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**Relating diet, demographics and lifestyle to increasing US obesity rates/ Der Einfluss von Ernährung, Demographie und Lifestyle-Faktoren auf das Vorkommen von Adipositas in den USA**

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Christiane Schroeter

Purdue University, West Lafayette, USA

**Abstract**

Changes in the American lifestyle are putting more individuals at risk due to the declining quality of their diets. In the last 20 years, the readily available high-fat foods (e.g., "fast foods") combined with the decreased caloric requirements due to lower physical activity levels is assumed to be the major factor in the sharp rise in the prevalence of obesity. The typical away-from-home meal is less healthy than food at home, since it tends to contain more total fat and saturated fat, less calcium, fiber, and iron, and fewer servings of fruits and vegetables. Furthermore, due to the super-sizing trend that is sweeping the market, when Americans eat out, they eat more. Thus, a rising away-from-home consumption appears to establish a significant barrier to improve American dietary habits and health status. The continuously increasing trend towards obesity is affecting the public health system tremendously, since four of the ten leading causes of death in the US, including heart disease, cancer, stroke, and diabetes, are strongly associated with poor diet and physical inactivity. In terms of lost productivity and medical expenses, it leads to an estimated cost of \$200 billion each year. Despite the considerable change in demographics and lifestyles, little research has documented the impact of changes in these factors on the rising US obesity. The objective of this study is to determine the impact of food source, diet, demographic, and lifestyle on the prevalence of obesity and overweight.

This study will be based on data from the National Health and Nutrition Examination Survey (NHANES, 1999-2000), which, among many other variables, includes measured weight and height and hence provides the best opportunity to track trends in weight in the US NHANES, administered by the US Department of Health and Human Services. The NHANES provides nationally representative information on the health and nutritional status of the US population. While controlling for demographics, lifestyle and diet information, the main goal is to determine whether the source from which food is obtained also contributes to the increased overweight. Linear regression is applied to estimate the effect of food source, particularly fast-food outlets and restaurants, on the body mass index (BMI). BMI expressed as  $\text{weight}/\text{height}^2$  (i.e.  $\text{kg}/\text{m}^2$ ), is commonly used to classify overweight (BMI: 25.0-29.9) and obesity (BMI:  $\geq 30.0$ ) among adults (age 18 years and over). Previous studies have found gender-specific differences in the effect of different factors on the BMI. This is tested empirically in this study. Quantifying the effects of demographic and lifestyle determinants on BMI will provide a better understanding of the impact of different factors on obesity.

**Key words**

obesity; food source; fast food; diet; lifestyle

**Zusammenfassung**

Veränderungen im US-amerikanischen Lebensstil bilden Risikofaktoren für die amerikanische Bevölkerung aufgrund der sinkenden Ernährungsqualität. Es wird angenommen, dass der in den letzten 20 Jahren gestiegene Anteil an fettreichen Speisen (z.B. "Fast Food") kombiniert mit dem gesunkenem Anteil an körperlicher Tätigkeit die Hauptursache für das vermehrte Vorkommen von Adipositas bildet. Die typische Außer-Haus-Verpflegung ist weniger gesund, als zu

Hause zubereitete Speisen, da Außer-Haus-Verpflegung dazu neigt, mehr gesättigte Fettsäuren und Fett zu enthalten, weniger Kalzium, Ballaststoffe und Eisen sowie kleinere Portionen von Früchten und Gemüse. Ferner besteht die Tendenz zu größeren Portionen ("super-sizing"), was dazu führt, dass Amerikaner mehr essen, wenn sie essen gehen. Folglich erscheint der Anstieg in der Außer-Haus-Verpflegung eine Verschlechterung der Ernährungsgewohnheiten und im Gesundheitsstatus der amerikanischen Bevölkerung zu begünstigen. Der kontinuierliche Anstieg im Vorkommen von Adipositas hat einen starken Einfluss auf das öffentliche Gesundheitssystem in den USA, da vier von den zehn häufigsten Todesursachen - Herzinfarkt, Krebs, Schlaganfall und Diabetes - alle stark mit schlechter Ernährungsqualität und körperlicher Untätigkeit verbunden sind. Die Summe von Produktivitätsausfällen und medizinischen Ausgaben führt zu geschätzten Kosten von \$200 Milliarden pro Jahr. Trotz der beträchtlichen Änderungen in der soziodemographischen Struktur und dem Lebensstil in den USA sind die Auswirkungen dieser Faktoren auf das erhöhte Vorkommen von Adipositas bisher kaum untersucht worden. Ziel der vorliegenden Studie ist es, die Einflüsse von Nahrungsquelle, Ernährungsgewohnheiten, soziodemographischen Variablen und Lebensstil auf das Vorkommen von Übergewicht und Adipositas zu bestimmen. Diese Studie verwendet Daten der US-amerikanischen Nationalen Gesundheits- und Nahrungsuntersuchungs-Befragung (NHANES, 1999-2000). Diese Studie erfasst neben vielen anderen Messgrößen auch das Körpergewicht und die Größe der Individuen und bietet deshalb die beste Grundlage dafür, Trends im Körpergewicht bei der amerikanischen Bevölkerung zu verfolgen. NHANES 1999-2000 wird vom amerikanischen Gesundheitsministerium verwaltet und stellt repräsentative Informationen über die Gesundheit und den Ernährungsstatus der Bevölkerung in den USA dar. Das Hauptziel dieser Studie ist zu testen, ob die Art der Nahrungsquelle zur zunehmenden Bedeutung von Adipositas beiträgt. Zusätzlich werden die Einflüsse soziodemographischer Variablen, des Lebensstils und der Ernährungsgewohnheiten untersucht. In linearen Regressionsmodellen wird die Wirkung der Nahrungsquelle, besonders von Fast-Food-Anbietern und Restaurants, auf den Body-Mass-Index (BMI) geschätzt. Der BMI wird als Körpergewicht/Größe<sup>2</sup> ausgedrückt, also kg/m<sup>2</sup>, und wird normalerweise benutzt, um Übergewicht (BMI: 25,0-29,9) und Adipositas (BMI: ( 30,0) unter Erwachsenen (über 18 Jahren) zu klassifizieren. Bisherige Studien haben geschlechtsspezifische Unterschiede im Einfluss von verschiedenen Faktoren auf den BMI gefunden. Dies wird in dieser Studie überprüft werden. Eine Quantifizierung der Wirkungen von soziodemographischen Variablen und des Lebensstils auf den BMI kann zu einem besseren Verständnis der Rahmenbedingungen führen, die Adipositas fördern.

### **Schlüsselwörter**

Adipositas; Nahrungsquelle; Fast Food; Ernährung; Lifestyle

### **1. Introduction and objective**

Since the 1960s, the number of overweight and obese Americans has continuously increased to about two-third of the adult population. Each year, obesity leads to a loss in productivity and medical expenses of \$200 billion and results in 300 000 premature deaths in the US (US Department of Health and Human Services, 2000). Many other developed countries observe significant increases in their inhabitants' body weights; however, no other country experiences an obesity epidemic as the US (Cutler et al., 2003). Some heritability studies suggest that genetic factors account for as much as 70% of the variability in human body weight. However, the genetic background of Americans could not have changed that much over the past two decades to be solely responsible for the trend of a rising body weight (Yanovski and Yanovski, 1999). Available evidence from previous studies suggests that obesity is a multi-factorial disease, because multiple determinants influence the increase in body weight, ranging from economic factors such as income and prices, to demographics, lifestyle, and of course, dietary considerations. From an energy-accounting standpoint, obesity arises due to significant increases in calories consumed while energy expended remains constant (Young and Nestle, 2002). Cutler et al. (2003) propose that the increase in mass preparation has led to a decrease in time spent on food preparation and consumption and, consequently, to a rise in the amount and the diversity of foods consumed. Some studies suggest that eating out is one of the main culprits for the sharp rise in energy intake (Jeffery and French, 1998; Binkley et al., 2000). The average US American eats out four to five times per week and spends 45% of the food dollars away from home. Since the 1970s, portion sizes increased and the body weights of Americans started growing in parallel to the 'supersizing' trend, which means when Americans eat out, they eat more (Spake and Brophy, 2002; Young and Nestle, 2002). Apparently, consumers eating out search "value for dollar" (Sciencedaily, 2000). Undermining this problem is the fact that the per-capita number of fast food restaurants doubled between 1972 and 1997 (Chou et al., 2002). Other studies rule out the possibility that increased portion sizes contribute to obesity. Cutler et al. (2003) argue that calories at main meals, especially dinner, did not increase enough to support this theory. Furthermore, the researchers oppose the suggestion that eating out has made Americans obese. While they agree that fast-food consumption has increased, it largely replaces home consumption. Cutler et al. (2003) suggest that the increase of energy consumed stems from increased snack consumption. Hence, it seems that previous studies have not yet reached a clear conclusion how the different food sources influence obesity in the

US. It is important to quantify influences on obesity in order to develop effective prevention strategies. Overweight and obesity are commonly classified by the body mass index (BMI). BMI expressed as weight/height<sup>2</sup> (i.e. kg/m<sup>2</sup>), classifies overweight (BMI: 25.0-29.9) and obesity (BMI:  $\geq$  30.0) among adults (age 18 years and over) (CDC and NCHS, 2002b). The objective of this study is to determine the impact of (1) food source, (2) diet, (3) demographic, and (4) lifestyle information on BMI of US adults. This study expands on previous research in a number of ways. First, this study updates the analysis of Binkley et al. (2000), who used secondary data from the 1994-1996 Continuing Survey of Food Intake by Individuals (CSFII). This study uses data from the 1999-2000 National Health and Nutrition Examination Survey (NHANES). Apart from using a more recent data set, this study will more importantly focus on additional factors affecting obesity. Past studies have stressed a link between BMI and eating out by using variables representing restaurant and fast food. The drawback of such an approach, however, is that the remaining food source options, such as eating at home, are not taken into consideration. Information of perhaps even greater interest is whether other food sources besides restaurant and fast food contribute to the increase in obesity rates. While controlling for demographics, lifestyle and dietary information, the main goal of this study is to determine whether the source from which food is obtained contributes to the increase in reported rates of obesity in the US.

Quantifying the effects of food source, demographic and lifestyle determinants on BMI will provide a better understanding of the impact of these different factors on the obesity epidemic. The availability of this information will help health and nutrition educators considering design, development and improvement of strategies, programs and information for weight maintenance as well as weight reduction.

## **2. Quantitative importance of obesity in the US**

Trend data from the US National Health and Nutrition Examination Survey (NHANES) have shown that the percentage of obese people has increased from 14.5% in the years 1976-1980 to 22.5% in 1988-1994. Additional reports from other sources, such as the Behavioral Risk Factor Surveillance System (BRFSS) and the Harris poll, have supported these findings. However, reports from the BRFSS and the Harris poll are based on self-reported weight and height, a technique which leads to limitations of the results (Flegal et al., 2002). Mokdad et al. (1999) showed that obesity prevalence estimations tend to be lower than those that are based on measured data. In their study, they compared the BRFSS (1991-1994) with the corresponding NHANES (1988-1994) survey. The BRFSS showed a prevalence of obesity of 12 to 14.4% whereas the NHANES estimate of 22.5% was about twice as large. NHANES data, which among many other variables includes measured weight and height, provides the best opportunity to track trends in weight in the US. Comparing age-adjusted estimates of BMI from NHANES II (1976-80) to those from NHANES III (1988-94) shows an increase in the percentage of respondents who were either overweight or obese. Most of this increase is due to the growing obese category whereas only minor increases occurred in the overweight category. Results from the 1999-2000 NHANES indicate that an estimated 64% of US adults are either overweight or obese. Studies show that the BMI is approximately 8% higher than equivalent values obtained from NHANES III (1988-94) (CDC and NCHS, 2002b).

One of the US health objectives for 2010 is to reduce the prevalence of adult obesity to less than 15%. However, the NHANES 1999-2000 data suggests another increase in the proportion of obese US adults. The share increased from a previous level of 23% to a new level of 31%. Among adults, age 20-74 years, the estimated prevalence of obesity has doubled between NHANES II (1976-1980) and NHANES 1999-2000, from approximately 15% to an estimated 31% (CDC and NCHS, 2002b).

## **3. Methods**

### **3.1 Study sample**

This study uses data from NHANES 1999-2000. The purpose of NHANES, administered by the US Department of Health and Human Services, is to provide nationally representative information on the health and nutritional status of the US population. Overall, NHANES selects 40 000 people of 2 months of age and older from households across the US to participate in the cross-sectional survey. Respondents answer a forty-minute personal household interview and undergo a three-hour examination (or less, depending on age) in a mobile examination center (MEC) (CDC, 2004; CDC and NCHS, 2002a; CDC and NCHS, 2002b).

In this study, attention has been limited to respondents 18 years and older. The final sample consisted of 3 866 adult men and women. Before analyzing, the data was normalized. Previous studies have found gender-specific differences in the effect of different factors on the BMI. The significance of such differences was examined using a Chow test. The

hypothesis that males and females could be modeled together was clearly rejected ( $F=9.38$  with 11 and 3844 degrees of freedom,  $P<0.0001$ ).

### **3.2 Variables used in analysis**

A total of ten variables characterizing diet, demographics, and lifestyle were included into this study. Table 1 provides an overview of all variables used in the analysis, while table 2 shows the expected signs as well as the descriptive statistics of the variables.

This study uses four food source variables, which are restaurant, fast food, home and other kilocalories (kilocalories henceforth abbreviated by kcal). Overall, the sum of the four food source variables is equal to the total individual daily food consumption. Hence, besides two variables representing eating out, restaurant and fast food, the variable home represents eating at home, while other kcal represents the remaining possible sources of the individual food consumption. NHANES 1999-2000 distinguishes between 20 different options for meal places. Thus, other kcal sums up all the kilocalories of the remaining categories after restaurant, fast food and home were formed. Other kcal aggregates the consumption at all places other than the three previous food sources. Other kcal includes options such as eating at a community feeding program, in school or a day camp.

A measure representing differences in principle dietary behavior is the dummy variable vegetarian which measures whether respondents are currently vegetarians. Three different dummy variables are included in the variable category demographics, which are Age, Non-Hispanic Black, and Mexican American. A dummy variable named smoking represents the lifestyle category in this study and it measures whether respondents are currently smokers.

### **3.3 Rationale for expected effects of variables**

Each variable either influences BMI positively, i.e. weight increasing, or negatively, i.e. weight decreasing. In the following, the expected signs of the independent variables will be discussed, which are shown in table 2.

Two differing hypotheses attempt to explain the influence of food source variables on BMI. According to one hypothesis, given that eating out increases the BMI, positive signs for restaurant and fast food can be expected. However, following the other hypothesis that eating out does not increase body weight, there might be no significant influence of these variables on BMI. Regarding the expected sign of home, previous studies show that consumers value the nutritional properties of food more when eating at home (Lin et al., 2000). Hence, a negative effect is expected for home. According to Cutler et al. (2003) snacks purchased in-store or take-out food contribute to the rise in obesity. Lin et al. (1998) determined that even though the number of meals consumed has remained stable, the amount of snacking has doubled. Hence, the effect of other kcal on BMI is expected to be positive.

Vegetarian is expected to be negative, since vegetarianism is associated with a healthy lifestyle. The American Dietetic Association supports vegetarian diets due to its higher fiber consumption, greater consumption of vegetables and different macronutrient content (lower protein, fat, and animal fat intake) (Anonymous, 2003). The Oxford Vegetarian Study showed lower BMIs for vegetarians in comparison with non-vegetarians for all age groups and for both men and women (Appleby et al., 1999).

The impact of age can be separated into two different effects. Younger people tend to be more active than older people are. Hence, the effect on BMI should be positive over the lower range of age. However, with increasing age the effect is becoming negative, since obesity increases the chance of morbidity. To control for the ambiguous effect, an additional variable, age squared, has been created (Binkley et al., 2000).

Several studies show that Non-Hispanic Blacks and Mexican Americans are more likely to be overweight (Kuczmarski et al., 1994; Must et al., 1999; Flegal et al., 2002). Flegal et al. (2002) showed that prevalence of both obesity and extreme obesity was high among these two ethnic groups, especially for women. Hence, positive signs are expected on all ethnic variables.

Smoking is expected to have a negative influence on BMI. On one hand it is assumed that smokers are substituting food for cigarettes. Galuska et al. (1996) determined that respondents who smoked less increased their food consumption. Smoking is usually a different form of oral gratification which does not involve the consumption of calories. However, smoking does have another effect - it actually increases caloric requirements by increasing resting metabolic rate. People who smoke require approximately 10% more calories to maintain their body weight than when they are not smoking (Myers, 2003).

### **3.4 Statistical analysis**

The statistical analysis, similar to that in Binkley et al. (2000), employs linear regression analysis to estimate the effect of food source, dietary, demographic, and lifestyle variables on BMI. By using linear regression, factors such as diet, demographics and lifestyle can be controlled, while the effect of food source on BMI is determined.

#### **4. Empirical results and discussion**

The results of the regression analysis are indicated in table 3. For both the male and the female sample, the two eating-out variables, restaurant and fast food, are not significant, even when controlling for other determinants. Both eating out at restaurants and fast-food outlets did not significantly increase the male or female BMIs. In consideration of nutrition physiology, which suggests that the typical away-from-home meal is less healthy than home-cooked food, because it contains more total fat, more saturated fat, less calcium, fiber, iron and fewer servings of fruits and vegetables (Lin et al., 1999), these results are somewhat surprising. However, previous studies confirm these results. The results for restaurant agree with Jeffery and French (1998) who did not find any significant effect of eating at restaurants on the BMI of men or women. In contrast to this, Binkley et al. (2000) determined that the effect of eating at restaurants was significant for men. The fast food results found for the male sample agree with Jeffery and French (1998) as well: the researchers determined that eating at fast-food outlets had no effect on the BMI of men. However, in their sample, eating at fast-food outlets significantly increased the BMI of women, while it had no effect on the female sample in this study. Again, the results by Binkley et al. (2000) differ from these findings: the researchers found support for the hypothesis that eating at fast-food outlets increases both the male and the female BMIs.

However, other kcal in the female sample is positive and significant. This confirms the findings by Cutler et al. (2003) who suggest that eating out does not have a significant influence on obesity because the food eaten out is offset by reduced home consumption. The researchers, instead, argue that the large increase in snack food consumption is mainly responsible for the rise in obesity. The results found differ from Binkley et al. (2000) who suggest that eating out increases the mean BMI of men and women significantly. These conflicting results could have been obtained because of the use of different data sets with differing sample compositions on the basis of features such as ethnic proportions, age and gender distributions.

Vegetarianism is negatively affecting BMI in the male sample. This outcome is consistent with the expectations of vegetarianism being a healthy lifestyle (Anonymous, 2003). Binkley et al. (2000) found this variable to be significant in the male as well as the female sample.

The age variables show the expected signs and the data supports the significance of both variables. Age is positive, whereas age squared is negative, underlining the fact that people tend to gain weight, as they get older. With growing age, the metabolic rate slows down and, therefore, the body does not require as many calories to maintain its weight anymore (Myers, 2003). Furthermore, obesity lowers life expectancy, which means that those older respondents that are heavier are less likely to be sampled due to their reduced life expectancy. Hence, the effect of aging of the US population on the level of obesity is countervailing (Binkley et al., 2000).

Both of the ethnic variables are positive and significant for women, which supports the findings of previous studies (Kuczmarski et al., 1994; Must et al., 1999; Flegal et al., 2002). However, these variables are not significant in the male sample.

Smoking is negative and significantly related to BMI in the male sample, which is consistent with the expectations as well as previous studies. Binkley et al. (2000) found the effect of smoking to be negative and significant for the male as well as female sample. Using data from the NHANES II, Albanes et al. (1987) determined that cigarette smokers weighed less and were leaner than nonsmokers. With the duration of smoking, the body leanness increased further. The researchers concluded that this evidence could not be explained by differences in caloric intake, physical activity, illness, or socioeconomic status.

#### **5. Summary**

This study examined the influence of food source, diet, demographics, and lifestyle influence the rising BMI rates. Four food source variables represent the total individual food consumption. Restaurant and fast food represented the options for eating out, while home stood for the kilocalories consumed at home and other kcal the ones consumed at all other places.

Consumption data was used from the National Health and Nutrition Examination Survey (NHANES, 1999-2000). Men and women 18 years and older comprised the sample population used in this study, which consisted of 3 886 respondents.

Variables representing the different variable categories were formed. The category food source consisted of four variables: restaurant, fast food, home and other kilocalories (kcal). The category diet was represented by vegetarian. Age, as well as three ethnic variables were employed as demographical measures. Smoking represented the lifestyle category. After forming the variables, linear regression was used to determine the effect of food source on BMI, while controlling for factors such as diet, demographics and lifestyle.

## 6. Conclusions

Determining the elements and factors driving obesity is an important task in order to decrease the obesity epidemic and the associated rise in health costs. Clearly, obesity is a multifactorial disease, influenced by economic elements such as income and prices, demographic characteristics, dietary preferences and lifestyle. Future obesity therapies should be based on a better understanding of the behavioral and environmental processes, which are responsible for the body-weight regulation (Yanovski and Yanovski, 1999; Mokdad et al., 2000).

Obesity contributes to heart disease, stroke, high blood pressure, cancer and diabetes, which are the five of the leading causes of death in the US (Sciencedaily, 2000). It is important to develop appropriate interventions to improved nutrition and increased physical activity. The results of this study underline the current US policy efforts which focus on the importance of a balanced diet, particularly a low-fat one, as well as the benefits and need for exercise (Binkley et al., 2000). Informing the public through public awareness campaigns that describe and explain the prevention of obesity is a powerful motivator. Public awareness programs are needed to (1) improve the public's understanding of food and nutrition; (2) increase awareness among producers, processors, grocers, and consumers of their shared responsibility in promoting healthy nutrition and weight control programs, and (3) provide people with the tools they need to make informed decisions (Frewer et al., 1996). More emphasis should be given to the consequences of obesity instead of the causes, in order to cause consumers to adjust their lifestyles accordingly (Binkley et al., 2000).

Furthermore, obesity is a global epidemic, which influences all developed countries. The US is a clear outlier, but the obesity levels in countries such as England, Germany, and Australia are rising as well (Cutler et al., 2003). More research can contribute to the development of strategies that decrease the obesity epidemic while taking into consideration economic, sociodemographic and cultural differences. In order to alter the trend of increasing obesity, strategies and programs for weight maintenance as well as weight reduction have to become a higher public health priority.

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