Economics of Adults Obesity and Diabetes in Appalachia

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1. Introduction

- Obesity is a major health problem and 34% of the U.S. adult population are obese (Sabate and Wien, 2010; Finkelstein et al., 2009).

- With the current trend 50% will be obese in 2030 (Dor et al., 2010).

- Diabetes (type II), heart disease, hypertension, cancer, arthritis, asthma, and some psychological disorders are linked with obesity (Sturm et al., 2004; Malnick and Knobler, 2006; Miljkovic and Nganje, 2008).

- The epidemic of obesity absorbs increasingly greater health care budgets.
- Four major categories of economic impacts associated with obesity: direct medical costs, productivity costs, transportation costs, and human capital costs. (Hammond and Levine (2010))
- The overall annual cost of being obese is $2,646 for an obese man and $4,879 for an obese woman (Dor et al., 2010).

- The prevalence of diabetes (type II) continued to increase with increasing obesity in the United States (Gregg et al., 2005).

- It requires a lifetime of medical care and drug therapy from the beginning in controlling diabetes (type II) which lowers quality of life.

- Economic costs attributable to obesity were $11.3 billion for diabetes (type II) (Colditz, 1992) .

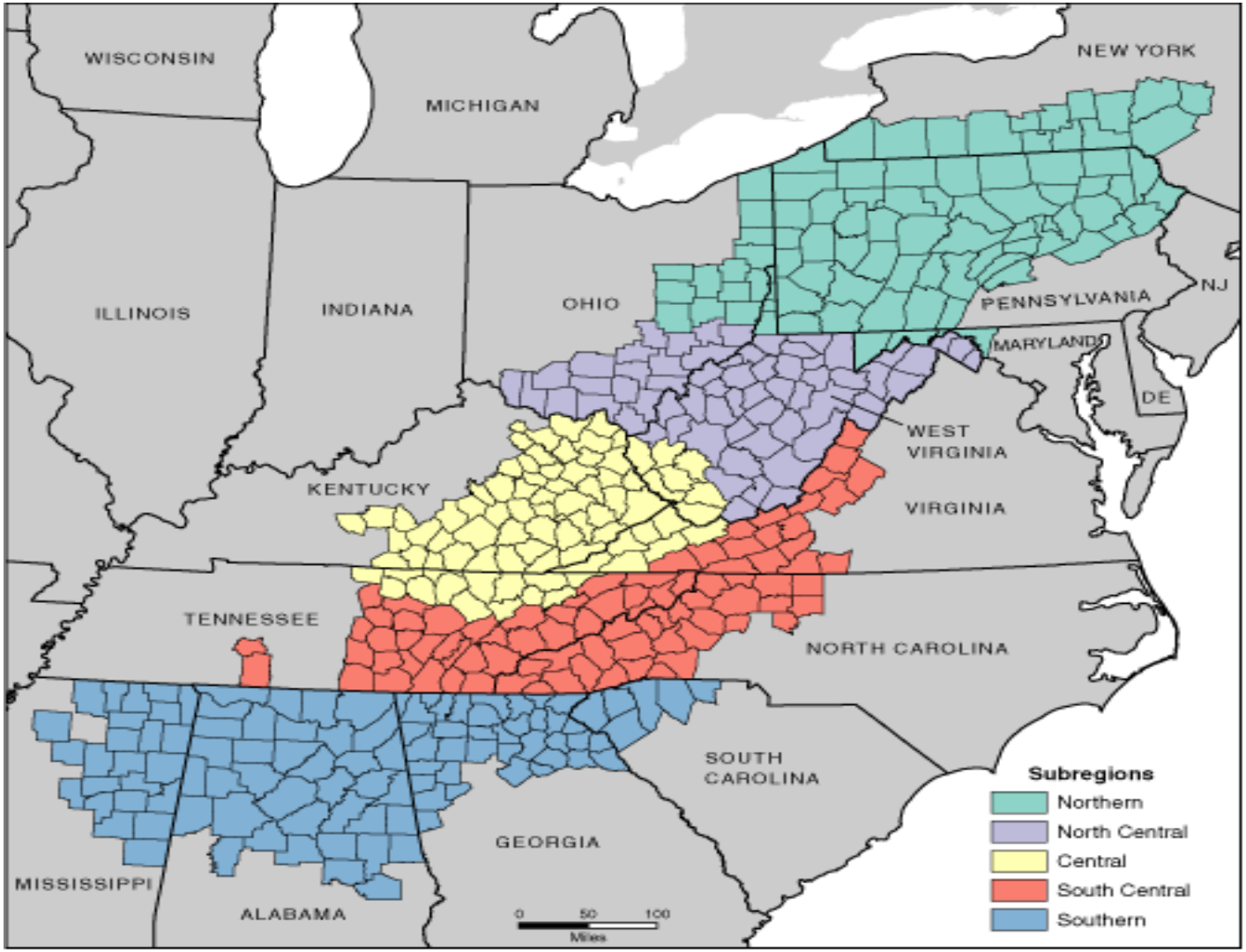
- The childhood obesity shows a positive relationship with diabetes (type II) among children, especially between 10-17 years old (Kumanyika et al., 2008).

2. Objectives

- To examine the association between obesity and diabetes and to estimate the cost of diabetes linked to obesity in Appalachia

The Appalachian Region

- Consists of 420 counties in 13 states(figure 1).
- Home for nearly 24.8 million people, and its population growth from 2000 to 2008 was slower than the national rate (ARC, 2010).
- The region's economy is highly dependent on mining, forestry, agriculture, chemical industries, professional service, and manufacturing (ARC, 2011).
- Exhibits high economic distress with high poverty, poor healthcare services, and high educational disparities (ARC, 2011).
- Lack of human, financial, and technical resources due to its geographic isolation, disproportionate social and economic distress, low household incomes, and a declining tax base.
- High unemployment rates, low per capita personal income, low per capita investment income, low education level



Map by: Appalachian Regional Commission, November 2009.

- As a whole, Appalachia reports higher rates of serious disease and mortality rates than national levels (ARC, 2010).

- Nearly 44 percent of the Appalachian population is obese with the highest rate reported in southeast Appalachia (Wewers et al., 2006).

- Roughly 10 percent of the population is suffering from diabetes, which may be highly related with obesity (Wewers et al., 2006).

- According to CDC (2009), the prevalence of obesity (more than 31 percent) and diabetes (more than 10.6 percent) is higher in most Appalachian counties.

3. Methods and data

- A Logit analysis of a response function is used with the total expenditures for diabetes to estimate the economic cost.

- A Logit analysis of a response function for diabetes with obesity as a qualitative exogenous variable would give the coefficient for the marginal impact of obesity for diabetes.

- This coefficient for obesity indicates the contribution of obesity to diabetes.

- Multiplying the coefficient value by the known healthcare expenditures of diabetes would give the cost of diabetes linked to obesity (Quah and Boon, 2002; Srivastava and Kumar, 2001; Lvovsky, 1998; Zuidema and Nentjes, 1997; Ostro, 1995).

(1) $D_i = f(E_i, O_i, I_i, SF_i, EF_i, BF_i)$

The marginal effect of the estimated equation can be expressed as:

(2) $D_i = \alpha_0 + \alpha_1 E_i + \alpha_2 I_i + \alpha_3 O_i + \sum \psi SF_i + \sum \delta EF_i + \sum \omega BF_i$

To obtain the total economic cost (TEC_H) of obesity related to diabetes, the total expenditures on healthcare for diabetes (THE_D) in Appalachia is multiplied by the coefficient of O_i which is α_3 from the marginal effects of the Logit equation for diabetes.

(3) $TEC_D = THE_D \times \alpha_3$

Sources of Data

- Individual level data collected by Behavior Risk Factor Surveillance Systems (BRFSS) survey for 2009.

- The calculation of the cost of diabetes in Appalachia is based on the estimations of the Milken Institute (2007), who calculated the treatment costs as well as costs due to lost productivity.

4. Results and discussion

a) Examine the association between obesity and diabetes: Logit Analysis for diabetes

Table 1. Definitions of variables for Logit analysis

Variable	Description and unit	Mean	Std. Dev.	Min	Max
Diabetes	1if diabetic; 0 otherwise	14.49	35.27	0	1
Obesity	1 if obese; 0 otherwise	30.89	46.56	0	1
Age	In years	55.46	16.06	27	99
Marital status	1 if married; 0 otherwise	56.68	49.55	0	1
Education	1 if some college or higher; 0 otherwise	51.14	49.98	0	1
Employment	1 if employed; 0 otherwise	40.17	49.02	0	1
Income	Annual income in dollars	40,774	24,815	5,000	80,000
Gender	1 if male; 0 if female	38.21	48.59	0	1
Race	1 if white; 0 if race other than white	90.41	29.44	0	1
Sleep	Number of sleepless days in previous month	8.50	10.55	0	15
Exercise	Number of minutes engaged in physical activities for the previous week	403.57	674.95	0	1092
Drinks	1 if drinks alcohol; 0 otherwise	0.3375	0.4728	0	1
Smokes	1 if smokes; 0 otherwise	0.2093	0.4068	0	1

Table 2. Logit regression results: marginal effects of diabetes

Variable	Marginal Effects	Std. Err	P>|z|
Obesity	0.10855***	0.0038	0.00
Age	0.00268***	0.0001	0.00
Marital status	-0.00362	0.0043	0.40
Education level	-0.00533	0.0042	0.20
Employment	-0.04043***	0.0049	0.00
Income	-0.00001***	0.0000	0.00
Gender	0.03434***	0.0041	0.00
Race	-0.04061***	0.0058	0.00
Exercise	-0.00002***	0.0000	0.00
Drinks	-0.05757***	0.0048	0.00
Smokes	-0.00284	0.0053	0.59

Number of Observations = 21,225. LR $chi^2(12) = 2315.23$; Prob > $chi^2 = 0.0000$.
Log likelihood = -7494.72; Pseudo $R^2 = 0.1338$.
***, **, * *are significant at* 1%, 5% *and* 10% *respectively.*

b) Estimate the cost of diabetes linked to obesity in Appalachia

I). Calculating total healthcare expenditures for diabetes (THE_D)

Table 3. Calculation of total healthcare expenditure for diabetes for the Appalachian region ($billion), 2009

Appalachian States	Total Population in State	Total Population in Appalachian Counties	Cost of Diabetes* ($billion)	Cost of Diabetes for Appalachia* ($billion)
Alabama	4,779,736	3,024,719	3.39	2.15
Georgia	9,687,653	2,924,921	6.04	1.82
Kentucky	4,339,367	1,194,500	3.09	0.85
Maryland	5,773,552	247,997	3.33	0.14
Mississippi	2,967,297	623,260	2.77	0.58
New York	19,378,102	1,049,686	13.72	0.74
North Carolina	9,535,483	1,662,282	6.14	1.07
Ohio	11,536,504	2,013,203	8.26	1.44
Pennsylvania	12,702,379	5,736,617	9.64	4.35
South Carolina	4,625,364	1,167,523	2.20	0.56
Tennessee	6,346,105	2,801,826	4.89	2.16
Virginia	8,001,024	681,686	4.68	0.40
West Virginia	1,819,777	1,819,777	1.56	1.56
Total cost of diabetes for Appalachia				**17.83**

*Calculated by authors
Sources: U.S. Census Bureau (2010) and Milken Institute (2007)

II). Calculating economic cost of diabetes linked to obesity (TEC_D)

- $TEC_D = THE_D \times \alpha_3$
- TEC_D = \$17.8 billion X 0.10855
  = \$1.934 billion for 2009 in Appalachia

III). Estimating reductions in economic cost of diabetes linked to obesity (TEC_D) associated with reductions in obesity of individuals

Table 4. Total economic costs of obesity-related diabetes (TEC_D) at different obesity rates 2009*

TEC_D	\$million
Current TEC_D with 31% Obesity Rate	1,934.12
TEC_D with 21% Obesity Rate (reduced to the Colorado level)	1,310.21
TEC_D with 25% Obesity Rate (reduced to the current national level)	1,559.77
TEC_D with 15% Obesity Rate (reduced to the federal target)	935.86

*Calculated by author

5. Conclusions and policy suggestions

- Logit analysis - obesity significantly increases the risk of diabetes of adults in Appalachia.
- Significant impacts of age, gender, race and drinks on diabetes
- Indicate the importance of increasing income and employment opportunities in controlling diabetes. This is crucial within the prevailing socioeconomic context of Appalachia.
- Total economic cost of diabetes linked to obesity is $1.934 billion is a significant impact on diabetes in Appalachia.

Thank you