier food choices as in a more advantaged area. One possible explanation could be that within the German population social inequality is less pronounced than in other countries such as the U.S. and therefore the difference of social status in the chosen urban districts was too small to be a factor in the food environment. However, for the districts observed, energy dense foods were cheaper and therefore potentially more in demand in low SI districts than nutrient rich foods. Nevertheless, while prices for healthy foods appear to be similar in the districts, the purchase of such foods is determined by financial resources available to buyers. In particular, food inequity could be questioned since people with lower purchasing power have to pay similar prices for healthy foods compared to those with higher purchasing power.

Our findings could suggest that inequalities in food intake may have little to do with the food environment in Germany but rather the economics of food choice. Social inequality in Germany has been linked to obesity and other chronic disease and as Drewnowski and colleagues (Drewnowski et al. 2005; Drewnowski 2004) have recently pointed out, more likely factors for the lower nutritional quality of diets of low-income households could be the low cost of energy-dense foods. Thus, as long as energy dense foods are highly palatable and cheaper we believe it

will be difficult to change low-income household's food choices and health inequity through pricing remains.

Further research needs to be conducted not only in other geographical areas in Germany and Europe in general but also other mechanisms such as cooking skills and habits in households as well as food costs and its relationship with energy density need to be examined. Currently not enough is known if and how household and food shopping environments affect population intake of fruits and vegetables and its relationship to socioeconomic inequalities in food intake.

Conflict of interest statement

The authors declare that they have no conflict of interest.

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Table

Table 1. Fruit and vegetable variety and mean pricing in Euro (€) and Standard Error of the Mean (SEM) of foods by neighbourhood socioeconomic standing.

	Low SES (N=72)	High SES (N=45)
Number of fruits (SD)	14.21 (5.94)	16.09 (3.23)
Number of vegetables (SD)	18.75 (6.13)	20.64 (4.14)
Apples (1000g) in € (SEM)	1,44 (,06)	1,49 (,08)
Bananas (1000g) in € (SEM)	1,39 (,05)	1,42 (,07)
Tomatoes (1000g) in € (SEM)	1,93 (,09)	1,59 (,11)
Carrots (1000g) in € (SEM)	1,30 (,04)	1,12 (,06)
Potatoes (1000g) in € (SEM)	0,85 (,05)	0,84 (,04) †
Whole-wheat bread (100g) in € (SEM)	0,19 (,03)	0,14 (,00) †
Fresh milk (1l) in € (SEM)	0,63 (,04)	0,48 (,00) †
Frozen pizza (300g) in € (SEM)	0,83 (,06)	0,71 (,01)*
Chocolate (100g) in € (SEM)	0,51 (,04)	0,36 (,00) †
Potato chips (100g) in € (SEM)	0,46 (,04)	0,30 (,02) †
Beer (0.5l) in € (SEM)	0,41 (,03)	0,34 (,03)
Cigarettes (17 per packet) in € (SEM)	3,39 (,03)	3,28 (,01) †

* $p < 0.05$

† $p < 0.01$

Figure

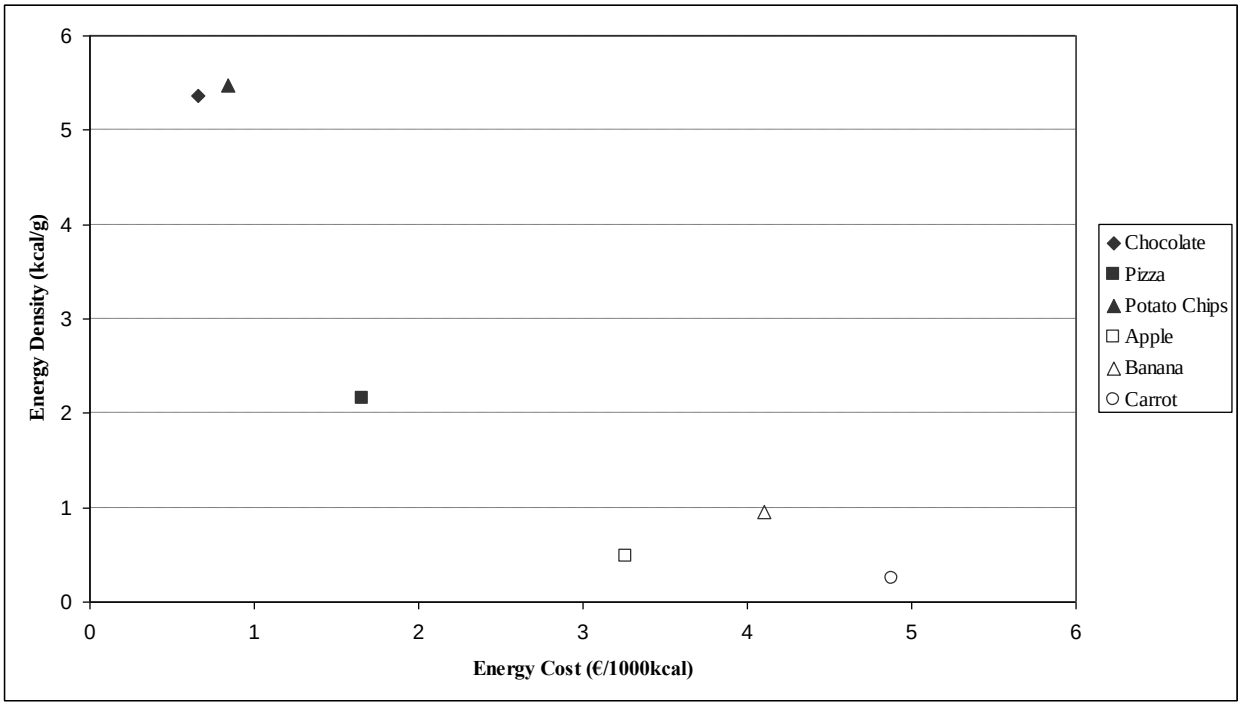

Figure 1. Relationship between energy density (kcal/g) and energy costs (Euro€/1,000kcal) of selected food items