Estimating the Economic Impact of Disease on a Local Economy
The Case of Diabetes in the Lower Rio Grande Valley of Texas

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ABSTRACT

The purpose of this study is to investigate the economic impact of wage reductions that people experience from contracting diabetes. Incorporating wage reduction information into an input-output model reveals that as diabetics' wages decrease by $1.00, production and income in the local economy decline by $0.36 and $0.38, respectively.

INTRODUCTION

Diabetes is a debilitating and often incapacitating disease. In addition to being the 6th leading cause of death among men and 5th among women (Centers for Disease Control and Prevention, 2005) in 2001, diabetes is known to serve as a complicating factor in ailments such as heart disease, stroke, blindness, and end-stage renal (kidney) disease to name a few.

In the U.S., approximately 13 million adults have been diagnosed with diabetes. According to the Centers for Disease Control and Prevention (2005), another 5 million adults, who have not been diagnosed, unknowingly suffer from this disease. Approximately 83 percent of adults diagnosed with diabetes are 45 years or older.

In addition to the incapacitating nature of diabetes, it can also exert a devastating effect on the finances of the afflicted. People who suffer from this disease experience reduced income resulting from decreased work productivity and/or the cessation of employment. Based on a study of Mexican-Americans living in Texas' Lower Rio Grande Valley (Bastida and Pagan, 2002), annual earnings lost due to diabetes, among individuals aged 45 year or older, were $1,584.66 for males and $3,584.53 for females.

In its most recent study on the cost of diabetes, the American Diabetes Association (2002) estimated that the economic cost of this disease in the U.S. was approximately $132 billion, wherein 70 percent ($92.2 billion) of this cost was attributed to the direct cost of treatment. The remainder ($39.8 billion) accounted for indirect costs associated with reductions in productivity due to lost work-days, restricted activity days, permanent disability, and mortality. According to the association, these costs underestimate the true burden of the disease due to the omission of intangible items[1].

The purpose of this paper is to further investigate the economic cost of diabetes. Rather than focus on the medical costs[2] associated with treatment, which the studies commissioned by the American Diabetes Association (1998 and 2002) have done, this study examines the impacts that reductions in earnings (resulting from lost labor

[1] Pain and suffering; care provided by non-paid caregivers; diabetics' spending on allied health care services (e.g., dental care, optometric care, dietetic care, etc.).
[2] These costs are primarily transfer payments (Medicare/Medicaid).

productivity) have on the economy, specifically the impact of reductions in earnings on inter-industry transactions in a region's economy.

Studies, such as those commissioned by the American Diabetes Association, have not given much attention to the potential impact of the disease on the broader community in which the diabetic resides and works in. The fact that diabetics may be less likely to work or be less productive (if they work); this leads to a decline in income. Reductions in a diabetic's income would lead to decreased demand for goods and services produced by various sectors of the local economy. This, in turn, would lead to a series of adverse indirect and induced impacts on the local economy such as reductions in local production of goods and services and income for workers involved in the production and sales of these products.

These effects could have significant implications for an economy where a significant proportion of the population is stricken with diabetes. Such is the case of the Lower Rio Grande Valley of Texas[3], where over 87% of the residents are Mexican-Americans[4] (Texas State Data Center, 2005) and the diabetes prevalence rate has been estimated at approximately 39% (Bastida and Pagan, 2002).

The results of this study could be of interest to public health policy makers, health care researchers, and decision-makers involved in economic development activities. This study hopes to provide them with an added perspective into the estimation of the cost of diabetes and its potential negative impact on local economic activity.

MEASURING THE ADVERSE IMPACT OF DIABETES ON THE ECONOMY

In order to estimate the adverse impact that reductions in diabetics' earnings have on the economy, the use of an input-output model was utilized. The basis of the input-output model can be traced back to the standard model used in macroeconomic analysis.

According to Hewings (1985), the standard macroeconomic model can be written as follows:

$$Y = C + I + G + (EX - IM) \qquad \text{[Eq. 1]}$$

where Y represents gross national income; C represents consumption; G represents government expenditure; and, $(EX\text{-}IM)$ represents net exports.

It should be noted that this accounting identity could represent an area that is smaller than a nation (i.e., a county or state). For instance, Y is local income and $(EX -$

[3] The Lower Rio Grande Valley of Texas (LRGV) is composed of the four southernmost counties in the state: Cameron, Hidalgo, Starr, and Willacy.

[4] According to the National Diabetes Information Clearing House (2002), approximately 2 million of the 30 million Hispanic Americans were diagnosed with diabetes in 2000. It was believed that another 1.2 million suffer from the disease but have not been diagnosed. This segment of the population was twice as likely to have diabetes than non-Hispanic whites of similar age. In fact, it was estimated that roughly 25 to 30 percent of middle-aged Hispanic Americans have diabetes (diagnosed or otherwise).

IM) represents community monetary surpluses $(EX > IM)$ or leakages $(EX < IM)$. Government expenditures can be local, state, and federal.

Eq. 1 can be simplified by making the following transformations:

$$E' = I + G + (EX - IM) \qquad \text{[Eq. 2]}$$

$$C = cY \qquad \text{[Eq. 3]}$$

where c represents the average propensity to consume out of income. Note that c takes on a value between 0 and 1. This means that consumption is always less than income. This is based on the assumption that consumers have a tendency to save part of their income rather than spend all of it.

Eq. 1 can now be rewritten in the following form:

$$Y = cY + E' \qquad \text{[Eq. 4]}$$

Eq. 4 can be arranged as follows:

$$Y - cY = E'$$

$$Y(1-c) = E'$$

$$Y = [1/(1-c)]\, E'$$

$$Y = (1-c)^{-1}\, E' \qquad \text{[Eq. 5]}$$

where $(1-c)^{-1}$ represents the multiplier effect. In mathematical terms, this will take on a value that is always greater than 1.

Eq. 5 represents the link between exogenous forces (E') and gross national income. This relationship shows that exogenous forces will generate an impact on national income that is larger than the initial exogenous change. For instance, consider our case of individual income reductions due to diabetes. If income falls by X for all affected diabetics, the total effect will be much greater than X due to the multiplier effect.

In general, the input-output model traces linkages that exist between various sectors (producing and consuming) in an economy. According to Miller and Blair (1985), the structure of the input-output model is composed of a set of linear equations with n unknowns. This system represents the flow of products from producing sectors to consuming sectors. In addition, this flow of products is measured in monetary terms to avoid the difficulty of equalizing diverse measurement units.

The generalized form of the linear equation used in input-output models can take on the following form:

$$
\begin{aligned}
X1 &= A11X1 + A12X2 + \ldots + A1iXi + \ldots + A1nXn + Y1 \\
X2 &= A21X1 + A22X2 + \ldots + A2iXi + \ldots + A2nX2 + Y2 \\
&\vdots \\
Xn &= An1X1 + An2X2 + \ldots + AniXi + \ldots + AnnXn + Yn
\end{aligned}
\qquad \text{[Eq. 6]}
$$

Where *X*'s represent distribution of *X* sector's output to various other sectors; *A*'s represent the monetary values of the flow of products across sectors; and, *Y*'s represent final demand by *C, I, G, (EX-IM)* from each sector.

This system of equations can be represented in the following matrix form:

$$X = AX + Y \qquad \text{[Eq. 7]}$$

Making the necessary mathematical transformations, we arrive at the following equation:

$$X - AX = Y$$

$$X(1\text{-}A) = Y$$

$$X = [1/(1\text{-}A)]\ Y \ \ or\ \ X = (1\text{-}A)^{-1}\ Y \qquad \text{[Eq. 8]}$$

Eq. 8 provides us with the predictive input-output model. Similar to Eq. 5, this equation shows us that changes in final demand (*Y*) will yield an effect on interindustry production (*X*) that is larger than the original change in final demand. This is due to the multiplier effect $[(1\text{-}A)^{-1}]$.

Based on Eq. 8, the incidence of diabetes can be treated as an exogenous element (*Y*) in the equation. Decreased earning capacity that results from contracting the disease will lead to decreased expenditures on the part of consumers with diabetes. Theoretically, this will lead to a decrease in *Y*. The effect of this decrease of *Y* on production in the economy (*X*) will be compounded by the multiplier effect $(1\text{-}A)^{-1}$. This means that *X* will decrease by a larger magnitude that the decrease in *Y*.

This study used an IMPLAN (1998) input-output model for the four counties that comprise the Lower Rio Grande Valley. Data on the reduced income for diabetics in the four-county area was estimated in the following manner:

1. Population estimates of persons 45 years and older[5] by gender for the 4 LRGV counties were obtained from the Texas State Data Center (2005). This information is presented in Table 1.

[5] The reason for limiting the population to those 45 years and older is based on the CDC's pronouncement that the majority of diabetics in the U.S. (83%) come from this age group.

2. Diabetes prevalence rates (by gender) reported by Bastida and Pagan (2002) were multiplied to the LRGV population of persons aged 45 and over to arrive at an estimate of the number of diabetics in the region. This information is shown in Table 1.

3. The estimated number of diabetics in the LRGV (by gender) was then multiplied by the estimated reductions in earnings estimated by Bastida and Pagan (2002) to arrive at the total amount of earnings lost due to diabetes. Table 1 shows the value of reduced earnings for LRGV diabetics.

4. The total value of reduced earnings was divided into various expenditure categories using information from the Bureau of Labor Statistics' Consumer Expenditure Survey (2003) on average annual expenditures and characteristics of Hispanic or Latino origin reference persons. This information is presented in Table 2.

5. The resulting information (from #4), which essentially represents decreases in final demand for various industry sectors in the economy were incorporated into the LRGV input-output model (IMPLAN), using the model's Impact Analysis module to generate multiplier effects.

RESULTS

Based on Table 1, it was estimated that diabetics in the LRGV would experience a $114 million decrease in income. This would lead to a reduction in demand for goods and services in the industries listed in Table 2.

The IMPLAN input-output model used in this study generated estimated direct, indirect, and induced effects[6] of income reduction on output[7], labor income[8], and employment[9] in the LRGV economy. These results were presented in Tables 3 through 5.

Table 3 revealed that the impact of wage reductions, which was attributed to diabetes, on output in the LRGV economy was estimated to be approximately the $156 million. In addition to the direct impact of $114 million, an additional reduction $42 million worth of output in industries in the LRGV was estimated. This meant that

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[6] Direct effects represent reductions in output, labor income, and employment accruing to industries from which diabetics purchased their goods and services. Indirect effects denote reductions in output, labor income, and employment in industries that provide inputs to the directly affected industries. Induced effects indicate reductions in household spending as a result of decreased production in directly affected and input supplying industries.

[7] Output represents the value of production in all industries in the LRGV.

[8] Employee compensation and proprietor income comprise labor income.

[9] Employment corresponds to the annual average number of wage and salary employees and self-employed persons. The number of employed persons is comprised of both full-time and part-time workers.

industries which supplied inputs to the directly affected industries reduced production by approximately $18 million. An additional induced effect of $24 million would be experienced.

In terms of labor income, Table 4 shows that the $114 million decrease in demand for goods and services in the LRGV economy diminishes income in directly affected industries by $40.3 million. Due to the decreased production, industries that provide inputs to the directly affected industries would also experience reductions in output and consequently income. Indirectly affected industries would experience a $6.2 million reduction in wages, salaries, and proprietors' income. These wage reductions in directly and indirectly affected industries would create a ripple effect through the rest of the LRGV economy by causing a further decline in income of $9.1 million.

A $114 million reduction in income would also cause changes in the number of persons employed in the economy. A reduction in demand would force industries to cut back, not only material inputs from other industries, but also labor.

In the case of diabetes in the LRGV, a $114 million reduction demand for goods and services leads to an increase in the area's unemployment by 2,772 workers. Approximately 77 percent of these unemployed workers come from industries directly affected by the decrease in final demand. Detailed information is presented in Table 5.

DISCUSSION

It was stated that most economic studies pertaining to diabetes have focused primarily on the cost of treatment. While most of these costs represent transfer payments, the pure economic costs of the disease correspond to direct costs associated with income loss and/or reduction on the part of the afflicted person.

This study showed a broader perspective of the cost concept related to diabetes. Through the use of an input-output model, multiplier effects on the economy that result from income loss and/or reduction were exhibited.

Based on the results of the input-output model, we could infer the following:

Output: For every dollar of income lost due to diabetes, an additional $0.36 is lost due to reduced economic activity (production of goods and services).

Income: For every dollar of income lost due to diabetes, an additional $0.38 of income to workers in the region is lost due to reduced economic activity (production of goods and services).

Employment: For every dollar of income lost due to diabetes, a total of 1.30 jobs are lost due to reduced economic activity (production of goods and services).

Given these multiplier effects[10], it is reasonable to see that the economic consequences of diabetes extend far beyond the cost of treatment and lost productivity. Furthermore, these effects should signal to us that addressing the impact of diabetes cannot be the sole purview of public health policy makers. Other decision makers, particularly those involved in economic development need to come forward and assist in creating policies aimed at disease prevention efforts.

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[10] The output, labor income, and employment multipliers are estimated by dividing the total effect by the direct effect.

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Table 1: LRGV Population Characteristics, 2000.			
Characteristic	**Male**	**Female**	**TOTAL**
Number of Persons aged 45 and older	86,488	107,037	193,525
Number of Diabetics aged 45 and older	14,098	25,689	39,787
Lost Earnings due to Diabetes	$22,339,814	92,082,561	$114,422,375

Sources: TX State Data Center for Characteristic #1
Bastida and Pagan for Characteristics #2 and #3

Notes: (1) To arrive at Characteristic #2, Characteristic #1 was multiplied by the diabetes prevalence rate by gender (16.3% for males and 24% for females).
(2) To arrive at Characteristic #3, Characteristic #2 was multiplied by lost earnings by gender ($1,584.66 for males and $3584.53 for females).

Table 2: Value of Reduced Earnings for LRGV Diabetics using the CES Hispanic-American Average Annual Expenditure Proportions.			
Expenditure Category	**SIC Code**	**Expenditure Proportion (%)**	**Reduction in Expenditure ($ million)**
Food for Home Consumption	54	10.9	12.4
Food Consumed away from Home	58	6.4	7.3
Housing	65	24.6	28
Utilities	49	7.5	8.6
Housekeeping Supplies	59	1.4	1.6
Household Furnishings & Equipment	57	5.5	6.3
Apparel	56	5.3	6.1
Transportation	41, 55, 75	20.5	23.4
Entertainment (fees and admissions)	78 – 79	0.8	0.9
Recreational Item (toys, pets, etc.)	59	1.1	1.3
Personal Care Products & Services	72	1.5	1.7
Education	82	1.4	1.6
Reading Materials (books, magazines, etc.)	59	0.1	0.2
Tobacco Products and Supplies	59	0.5	0.6
Alcoholic Beverages	59	1.0	1.1
Cash Contributions	86	1.8	2.1
Savings, Pensions, Personal Insurance, etc.	60, 62 – 64	8.5	9.8
Miscellaneous Expenditures	59	1.3	1.4
TOTAL		100	114.4

NOTE: (1) Health Care expenditures were excluded from consideration because this does not lead to a reduction in expenditures. On the contrary, diabetics and other persons with illness will always experience increased health care expenditures.
(2) Column total may not add up to rounding off error.

TABLE 3: Output Effects				
Industry	**Direct**	**Indirect**	**Induced**	**Total**
	($ 000)			
Agriculture, Forestry, Fishing	0	226	316	542
Mining	0	808	109	917
Construction	0	2,216	365	2,581
Manufacturing	0	1,567	1,513	3,080
TCPU	8,598	3,031	2,428	14,057
Wholesale Trade	0	825	1,113	1,938
Retail Trade	61,755	780	5,474	68,009
FIRE	36,244	5,183	6,059	47,486
Services	7,825	3,298	6,332	17,455
Government	0	0	87	87
TOTAL	114,422	17,934	23,796	156,152

TABLE 4: Labor Income Effects				
Industry	**Direct**	**Indirect**	**Induced**	**Total**
	($ 000)			
Agriculture, Forestry, Fishing	0	78	78	156
Mining	0	190	26	216
Construction	0	902	162	1,064
Manufacturing	0	340	264	604
TCPU	1,712	965	711	3,388
Wholesale Trade	0	319	430	749
Retail Trade	30,109	346	2,606	33,061
FIRE	4,843	1,349	1,344	7,536
Services	3,643	1,760	3,353	8,756
Government	0	0	87	87
TOTAL	40,307	6,249	9,061	55,617

TABLE 5: Employment Effects				
Industry	**Direct**	**Indirect**	**Induced**	**Total**
	(Number of Jobs)			
Agriculture, Forestry, Fishing	0	8	7	15
Mining	0	4	1	5
Construction	0	40	7	47
Manufacturing	0	12	11	23
TCPU	18	21	16	55
Wholesale Trade	0	12	16	28
Retail Trade	1,655	19	156	1,830
FIRE	177	36	39	252
Services	282	86	137	505
Government	0	0	12	12
TOTAL	2,132	238	402	2,772