International Journal of Health Research and Innovation, vol. 1, no. 2, 2013, 1-12
ISSN: 2051-5057 (print version), 2051-5065 (online)
Scienpress Ltd, 2013

Adult Obesity and Arthritis: An Empirical Analysis for West Virginia, USA

Janaranjana Herath[1], Tesfa Gebremedhin[2] and Jerry Fletcher[3]

Abstract

The relationship between obesity and arthritis remains unclear. Arthritis shows an increasing trend with increasing body weights [11]. West Virginia reports high obesity levels. This study attempts to examine the impacts of obesity on arthritis and to estimate the cost of arthritis linked to obesity in West Virginia. Data collected from Behavioral Risk Factor Surveillance System (BRFSS) for 2001 and 2009 are used for the analysis [24; 25]. A system of simultaneous equations and a Logit analysis are used as estimation methods. The results reveal significant impacts of obesity on arthritis, and the impacts of employment and income growth on obesity and arthritis. The estimated total economic cost of arthritis linked to obesity is $200 million for West Virginia. As the obesity rate is in an increasing trend, reducing the costs of arthritis needs mitigating obesity. The study highlights the need for a comprehensive policy alternative in West Virginia.

Keywords: Arthritis, Obesity, Economic Cost, Logit Analysis, Simultaneous Equations, West Virginia

1 Introduction

Obesity is a major health problem in the United States. Approximately 34 percent of the U.S. adult population is obese, that is, a total of over 72 million people [1]. If the current trend of obesity continues, 50 percent of the U.S. population will be obese in 2030 [2]. Obesity is linked with several diseases like heart disease, diabetes (type II), hypertension, cancer, arthritis, asthma, and some psychological disorders [3-5]. Obesity and body

[1]Assistant Professor, Tillman School of Business, Mount Olive College/University, Corresponding Author.
[2]Professor, Division of Resource Management, West Virginia University.
[3]Professor and Director of the Division of Resource Management, West Virginia University.

Article Info: *Received :* April 5, 2013. *Revised :* April 30, 2013.
Published online : June 30, 2013

weight degrades the quality of life by limiting mobility, physical endurance, social, academic and job participation [6].

Arthritis, the leading cause of disability in the United States, limits the activities of nearly 21 million adults, and comprises more than 100 diseases [7]. The most common form of arthritis is osteoarthritis that affects nearly 10 percent of Americans, especially to people older than 75 years of age. Rheumatoid arthritis, juvenile rheumatoid arthritis, lupus, gout, and fibromyalgia are the other types of arthritis [8]. Nearly 50 million doctor-diagnosed adults in the United States are reported to have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia [9] and this number is increasing. By 2030, an estimated 67 million Americans ages 18 years or older are projected to have doctor-diagnosed arthritis [10]. In 2007–2009, 50 percent of adults 65 years or older reported an arthritis diagnosis [9].

Even though the relationship between obesity and arthritis remains unclear, obese individuals are more likely to report doctor-diagnosed arthritis than normal weight individuals [11]. According to studies of the Johns Hopkins Arthritis Center [12], obese women have four times the risk of knee osteoarthritis than their non-obese counterparts. Moreover, the study shows the possibility of reducing a woman's risk of knee arthritis by 50 percent by losing only 11 pounds of weight. Cheng et al. [9] revealed that 31 percent of obese people reported doctor-diagnosed arthritis. Arthritis limits the ability to work. Nearly 5 percent of U.S. adults between the ages of 18 and 64 have arthritis and are affected by arthritis-attributable work limitations [13]. Approximately 44 percent of adults with doctor-diagnosed arthritis reported no leisure time physical activity or exercises compared with 36 percent of adults without arthritis [14]. Risk factors for arthritis are included with female gender, older age, obesity, physical inactivity, sports and other injuries to a joint, and occupational lifting [7].

Economic losses associated with obesity and arthritis are high. The annual cost of obesity was $147 billion in 2008 and people who were obese had medical costs that averaged $1,429 higher than the cost for people of normal body weight [15]. The overall annual cost of being obese is $2,646 for an obese man and $4,879 for an obese woman [2]. The Arthritis Foundation shows that arthritis costs society about $125 billion annually, $43 billion in direct medical costs and $82 billion in indirect costs [6]. The total cost attributed to arthritis and other rheumatic conditions in the United States increased to $128 billion from $86.2 billion from 1997 to 2003 [16]. The direct medical costs for arthritis and other rheumatic conditions increased in $30 billion while indirect costs for arthritis and other rheumatic conditions increased by $12 billion.

The objectives of this study are to examine the link between obesity and arthritis, and to estimate the cost of arthritis linked to obesity in West Virginia. The paper is presented in six sections. Section 2 provides the background information of West Virginia. Section 3 explains the empirical models of the estimation and data sources. Section 4 discusses the empirical results and analysis. Section 5 presents the conclusions and suggestions.

2 Background of the Study Area

The total population of West Virginia is about 1.85 million and approximately 56 percent of them live in urban areas [17]. Approximately 79 percent of the total population is adults, and 49 percent of the total population are male. West Virginia reports significantly high poverty rate, especially in rural areas. The annual per capita personal income was

\$32,219 in 2009, which was 17.7 percent below the national per capita income of \$39,138 [18]. The per capita income is low in the rural areas compared to the urban areas.
The obesity level in West Virginia is very high; 33.5 percent which is 8 percent higher than the national average rate [17]. Nearly 30 percent of West Virginia adults are obese. According to CDC (2007) medical costs associated with adult obesity were \$500 million in 2003. In 2003, 37 percent of West Virginia adults (35 percent of men and 39 percent women) reported that they had been diagnosed with arthritis [7]. CDC estimated that the cost of arthritis related conditions was \$1,188 million in 2003 (BRFSS, 2003). Adults with arthritis in West Virginia are more likely to report high blood pressure, high cholesterol, diabetes, and asthma than are people without arthritis.

3 Method of Analysis

3.1 Empirical Model to Examine the Link between Obesity and Arthritis in West Virginia

Within the context of consumer's utility maximization, income, employment, obesity, and arthritis are interdependent. Thus, to examine the link between obesity and arthritis, a model with a system of simultaneous equations is used for better results. A simultaneous equations approach accounts for interactions among the interdependent variables which gives comprehensive estimations. The most important advantages of this system of equations estimation method are having a small asymptotic variance, and overcoming inconsistency and bias, that leads to efficient estimation. As the intention is to examine the link between obesity and arthritis at county level, county average values of income, employment, obesity, and arthritis are used as interdependent variables in the model for the period of 2001 to 2009. All other exogenous variables of social factors (SF), behavioral factors (BF) and environmental factors (EF) are also applied at the county level for the same period. Three-stage least squares (3SLS) estimation was used for the empirical analysis. The model for the study is derived from the simultaneous equations approach of Deller et al. and Rosenberger et al. [19; 20].
The variables $Income^*$, $Employment^*$, $Obesity^*$, and $Arthritis^*$ represent the long term equilibrium levels of income, employment, obesity, and arthritis. The Ω^I, Ω^E, Ω^O, and Ω^A are a set of variables describing initial conditions that measure social factors (SF), environmental factors (EF,) and behavioral factors (BF) that are linked to obesity-related arthritis implications. Thus, the general form of the four equations model can be shown as follows.

$$Income^*=f(Employment^*, Obesity^*, Arthritis^*,\Omega^I) \quad (1)$$
$$Employment^*=g(Income^*, Obesity^*, Arthritis^*,\Omega^E) \quad (2)$$
$$Obesity^*=h(Income^*, Employment^*, Arthritis^*,\Omega^O) \quad (3)$$
$$Arthritis^*=k(Employment^*, Income^*, Obesity^*,\Omega^A) \quad (4)$$

From the equilibrium framework of this model, a short-term adjustments of income, employment, obesity, and arthritis (ΔI, ΔE, ΔO, and ΔA) to their long-term equilibriums (I^*, E^*, O^*, and A^*) can be derived for the empirical analysis as follows. ΔI, ΔE, ΔO, and ΔA are the changes in income, employment, obesity and arthritis, respectively. I_{t-1}, E_{t-1}, O_{t-1} and A_{t-1} are initial conditions of income, employment, obesity, and arthritis. The linear estimated parameters of initial conditions, changes of interdependent variables, and other social environmental and behavioral factors are given by β, r and δ while intercept values are given by α. The model captures structural relationships while simultaneously isolating the influence of obesity on arthritis.

$$\Delta I= \alpha_{oI}+ \beta_{1I}I_{t-1} +\beta_{2I}E_{t-1} +\beta_{3I}O_{t-1} +\beta 4IA_{t-1} + r_{1I}\Delta E + r_{2I}\Delta O +r_{3I}\Delta A+ \sum\delta_I\Omega^I \quad (5)$$
$$\Delta E= \alpha_{oE}+ \beta_{1E}I_{t-1} +\beta_{2E}E_{t-1} +\beta_{3E}O_{t-1} +\beta_{4E}A_{t-1} + r_{1E}\Delta I + r_{2E}\Delta O +r_{3E}\Delta A + \sum\delta_E\Omega^E \quad (6)$$
$$\Delta O= \alpha_{oO}+ \beta_{1O}I_{t-1} +\beta_{2O}E_{t-1} +\beta_{3O}O_{t-1} +\beta_{4I}A_{t-1} + r_{1I}\Delta I + r_{2I}\Delta E +r_{3I}\Delta A + \sum\delta_O\Omega^O \quad (7)$$
$$\Delta A=\alpha_{oI}+ \beta_{1A}I_{t-1} +\beta_{2A}E_{t-1} +\beta_{3A}O_{t-1}+\beta_{4A}A_{t-1}+ r_{1I}\Delta I +r_{2I}\Delta E +r_{3I}\Delta O +\sum\delta_A\Omega^A \quad (8)$$

3.2 Empirical Model to Estimate the Cost of Arthritis linked to Obesity in West Virginia

To estimate the cost of arthritis associated with obesity, Logit analysis of a response function is used with the total expenditures for arthritis. Individual level data for 2009 related to arthritis are used for the analysis.

A Logit analysis of a response function for arthritis with obesity as a qualitative exogenous variable would give the coefficient for the marginal impact of obesity for arthritis. In a perfectly defined Logit equation, this coefficient for obesity shows the contribution of obesity to arthritis. Multiplying the coefficient for obesity by the known healthcare expenditures of arthritis gives the cost of arthritis linked to obesity. This type of cost calculations were used in many researches [21- 23].

Assume, A_i to represent the arthritis disease of the i^{th} individual, which appears as a qualitative dependent variable equal to one, if the individual has the disease and zero, otherwise. E_i and O_i are qualitative variables; E_i is equal to one, if the i^{th} individual is employed, and O_i is equal to one, if the i^{th} individual is obese. I_i is household income for the i^{th} individual. SF_i, EF_i, and BF_i represent social factors (SF), behavioral factors (BF), and environmental factors (EF) as specified for each individual.

$$A_i = f(E_i, O_i, I_i, SF_i, EF_i, BF_i) \quad (9)$$

Thus, the marginal effect of the estimated equation can be shown as follows.

$$A_i = \beta_0 + \beta_1E_i + \beta_2I_i + \beta_3O_i + \sum rSF_i + \sum\delta EF_i + \sum\omega BF_i \quad (10)$$

where β_0 indicates the intercept of the equation, $\beta_{1,}$ $\beta_{2,}$ and β_3 are coefficient estimations of E_i , O_i, and I_i. The summations of the coefficients of SF_i, EF_i, and BF_i are indicated by r, δ, and ω.

If the total expenditures of healthcare for arthritis (THE_A) in West Virginia is known, the total economic cost of obesity related to arthritis (TEC_A), can be calculated by multiplying the coefficient of O_i (β_3) by $THE_{A.}$ as follows.

$$TEC_A = THE_A \times \beta_3 \quad (11)$$

The total estimated economic cost (TEC_A) does not account for any loss in productivity due to absenteeism or the loss to an individual over his/her lifetime of lost income.

3.3 Types and Sources of Data

Behavior Risk Factor Surveillance Systems (BRFSS) survey data for 2001 and 2009 are the main source of data [24; 25]. In examining the link between obesity and arthritis, county level data of both 2001 and 2009 are used. Individual level data of 2009 are used in estimating the cost of arthritis linked to obesity. BRFSS is a survey of health risk behaviors in non-institutionalized civilian adults, age 18 years and over. These data were collected from a stratified random sample through computer-assisted telephone interviewing by state health departments with the collaboration of the Center for Disease Control and Prevention (CDC). Data for the county level employment, income, number of adults, and population, are collected from Bureau of Economic Analysis [26] and the U.S. Census Reports [17, 27]. Statistical package of STATA was used for all analyses [28].

4 Empirical Results and Analysis

Descriptions of variables used for county level estimation are presented in Table 1. Importantly, percentage of obese individuals (ΔOBE) has increased by 4 percent; percentage of average annual household income (ΔINC) has increased by 16.3 percent, percentage of employment has decreased by 3.5 percent and percentage of arthritis has increased by 8.3 percent for the period of 2001 to 2009.

4.1 Examine the Impacts of Obesity on Arthritis in West Virginia

Empirical results for the system of simultaneous equations for county level data are shown in Table 2. The first column of the Table shows exogenous variables used in each equation. Columns 2 and 3 indicate results for the income change (ΔINC) equation. Columns 4 and 5 present results for employment change (ΔEMP). Results for the obesity change (ΔOBE) equation are shown in columns 6 and 7, while results for the arthritis change (ΔART) equation are presented in columns 8 and 9.

Table 1: Definitions for county level variables used for analyses, 2001and 2009

Variable	Description	Mean	Std. Dev.
ΔOBE	Percentage of obesity change	4.0	5.0
ΔINC	Percentage of income change	16.3	2.60
ΔEMP	Percentage of employment change	-3.5	3.12
ΔART	Percentage of arthritis change	8.3	7.74
OBE01	Percentage of obese adults 18 and older, 2001	24.7	3.5
INC01	Average annual household income , 2001	24558.7	4266.9
EMP01	Number of adults 18 and older who were employed , 2001	14041	15253
ART01	Percentage of adults 18 and older with arthritis, 2001	31.8	5.4
OBE09	Percentage of obese adults 18 and older, 2009	29.6.	3.6
INC09	Average annual household income, 2009	35711	5896
EMP09	Number of adults 18 and older who were employed, 2009	13086	14067
ART09	Percentage of adults 18 and older with arthritis, 2009	40.0	7.2
SLP09	Average number of sleepless days of an adult 18 and older, 2009	9.30	1.5
AGE09	Average age of adults 18 and older, 2009	55.4	2.5

MAR09	Percentage of population that was married, 2009	55.0	6.9
EDU09	Percentage of population that has had some college level, completed a college degree or has a professional or graduate degree, 2009	50.0	8.4
MLE09	Percentage of males, 2009	39.3	5.4
SMK09	Percentage of county's population 18 and older who smoke, 2009	26.4	15.2
DNK09	Percentage of county's population 18 and older who consume alcohol, 2009	23.5	8.5
EXE09	Average total minutes of exercise per week by an adult 18 and older, 2009	268.5	60.3
HLT09	Percentage of county's populations say that their health conditions are good	71.1	7.3

The empirical results for income change (ΔINC) equation shows that obesity change (ΔOBE) has increased income change (ΔINC) from 2001 to 2009. A one percent increase in obesity growth has increased income growth by1.4 percent. This could mean that more income generating opportunities occurred, especially in the healthcare sector, along with increasing obesity. Also, the counties reported higher initial level of obesity (OBE01) increased the income change. The arthritis change (ΔART) indicates a significant and negative relationship with income change (ΔINC). Thus, income has decreased with increasing arthritis. This may be due to less income earning opportunities with prevailing arthritis. Since older persons have more arthritis this may be a result of lower retirement income. Income in 2001 is significant and negatively related but the coefficient is very small.

The results for employment change (ΔEMP) equation show a significant and positive relationship of obesity change (ΔOBE) and employment change (ΔEMP). However, a decline in employment is indicated from 2001 to 2009. This result implies that a one percent increase in obesity growth in West Virginia is associated with a decrease in employment growth by 0.85 percent. This may be due to less employment opportunities for obese individuals. In a study, Cawley and Danziger [29] reveal the existence of weight-based discrimination for wages and employment. Also, the counties with higher initial levels of obesity (OBE01) have decreased employment growth of West Virginia. Arthritis change (ΔOBE) indicates a significant and negative relationship with employment change; a one percent increase in arthritis has decreased employment (ΔEMP) growth by 0.36 percent. Also, the counties with high initial level of arthritis have reduced the rate of employment decline. This may be partially due to more employment created in healthcare sector associated with arthritis disease.

Regression result for the obesity change equation (ΔOBE) indicates a significant and positive relationship with income change (ΔIMC), such that one percent increase in income growth causes an increase in obesity by 0.39 percent. Also, increasing initial level of income change (INC01) has a positive relationship with obesity change. This occurs because income levels as well as obesity rates have been increasing within the last one to two decades in West Virginia [30]. Result shows that an increase in arthritis change (ΔART) increased obesity change (ΔOBE) by 0.35 percent too. This result is expected as those who suffer from arthritis face limitations on physical activity because of their disease, which can lead to increasing weight [31]. The significant and positive result for initial condition of arthritis (ART01) indicates that counties reported higher arthritis levels increased obesity growth. The initial condition of obesity (OBE01) indicates that the counties that reported higher obesity rates contributed less growth in obesity. The higher the presences of married and smoking individuals indicate significant and positive relationships with obesity change.

Table 2: Results for system of equations including change in arthritis (ΔART)

Variable	Income Change		Employment Change		Obesity Change		Arthritis Change	
	Coef.	P>|Z|	Coef.	P>|Z|	Coef.	P>|Z|	Coef.	P>|Z|
ΔINC			-0.0242	0.94	0.3919*	0.08	-0.3726	0.64
ΔEMP	-0.8423	0.20			0.6807	0.11	-1.5478**	0.03
ΔOBE	1.4449***	0.00	0.8571***	0.00			2.3968**	0.02
ΔART	-0.2430*	0.10	-0.3653***	0.00	0.3447***	0.00		
INC01	-0.0001**	0.01	-0.0003**	0.03	0.0003**	0.01	-0.0001**	0.02
EMP01	-0.00003	0.42	0.00001	0.70	0.00005	0.89	-0.00001	0.89
OBE01	1.5117**	0.02	0.8823 **	0.01	-1.066 ***	0.00	2.5211	0.27
ART01	-0.3008	0.14	-0.4860 ***	0.00	0.4221***	0.00	-1.2015***	0.00
AGE09	-0.0013	0.51					0.00056	0.85
EDU09	-0.0008	0.20	0.0001	0.79				
MLE09	0.0006	0.33	0.0002	0.73				
EXE09							-0.0001	0.64
MAR09	-0.0008	0.86			0.0001*	0.10		
SLP09					0.0011	0.56		
HLT09			-0.0003	0.56				
SMK09					0.00002*	0.10	-0.0004	0.53
DNK09					0.00034	0.64	0.0004	0.82

N.Obs =55; R^2 value: ΔINC = 0.89; ΔEMP = 0.41; ΔOBE= 0.58; ΔART=0.28
Chi^2 value: ΔINC =969.3; ΔEMP = 88.1; ΔOBE= 155.8; ΔART = 123.1
***, **, * are significant at 1%, 5% and 10% respectively

Results for Arthritis change (ΔART) equation indicate that employment change (ΔEMP) has a significant and negative relationship with arthritis change (ΔART) in West Virginia; a one percent decrease in employment change, decreases arthritis growth by 1.5 percent. This might be associated with more availability of ‘physically inactive jobs’ with technological development. The results show a positive relationship between arthritis change (ΔART) and obesity change (ΔOBE) with a one percent increase in obesity level, an increase in arthritis by 2.5 percent. This indicates that obese individuals are more risk at getting arthritis [32]. The result is supported by studies of the Johns Hopkins Arthritis Center [12], which indicated that obese people have four times the risk of knee osteoarthritis than their non-obese counterparts. The initial condition of arthritis (ART01) shows a significant and negative relationship with arthritis change. This means that counties that reported higher percentages of arthritis in their population, reported lower growth rates for arthritis.

4.2 Estimation of the Cost of Arthritis Linked to Obesity in West Virginia

4.2.1 Logit analysis

For Logit analysis, individual data were used for arthritis, after removing data for individuals who were pregnant or who had any kind of missing data for exogenous variables. Thus, the sample size was 2004 individuals for whole West Virginia. The presence of arthritis was the dependent variable. For each individual socioeconomic variables; the presence of obesity (1=obese; 0 otherwise), age (1= age 65 or more; 0 otherwise), marital status (1=married; 0 otherwise), employment status (1=employed; 0 otherwise), gender (1=male; 0 otherwise), education level, annual household income, and family size were the used. Considering behavioral factors, variables of sleepless days in the last month (Sleep), if the individual consumes alcohol (Drinks, 1= drinks, 0 otherwise), if the individual smokes (Smokes, 1=smokes 0 otherwise), and total minutes an individual engaged in exercise in the previous week (Exercise) were used.

Logit estimation results for arthritis in Table 3 show obesity is highly significant and positively related to arthritis, which corresponds with CDC [11] (2009a) results showing high rates of arthritis among obese individuals. According to the results, an obese person is 12.7 percent more at risk of getting arthritis than a non-obese person. As expected, age of an individual affects arthritis positively. According to the results, when an individual's age is more than 65 years, the probability of getting arthritis increases by 10.4 percent. Results show that married individuals are more likely of getting arthritis. Employed individuals are less likely to get arthritis. If an individual is employed s/he has a 18 percent lower probability of getting arthritis. A significant and negative result for gender indicates that adult women are more likely to get arthritis compared to adult men. This may be due to a higher percentage of obese women compared to obese men [7]. Results indicate that more education decreases the risk of getting arthritis. Thus, an increase in income decreases the potential of getting arthritis. This may be due to having more time or resources for engaging in exercise or recreational activities. While larger family size lowers the potentials of getting arthritis, individuals sleeping less, show higher probability of getting arthritis. Individuals which consume alcohol have 10 percent higher probability of getting arthritis. Even though previous studies are limited in this area, Wang et al. [33] indicate that alcohol consumption increases obesity, which may affect arthritis. Smoking indicates a higher probability of getting arthritis. The result is supported by Eustice [34] who indicated that rheumatoid arthritis increases with smoking.

Table 3: Logit regression results: marginal effects for Arthritis

Variable	**dy/dx**	**Std. Err.**	**P>|z|**
Obesity	0.1266***	0.024	0.00
Age 65 or more	0.1042***	0.030	0.00
Married	0.0849***	0.028	0.00
Employ	-0.1800***	0.030	0.00
Gender	-0.0727***	0.024	0.00
Education	-0.0600*	0.032	0.06
Income	-2.19e-06***	0.000	0.00
Family size	-0.0507***	0.014	0.00
Sleep	0.0056***	0.001	0.00
Drinks	0.1006***	0.023	0.00
Smoke	0.0446	0.031	0.15
Exercise	-0.0001	0.000	0.29

N = 2004 ; LR chi2(13) = 261.77; Prob > chi2 = 0.0000:

Pseudo R^2 = 0.0949; Log likelihood = -1248.18

***, **, * are significant at 1%, 5%and 10% respectively

4.2.2 Estimating healthcare expenditures for arthritis (THE_A)

In a detailed study on national and state medical expenditures and lost earnings, Yelin et al. [35] show that the total cost of arthritis was $128 billion in 2003, including $81 billion in medical costs and $47 billion in indirect costs. The study shows that the cost of arthritis is in a range from 0.3 to 2.6 percent of each state's GDP. In calculating the cost of arthritis in West Virginia for 2009, this percentage of GDP is used, assuming that costs are still the same percentage of the state's GDP in 2009 as Yelin et al. [35] estimated for 2003. According to Yelin et al. the cost of arthritis in 2003 was 2.59 percent of GDP in West Virginia. As the GDP is 6.04 billion dollars in 2009 [26], the total cost of arthritis for 2009 in West Virginia can be estimated as $1,580 million (multiplying 61.04 by 2.59). As arthritis is mainly an adult disease and the rate of arthritis among children is very low (only 0.26 percent), the estimated cost of arthritis is assumed to be the total cost to adults in West Virginia.

4.2.3 Total economic cost of obesity-related arthritis (TEC_A)

To obtain the total economic cost (TEC_A) of arthritis, the total healthcare expenditures for arthritis (1.58 billion dollars) is multiplied by the coefficient of obesity (0.1266), which was estimated using the marginal effects from the logit analysis. Thus, the total economic cost of arthritis due to obesity is $200 million for 2009 in West Virginia. In other words, if obesity could be controlled completely the cost of arthritis would be reduced by up to $200 million for 2009.

5 Conclusions

The county level estimation for arthritis in West Virginia indicates increasing trend of arthritis with increasing obesity. In which both obesity and arthritis changes affect each other, but impact of obesity on increasing arthritis is significantly high. Thus, controlling obesity would contribute more on controlling arthritis. Employment growth affects positively in controlling obesity, which subsequently controls arthritis. Likewise, higher growth of income lowers arthritis growth rate in West Virginia.

Logit analysis based on individual level data highlights the importance of employment growth in mitigating arthritis in West Virginia. If an individual is employed s/he has a 18 percent lower probability of getting arthritis. Ageing increases the potential of getting arthritis, especially after 65 years of age. This could be associated with less engaging in physical activities. High percentage of alcohol consumption seems to be a barrier to mitigating arthritis.

Total economic costs of arthritis linked to obesity are estimated as $200 million. The cost indicates a significant impact of obesity on arthritis in West Virginia. According to Tomblin and Lewis [36] the state's prevalence of obesity has increased an average of 4.6 percent per year since 1989 and still has an increasing trend. Thus, reducing economic costs of arthritis can be addressed by reducing obesity.

Overall, the analysis for obesity and obesity-related arthritis highlights the need for a comprehensive policy alternative to control obesity to reduce the cost of arthritis in West Virginia. The policy should improve increasing employment and income earning opportunities, educational facilities, and certain infrastructure development. Most counties in West Virginia lack the essential infrastructure to take full advantage of emerging economic opportunities and to create sustainable local economies (ARC, 2010). Thus, any policy intervention without physical infrastructure development will be less effective and efficient.

ACKNOWLEDGEMENTS: Authors acknowledge and appreciate the review comments and suggestions of Dr. Dale Colyer.

References

[1] E. Finkelstein, J. Trogdon, J. W. Cohen and W. Dietz, Annual Medical Spending Attributable to Obesity: Payer and service- specific estimates. *Health Affairs,* **28**(5), (2009), 822-831. http://dx.doi.org/10.1377/hlthaff.28.5.w822

[2] A. Dor, C. Ferguson, C, Langwith and E. Tan, A Heavy Burden: The Individual Costs of being Overweight and Obese on the United States. Research Report. Department of Health Policy, School of Public Health and Health Services, The George Washington University, (2010).

[3] S. D. H. Malnick, and H. Knobler, The Medical Complications of Obesity, *An International Journal of Medicine,* **99**(9), (2006), 565-579. doi:10.1093/qjmed/hc1085

[4] S. K. Kumanyika, E. Obarzanek, N. Stettler, R. Bell, A. E. Field, S. P. Formann, Y. Hong, Population Based Prevention of Obesity: The need for comprehensive promotion of health eating, physical activity, and energy balance. *Circulation,* **118**, (2008), 428-464. http://dx.doi.org/10.1161/CIRCULATIONAHA.108.189702

[5] K. Y. Wolin, K. Carson and G. A. Colditz, Obesity and Cancer. *The Oncologist,* 15, (2010), 556-565. http://dx.doi.org/10.1634/theoncologist.2009-0285

[6] J. Manchin III, The Burden of Arthritis in West Virginia, (2006). www.wvdhhr.org/.../burdenofarthritis2006/burdenofarthritis2006hsc...

[7] Centers for Disease Control and Prevention [CDC], *Arthritis Related Statistics,* (2010). Retrieved from: http://www.cdc.gov/arthritis/data_statistics/arthritis_related_stats.htm

[8] C. G. Helmick, D. T. Felson, R. C. Lawrence, S. Gabriel, R. Hirsch, H Maradit Kremers, et al, Estimates of the Prevalence of Arthritis and Other Rheumatic Conditions in the United States. Part I. *Arthritis Rheum* **58**, (2008), 15–25. http://dx.doi.org/10.1002/art.23177

[9] Y. J. Cheng, J. M. Hootman, L. B. Murphy, G. A. Langmaid and C. G. Helmick, Prevalence of doctor-diagnosed arthritis and arthritis-attributable activity limitation United States, 2007–2009. *Morbidity and Mortality Weekly Report* (*MMWR)*, **59**(39), (2010), 1261–1265.

[10] J. M. Hootman and C. G. Helmick, Projections of U.S. Prevalence of Arthritis and Associated Activity Limitations. *Arthritis Rheum,* **54**(1), (2006), :226–229. http://dx.doi.org/10.1002/art.21562

[11] Centers for Disease Control and Prevention [CDC], Morbidity and Mortality Weekly Report, **58**, 45, (2009a). Retrieved from www.cdc.gov/mmwr

[12] Bartlett, S. (n.d.). *Osteoarthritis Weight Management*. Retrieved from http://www.hopkinsarthritis.org/patient-corner/disease-management/osteoandweight.html

[13] Morbidity and Mortality Weekly Report (MMWR), Racial/Ethnic Differences in the Prevalence and Impact of Doctor-Diagnosed Arthritis --- United States, 1999. **50**, (2005), 120-125.

[14] M. Shih, J. M. Hootman, J. Kruger and C. G. Helmick, Physical Activity in Men and Women with Arthritis, *American Journal of Preventive Medicine, 30*(5), (2006), 385-393. http://dx.doi.org/10.1016/j.amepre.2005.12.005

[15] U.S. Department of Health and Human Services, The Surgeon General call to Action to Prevent and Decrease Overweight and Obesity. Rockville, MD: U.S. Department of Health and Human Services, Office of Surgeon General, (2010).

[16] Morbidity and Mortality Weekly Report (MMWR), National and State Medical Expenditures and Lost Earnings Attributable to Arthritis and Other Rheumatic Conditions, United States 2003. **6**(01) (2007), 4-7. Retrieved from: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5601a2.htm?s_cid=mm5601a2_e

[17] U.S. Census Bureau, State and County Quick Facts, (2010). Retrieved from http://quickfacts.census.gov/qfd/states/54000.html

[18] R. A. Hammond and R. Levine, The Economic Impacts of Obesity in the United States: Diabetes, Metabolic Syndrome and Obesity, *Targets and Therapy*, **3**, (2010), 285-295.

[19] S. C. Deller, T. Tsung-Hsiu, D. W. Marcouiller and D. B. K. English, The role of amenities and quality of life in rural economic growth. A*merican Journal of Agricultural Economics*, **83**(2), (2001), 352–365.

[20] R. S. Rosenberger, Y. Sneh and R. Gurvitch, A spatial analysis of linkages between healthcare expenditures, physical inactivity, obesity and recreational supply. *Journal of Leisure Research*, spring 2005.

[21] E. Quah and T. L. Boon, The Economic Cost of Particulate Air Pollution on Health in Singapore, *Journal of Asian Economics*, **14**, (2002), 73-90. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6019a4.htm http://dx.doi.org/10.1016/S1049-0078(02)00240-3

[22] C. Bogahawatte, and J. Herath, Air Quality and Cement Production: Examining the Implications of Point Source Pollution in Sri Lanka (No. 36) (2008), The South Asian Network for Development and Environmental Economics.

[23] B. Ostro, Fine Particulate Air pollution and Mortality in Two Southern California Counties, *Environmental research,* **70**, (1995), 98-104. http://dx.doi.org/10.1006/enrs.1995.1053

[24] Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Data, U.S. Department of Health and Human Services, Atlanta, Georgia, (2001).

[25] Centers for Disease Control and Prevention [CDC]. *Behavioral Risk Factor Surveillance System Survey Data,* U.S. Department of Health and Human Services, Atlanta, Georgia, (2009b).

[26] Bureau of Economic Analysis [BEA], Regional Economic Accounts. (2009). Retrieved from http://www.bea.gov/regional/gdpmap/GDPMap.aspx

[27] U.S. Census Bureau. Summary File 1 (SF 1) 100-Percent Data, (2000). Retrieved from http://www.census.gov/census2000/sumfile1.html

[28] STATA 9.1. Statistical/Data Analysis. StataCorp, 4905 Lakeway Drive, College Station, Texas, 77845 USA. Retrieved from http://www.stata.com

[29] J. Cawley, and S. Danziger, Morbid Obesity and The Transition from Welfare to Work. *Journal of Policy Analysis and Management*, *24*(4), (2005), 727-743. http://dx.doi.org/10.1002/pam.20135

[30] Appalachian Regional Commission [ARC], Economic Assessment of Appalachia. An Appalachian Development Initiative Report, (2010). Retrieved from http://www.arc.gov/images/newsroom/publications/EconomicAssessmentofAppalachiaJune2010.pdf

[31] B. Hendrick, Obesity Increases Risk of Deadly Heart Attacks, WebMD Health News, (2011). Retrieved from: http://www.webmd.com/heart-disease/news/20110214/obesity-increases-risk-of-deadly-heart-attacks

[32] Morbidity and Mortality Weekly Report (MMWR), Arthritis as a Potential Barrier to Physical Activity among Adults with Obesity --- United States, 2007 and 2009. **60**(19) (2011), 614-618

[33] M. C. Wang, S. Kim, A. A. Gonzalez, K. E. Macleod and M. A. Winkleby, Socioeconomic and Food related Physical Characteristics of the Neighborhood Environment are Associated with Body Mass Index. *Journal of Epidemiology Community Health*, *6*, (2007), 491- 498. http://dx.doi.org/10.1136/jech.2006.051680

[34] C. Eustice, Smoking Puffs Up Risk Of Rheumatoid Arthritis, (2006). Retrieved from http://arthritis.about.com/od/smoking/a/rheumatoidrisk.htm

[35] E. Yelin, M. Cisternas, A. Foreman, D. Pasta, L. Murphy and C. Helmick, National and State Medical Expenditures and Lost Earnings Attributable to Arthritis and Other Rheumatic Conditions - United States, 2003. *Morbidity and Mortality Weekly Report,* **56**(1), (2007), 4–7.

[36] E. A. Tomblin, and M. J. Lewis, Obesity in West Virginia, (2011), Retrieved from: www.wvdhhr.org/bph/hsc/pubs/other/obesityreport2011/obesityreport2011.pdf