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The Economic Impact of Health Promotion in Indiana

Report

HEALTHCARE AND HUMAN SERVICES POLICY, RESEARCH, AND CONSULTING—WITH REAL-WORLD PERSPECTIVE.

Submitted by: **The Lewin Group, Inc.**

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Executive Summary

Indiana's composite health ranking, which represents a composite index of over 30 metrics, continued to decline over the years. As shown in the historical rankings based on the state composite measure created by the United Foundation, Indiana once ranked above 30 among all 50 states in the 1990s, but had declined to be 41 in 2018.[1] Indiana ranks poorly on two major health behavior risk factors, smoking and obesity, which research has shown to result in many costly chronic conditions. Indiana's smoking rate ranked in the bottom quintile (i.e., the bottom 20%) and the obesity rate ranked in the second to last quintile. Additionally, Indiana ranks in the 4th quintile in the prevalence of diabetes, which could be a consequence of obesity, or smoking, or both. Diabetes is in itself a top public health concern because of the many life shortening high cost complications it may cause.

The Indiana Hospital Association commissioned The Lewin Group to examine the economic impact of obesity, diabetes, and smoking on Indiana employers and the potential savings associated with improvements in these health measures. The types of costs (and savings) examined include three types of economic costs that are attributable to the three conditions. In other words, these are costs that would not have occurred if not for these three conditions. Specifically, we examine: 1) direct medical cost; 2) indirect costs in the form of reduced productivity; and 3) costs of higher health insurance premiums (both employer paid and employee paid) associated with obesity, diabetes, and smoking.

We estimate the prevalence rates of obesity, diabetes, and smoking for Indiana and other states (for comparison) using publicly available data from the 2017 Behavioral Risk Factor Surveillance System (BRFSS). The per-employee direct medical cost and indirect productivity cost estimates are from various sources (e.g., such as the Diabetes Burden Toolkit maintained by the Centers for Disease Control and Prevention, and published peer-reviewed studies). Calculations of insurance premiums attributable to specific health conditions among the employed population are also obtained from a combination of various data sources such as those from the State Health Access Data Assistance Center and Integrated Public Use Microdata Series.

We find that in 2017, among the adult population, Indiana's obesity prevalence is 33.6%, about 10% higher than the age and sex adjusted U.S. prevalence (30.05%). Indiana's diabetes prevalence of 11.8% is about 8% higher than the national prevalence of 10.8%. Lastly, Indiana's smoking rate is 21.9%, about 25% higher than the national rate of 16.4%, putting it at the highest quantile of smoking rate distribution across states. With Indiana's higher prevalence, the excess direct medical costs for total Indiana adult population are $2.7 billion for obesity, $5.2 billion for diabetes, and $3.0 billion for smoking. For the employed population, the excess direct medical costs are $1.3 billion for obesity, $2.3 billion for diabetes, and $1.9 billion for smoking. The total indirect costs (i.e., productivity losses among employed population) are $5.6 billion, $2.8 billion, and $3.3 billion for obesity, diabetes, and smoking, respectively. The estimated excess insurance premium due to these three conditions is $1.5 billion, $2.6 billion, and $2.2 billion for obesity, diabetes, and smoking respectively, with about 75% of these amounts paid by Indiana employers and 25% by Indiana employees. Dividing these total burden by the estimated number of Indiana employees (~2.9 million), we obtain the per employee excess cost due to these three conditions. For instance, the average employer paid excess premium for each employee is $390 for obesity, $675 for

diabetes, and $571 for smoking. The estimated per employee premiums paid by employees are $128 for obesity, $222 for diabetes, and $187 for smoking.

We apply these per employee excess costs to assumed reduced obesity, diabetes, and smoking prevalence in Indiana to obtain estimated total excess cost as a "what-if" scenario. In this "what-if" scenario, Indiana obesity, diabetes, and smoking prevalence are assumed to reduce by 10%, 8%, and 25% to match the national prevalence of these three conditions. The estimated reduction in the total economic burden from the status-quo to the "what-if" scenario is considered the potential savings from improving health among Indiana employees. Such a reduction, although may not be immediately feasible, can provide an estimated magnitude of the overall opportunity possibly achievable by investing more health resources in health promotion among Indiana's employee population.

Estimated total savings from simultaneous reduction of all three prevalence is $2.3 billion for Indiana employed population, if successful. This estimate accounts for the overlap in prevalence of three conditions in Indiana population (i.e., these health conditions are correlated). For example, there are well documented correlations between the prevalence of diabetes and obesity and, therefore, summing savings associated with each condition will overstate the potential savings. This total savings of $2.3 billion includes:

- a $751 million reduction in the direct medical costs
- a $431 million reduction in productivity losses due to presenteeism, i.e., illness-related poorer work performance while on the job
- a $216 million reduction in productivity losses due to absenteeism, i.e., increased workdays missed due to illness, and
- a $892 million reduction in future earnings loss due to premature mortality

The "what-if" scenario would also lead to a near $860 million reduction in total health insurance premium paid by both employers and employees, of which $647 million would be savings to the employers and $213 million to the employees.

Medical spending attributable to obesity, smoking, and diabetes are big drivers of the health care expenditures in the U.S. Obesity and smoking are health risk factors that are highly driven by lifestyle and diabetes is a costly chronic condition and a risk factor in itself for more severe complications such as heart disease, stroke, end-stage renal disease, among others. All three conditions are preventable and would have significant impact on all the stakeholders, especially employers who are the largest bearer of the consequences in the forms of excess insurance premiums paid for employees and the lost productivity due to these conditions and their comorbidities. The savings estimated from a "what-if" scenario shown in this report supports a strong business case for Indiana employers to invest in their employees' health and wellness.

I. Background

Indiana's composite health ranking, based on a composite index that accounts for over 30 metrics, continued to decline over the years. As shown in the historical rankings based on the state composite measure created by the United Foundation, Indiana once ranked above 30 among all 50 states in the 1990s, but had declined to be in the neighborhood of 40 in 2018.[2] Indiana ranks poorly on two major health behavior risk factors, smoking and obesity, which result in many costly chronic conditions. Indiana's smoking rate ranked in the bottom quintile and the obesity rate ranked in the second to last quintile. Additionally, Indiana ranks in the 4th quintile in the prevalence of diabetes, which could be a consequence of obesity or smoking. Diabetes is in itself a top public health concern because of the many micro- and macro-vascular high cost complications it may cause.

Medical spending attributable to obesity, smoking, and diabetes are big drivers of the health care expenditures. Nationally, overweight- and obesity-attributable medical costs alone account for 9.1% of total United States (U.S.) medical expenditures and obesity itself accounts for about 5.3% of total national health expenditures.[3] Diabetes is a growing epidemic in the U.S. in general rather than in Indiana alone. It is the nation's seventh-leading cause of death, which also contributes to deaths from heart disease and stroke. The direct medical expenses among those with diabetes are approximately 2.3 times higher than in population without diabetes.[4] The U.S. nationwide medical costs of diagnosed diabetes in 2017 were $237 billion, with the overall diabetes attributable direct and indirect costs was $327 billion.[5] Finally, although smoking prevalence has decreased substantially in the last half a century, it remains a leading cause of preventable death in the U.S. The total economic cost of smoking in U.S. is estimated to exceed $300 billion, of which nearly $170 billion in direct medical care for adults (or 8.7% of annual healthcare spending).[6]

Within the state of Indiana, these three high impact health conditions also represent a large economic burden. A recent Richard M. Fairbanks Foundation-funded report "The Obesity Epidemic in Marion County and Indiana: Causes, Consequences, and a Critical Review of Solutions to Address It" estimated that in 2017, the overall economic costs of obesity for the state of Indiana was $8.5 billion. This includes $2.9 billion in excess healthcare costs, $3.9 billion in labor market costs (increased absenteeism or increased workdays missed due to obesity and presenteeism or obesity-related poorer work performance while on the job for obese employees), and $1.7 billion in lost economic output resulting from premature mortality (net of government expenditures).[7] The overall economic costs of diabetes for the state of Indiana was $9.0 billion (in 2013 dollars). This includes $4.2 billion in direct medical costs attributable to diabetes, 0.2 billion due to lost productivity, $2.3 billion in lost economic output resulting from premature mortality.[8] Finally, Indiana's total costs of smoking are $31,137 per smoker, of which $2,669 are health care costs.[9]

The Indiana Hospital Association (IHA) commissioned The Lewin Group to estimate the economic impact of population health improvement through reducing the prevalence of obesity, diabetes, and smoking in the state of Indiana, including the impact on: 1) direct medical spending; 2) indirect productivity cost; and 3) health insurance premium spending.

Although driven by many factors, healthcare spending and health insurance costs are both, to a large extent, determined by the risk pool composition, such as age, tobacco status, geographic

location/rating area, and the benefit design, as well as insurer's assumptions based on whether experience to date differs from that expected in assumptions underlying prior premiums.[10]

The ACA restricts how health insurance premium rates can be set. Beginning in 2014, policies cannot charge more based on pre-existing conditions such as diabetes, asthma, pregnancy or a disability. While smoking status can be factored in the premium calculations, obesity and diabetes, are pre-existing conditions. However, similar to smoking, obesity and diabetes both contribute to the increases in the cost of health services use that underlie the health insurance premiums. When the population risk level increases, the impact on health insurance cost is shared by both the employers and employees (with or without the pre-existing conditions).

II. Methods

In order to estimate the potential savings associated with health improvement among the employed population in the state of Indiana, we compare the economic burden under a status-quo with that under a what-if scenario that assumes reduced smoking, obesity and diabetes. The cost components included in the economic burden estimates include direct medical cost, indirect productivity related costs (i.e., absenteeism, presenteeism, and future earnings loss due to disease related premature death), and insurance premium payments by Indiana employers and employees. The economic burden under the status-quo is calculated by applying the per-employee condition-attributable cost estimated using data from the literature (adjusted to 2017 dollars) to the estimated total number of Indiana employees with a particular condition (i.e., obesity, diabetes, and smoking) in 2017 using the observed, current condition prevalence in 2017 Behavioral Risk Factor Surveillance System (BRFSS) data. For the what-if scenario, we use the same per-employee condition-attributable cost, however, assume that the age and sex adjusted prevalence of these three conditions is reduced to the U.S. national level. The cost differences between the status-quo and the what-if scenarios are used as the estimated potential savings associated with a successful one-time, overall health promotion in Indiana.

Once the savings from reducing the prevalence of each of the three health conditions from the observed rate for Indiana in 2017 to the national prevalence rate are calculated, we also calculate the total overall potential savings from reducing the prevalence rates of all three conditions simultaneously to the national level. This total overall savings is calculated as the sum of the savings from reducing the prevalence of all three conditions, removing any possible double-counting due to the potential inclusion of the savings multiple times for those who have more than one of the three conditions (see more details below).

Below, we describe the data and methods used for each estimation component.

Prevalence Estimates

Prevalence estimates for all three conditions (i.e., obesity, diabetes, and smoking) are estimated using a single source of data – the 2017 BRFSS data. BRFSS is a telephone survey that collects state specific data on health-related risk behaviors, chronic health conditions, and use of preventative services among U.S. residents residing in 50 states and District of Columbia. This is a large health survey with over 400,000 adult (≥18) interviews each year. The data represents a sample of Indiana population. However, the population weights variable in the BRFSS data allow

us to calculate both the size of the state population and the prevalence of the three conditions among the state's adult population.[11]

The BRFSS survey includes a wide variety of questions allowing us to construct the condition variables such that they align with the definitions in the United Health Foundation's America's Health Rankings Annual report.[12] **Exhibit 1** provides a mapping of survey questions to conditions' definitions. Responses "refused", "don't know" or "not sure" are excluded from the analysis.

Exhibit 1: Mapping of BRFSS Questions to Outcome Measures

Health Condition	Description of Condition	BRFSS variable(s)/question(s)
Obesity	Percent of adults with BMI of 30.0 or higher	_BMI5: Body Mass Index (BMI) of 30.0 or higher
Diabetes	Percent of adults who reported being told they have diabetes, excluding prediabetes and gestational	DIABETE3: Ever told you have diabetes = Yes This includes both Type I and Type II diabetes. Gestational and prediabetes are excluded from the counts.
Smoking	Percent of adults who are smokers; at least 100 cigarettes in their lifetime and currently smoke every or some days	SMOKE100: Smoked at least 100 cigarettes = Yes OR SMOKDAY2: Frequency of days now smoking = "Every day" or "Some days"

Note: Codebooks are available on the BRFSS website: https://www.cdc.gov/brfss/annual_data/2016/pdf/codebook16_llcp.pdf

We first estimate the age group (i.e., 18-34, 35-44, 45-54, 55-64, 65+) and sex-specific raw rates for each of the three conditions for Indiana and other states in the U.S., as well as for the U.S. as a whole. The crude prevalence rate for adult population is calculated as a ratio:

$$Prevalence\ Rate\ in\ Indiana = \frac{Indiana\ Adult\ Population\ with\ a\ Given\ Condition}{Total\ Adult\ Indiana\ Population}$$

The crude prevalence rates are not directly comparable across states due to differences in the underlying population. To be able to compare Indiana prevalence estimates to other states, as well as to the U.S. national average, we calculate the age and sex adjusted prevalence rates by state using the direct standardization method.[13] This method assumes that the composition of population across states remains constant (i.e., the reference or standardized population is fixed). As we are interested in comparing Indiana prevalence rate to other states, in our calculations, we use Indiana population by age and sex as a reference population, implicitly assuming the same composition for all other states. The adjusted prevalence rates are calculated by applying each state's age and sex-specific prevalence rate (i.e., crude prevalence rates) to the corresponding strata of the Indiana population. This results in the expected prevalence counts in a given strata. Aggregating expected prevalence counts across age and sex groups results in the total "expected prevalence counts" by state. Then, the risk adjusted overall state-specific prevalence rate for adult population is calculated by:

$$Risk\ Adjusted\ Prevalence\ Rate\ in\ State\ A = \frac{Total\ Expected\ Prevelance\ Counts\ among\ the\ Adult\ Population\ in\ State\ A}{Total\ Adult\ Population\ in\ Indiana}$$

For Indiana, the crude prevalence rate and the risk adjusted rate are the same. For all other states, the risk adjusted rates differ from their crude rates. The risk adjusted rates for these other states are based on the state's own age and sex-specific rates, however weighted with the size of Indiana population in each corresponding age-sex strata. That is saying, with the state's own observed rates in each age and sex strata, when we assume its population structure is the same as Indiana's population structure, what would be the expected prevalence rate for that state.

As a robustness check to our methodology, the overall crude prevalence we estimate from the BRFSS data are compared with the estimates in the United Health Foundation's America's Health Rankings Annual report and the rates are identical for all three conditions.

Direct and Indirect Cost Estimates of Obesity

The estimates of Indiana specific economic burden associated with obesity are from the existing literature. Specifically, the direct health cost estimates associated with obesity, as well as indirect cost associated with lower productivity among employed (i.e., presenteeism, absenteeism) and cost associated with the premature death are from the study by Mantinan et al (2018).[14]

The cost estimates presented in Mantinan et al (2018) are derived from a variety of sources. Specifically, obesity related healthcare expenditures are estimated from a combination of the Medical Expenditure Panel Survey (MEPS) data and the State Health Expenditure Accounts (SHEA) published by the Centers for Medicare and Medicaid Services (CMS). As the average healthcare costs are higher among obese individuals, the cost estimates for obese population are adjusted upward by 28.5% relative to the healthy weight population. The productivity loss due to presenteeism and absenteeism combines survey based estimates of sick days among obese employees and the related loss in the potential earnings. Lastly, the costs of premature mortality combines data on multiple causes of death and Indiana specific rates of death by age with future potential earnings with a 3% discount rate. The expected mortality estimates are adjusted for the negative impact of obesity. Among individuals who are over age 64, there are no differences in mortality rates between obese and non-obese individuals. Therefore, the estimate of premature mortality costs for this group is zero.

While in Mantinan et al (2018) the costs estimates are the total costs in 2017 rather than per person costs in 2017, the estimates are broken down by type of costs and by sex and age group (i.e., younger than 18, 18-24, 25-34, 35-44, 45-54, 55-64, and age 65 or older). The costs for those younger than 18 are available, but we are not able to use them in our calculations as the BRFSS data that we use for prevalence counts include only adult population aged 18 and older.

To obtain an estimate of per-obese individual costs, we divide the aggregated direct and indirect costs associated with obesity (in million $s) from Mantinan et al (2018) by the obesity prevalence estimates we calculate from the BRFSS data. Because the indirect costs associated with productivity loss due to absenteeism and presenteeism, as well as future earnings lost affect only employed people, we use the obesity prevalence estimates among employed population. Additionally, as the age groups in Mantinan et al (2018) do not precisely match the ones we use in

the prevalence calculations, the cost estimates are aggregated in five groups combining estimates of 18-24 and 25-34 in one group.

Direct and Indirect Cost Estimates of Diabetes

Similar to obesity, the annual Indiana specific burden estimates for diabetes are from a single source of data: the online Diabetes Burden Toolkit published by the Centers for Disease Control and Prevention (CDC).[15] This toolkit provides state specific health and economic burden associated with diabetes by age (i.e., 18-44, 45-64, 65-74, and 75 or older) and sex. The excess direct medical cost of diabetes are estimated by applying the diabetes attributable fraction in medical cost estimated from the MEPS data to the total state medical expenditure obtained from CMS' SHEA. The estimates of productivity loss due to absenteeism rely on the estimated number of workdays missed that are attributable to diabetes. These workdays valued using the national age-sex specific earnings adjusted to the state level. Finally, the value of the workdays missed is multiplied by the estimated number of employed people with diabetes in each state, by age group, and sex. Presenteeism costs are calculated similarly, but assuming that on average 6.6% of annual productivity is lost at work as a result of diabetes. The rational for using this adjustment factor is based on the analysis done by the American Diabetes Association.[16] The mortality costs are calculated by multiplying the number of deaths attributable to diabetes[17] by age-sex strata in each state by the estimate of present value of lifetime earnings and household productivity costs.

All estimates in the Diabetes Burden Toolkit are expressed in 2013 dollars. Costs associated with the productivity loss are expressed for per employed diabetic, while medical costs are per diabetic. Finally, premature mortality costs capture the total work productivity costs in millions of dollars and assume zero costs for people aged 75 or older due to low labor force participation in that age group. To convert the total estimate of premature mortality costs to per capita terms, we first estimate the number of people with diabetes in Indiana in 2013, using the 2013 BRFSS data. The diabetes prevalence estimates are calculated for employed people with diabetes by age and sex that match age groups in the Diabetes Burden Toolkit. Then, the CDC's aggregate premature mortality estimates are divided by the 2013 diabetes prevalence (i.e., the number of individuals with diabetes) to obtain the cost associated with premature mortality per employed diabetic.

To express 2013 cost estimates for absenteeism, presenteeism, and premature mortality in 2017 dollars, we apply an average inflation rate of 1.28% per year as reported by the Bureau of Labor Statistics (BLS).[18] Finally, the medical costs in 2013 are adjusted to 2017 value using the 4% per year growth rate shown in the SHEA for Indiana. To calculate this rate, we combine 2010-2014 data.[19]

Direct and Indirect Cost Estimates of Smoking

To identify the burden estimates of smoking, we conducted a literature review. While a number of studies focuses on smoking, none is specific to Indiana. From the national studies, we are not able to identify a single study that includes both direct and all indirect components. Therefore, the burden estimates of smoking are from various sources in the literature. Specifically, the direct costs of smoking, as well as the related productivity loss due to presenteeism and absenteeism are from Berman et al (2014).[20] They calculate the total direct healthcare costs in U.S. by adjusting the 2010 total healthcare expenditures among employers in the private-sector by the 8% smoking attributable fraction of healthcare expenses. Then the costs are expressed as cost per employee in

private employment who smoke. Lost productivity due to excess absenteeism associated with smoking is calculated as a product of the number of additional days taken off from work among smoking employees relative to non-smoking employees, hours worked per day, and average hourly wage and benefits paid to a smoking employee.[21] Lost productivity due to excess presenteeism is calculated similarly, but using the excess presentism rate of 1% rather than the average excess days absent from work (this adjustment is done to account for interruption due to breaks taken for smoking).[22]

The estimates in Berman et al (2014) are expressed in 2010 dollars and have some limitations. While the cost estimates are reported as per smoking employee, these are not Indiana specific estimates. Additionally, the breakdown by age and sex is not provided. Due to lack of a better alternative, we assume that the costs are the same across sex-age groups.

The burden estimates associated with the premature mortality are calculated by combining the national estimate of premature mortality costs in the U.S. from Menzin et al (2012) with our estimate of deaths attributed to smoking.[23]

The premature mortality costs in Menzin et al (2012) are expressed as the present value of lifetime earnings per person who died due to smoking and are reported in 2009 dollars by age and sex strata. Relying on a variety of inputs, such as demographic composition of population, the labor force participation rate, and life expectancy by age-sex they developed a predictive model of the present value of lifetime earnings for a select set of developed and developing countries (including the U.S.) which also incorporated mortality rates from their Benefits of Smoking Cessation on Outcomes Model to obtain the smoking-related lost productivity costs.

The key component of premature death related cost calculation is the Indiana specific mortality attributable to smoking. These data are not available. Therefore, we retrieve this information from a mix of the national and state statistics. We use the following data sources to estimate the number of deaths attributable to smoking in Indiana:

- The national average annual (2005-2009) smoking attributed mortality (SAM) by age and sex from the 2014 CDC's report "The health consequences of smoking – 50 years of progress: a report of the Surgeon General".[24]
- Indiana specific all-cause deaths from the 2017 Indiana Mortality Report produced by the Indiana State Department of Health.[25]

First, we calculate the national smoking attributable mortality rates by dividing age-sex specific SAM by total all-cause deaths. We then apply the SAM rates to the all-cause deaths in Indiana in 2017, which yields smoking attributable mortality counts in Indiana in 2017. This is a conservative estimate for Indiana and can be refined in the future when Indiana-specific estimates of smoking attributable deaths are available. We note that death rates are not available for male/female ages 18-34. Therefore, within each sex, we use the linear interpolation to obtain the death rates for this age group using the rates of the available age groups. Second, we calculate total premature mortality costs attributed to smoking by multiplying the sex-age premature mortality costs (per death) from Menzin et al (2012) by our estimated smoking attributable deaths. Finally, we calculate an estimate of the premature mortality costs per smoker by dividing total premature mortality costs by the 2017 smoking prevalence in Indiana.

To bring the cost estimates up to 2017 dollars, we apply the inflation rate of 1.69% per year calculated from the BLS statistics on the consumer price index to absenteeism and presenteeism estimates, which are reported in Berman et al in 2010 dollars.[26] The costs associated with premature death are adjusted from 2009 dollars to 2017 dollars using the BLS reported inflation rate of 1.68% per year.[27] For direct costs, we apply a growth rate of 4% per year, which is the average rate from the 2010-2014 SHEA data.

Insurance Premium Estimates

Premium Calculations

The average insurance premium specific to Indiana by the coverage status (single vs family), the breakdown of population in high-deductible health plans (HDHP) versus non-HDHP, and the employer/employee contribution breakdown are taken from the State Health Access Data Assistance Center (SHADAC).[28] Based on SHADAC data, the average premium in Indiana in 2017 is $6,162 for single coverage plans and $18,253 for family coverage. Employers cover the large proportion of premiums: 76.3% for single coverage plans and 75.1% for family coverage plans. Finally, the majority of employees – 56% – have HDHP (and 44% have non-HDHP).

To assess the impact on employer paid portion of health insurance premiums, we have to estimate the percent of employees who use family versus single coverage plans by coverage plan type (HDHP versus non-HDHP). First, we estimate the breakdown between family and single coverage plans using the 2017 Integrated Public Use Microdata Series (IPUMS) data for Indiana.[29] Specifically, we use a variable (HIUNPERS) that provides the number of people covered under health insurance within a family unit. We define family insurance coverage as: a respondent has health insurance through employer AND is currently employed AND the number of people covered under the insurance plans exceeds one. We find that among the employed population in Indiana, 67% have family plans and 33% have single coverage plans. Second, to estimate the percentage of employees covered under family HDHP plans, we multiply the percent of Indiana employees with HDHP plans (i.e., 56%) by the percent of employees with family coverage plans (67%). For single coverage, we multiply the percent of Indiana employees with HDHP plans (i.e., 56%) by the percent with single coverage plans (33%). This calculations show that about 38% have high deductible family plans and 29.6% are estimated to have non-high deductible family coverage plans (a total of 67%). Then, we repeat calculations to obtain the estimates for employed population with HDHP (18.4%) and non-HDHP single coverage plans (14.4%).

As we do not know the average premium for single coverage with HDHP versus single coverage with non-HDHP (and premiums for family coverage with HDHP versus family coverage with non-HDHP), we assume that the average premiums of $6,162 for single ($18,253 for family coverage) available from SHADAC represent the overall average premiums (i.e., average between HDHP and non-HDHP plans with an assumption that premiums are larger for non-HDHP coverage). This results in a factor of 1.05 above the SHADAC's averages for the non-HDHP premium estimates (i.e., the average premiums for non-HDHP with family coverage are $19,214 and the premiums for non-HDHP with single coverage $6,486). Non-HDHP plans are estimated to pay on average about 10% higher premium than HDHP plans.[30] Therefore, the HDHP total premiums are assumed to be 90% of non-HDHP premiums for the respective coverage plan (i.e., family and single plans). **Exhibit 2** below summarizes total premium amounts for all plan type and coverage combinations. The employer paid premiums are estimated by applying SHADAC's percentages for employer

paid portions (i.e., 75.1% for family and 76.3% for single coverage) to the respective total premium amounts.

Exhibit 2: Total and Employer Paid Amounts by plan type and coverage

	Total Amount	Employer Paid Amount	Employee Paid Amount
High Deductible Family Plans (37.6%)	$17,292	$12,987	$4,305
High Deductible Single Plans (18.4%)	$5,838	$4,454	$1,384
Non-High Deductible Family Plans (29.6%)	$19,214	$14,429	$4,785
Non-High Deductible Single Plans (14.4%)	$6,486	$4,949	$1,537
Single Plans Overall	**$6,162**	**$4,702**	**$1,460**
Family Plans Overall	**$18,253**	**$13,708**	**$4,545**

Condition-attributable fraction of health care costs

Using the employment rates from the BRFSS data, we estimate percentage of Indiana population who are employed in 2017 (57%). Next, we need to know what percentage the condition specific costs contribute to the total health costs among employed Indiana population. The total estimated medical expenditures in 2017 in Indiana provided by the SHEA is $62.6 billion for the entire population and $35.8 billion for the employed population when we apply the per-capita cost by age and sex to the percentage employed from BRFSS. Then, we calculate the condition-attributable fraction of health expenditures by dividing the condition-attributable direct medical costs by the 2017 total personal health expenditures among the employed population. The estimated condition-attributable fraction of health care costs is 3.65% for obesity, 6.31% for diabetes, and 5.34% for smoking. Due to a lack of data in the literature on the condition-attributable fraction of health insurance premium payments, we assume that these condition-attributable fractions of health care expenditures apply to premium payments.

Total premium and condition specific excess employer paid premium

We calculate the total sum of premiums paid by employers using the premiums of high deductible family, high deductible single, non-high deductible family, and non-high deductible single premium costs from **Exhibit 2** and multiplying by the respective employee counts in Indiana as calculated above. Then, we apply the estimated percentages for coverage-plan type combinations (i.e., high deductible family, etc.) to obtain the number of employed by coverage-plan type. We also apply the age and sex specific condition prevalence rates to the employed population to obtain the number of employed obese, employed diabetic, and employed smokers for plan-coverage combinations.

To calculate the per-employee excess premium (separately for employer and employee paid amount) that is attributable to one of the three health conditions, we follow the following steps. First, we apply the condition-attributable fractions (e.g., 3.65% for obesity) to the employer and employee premiums paid in Indiana to get an estimate of condition-attributable insurance premiums. Then, we divide the condition-attributable premiums paid by the employee population

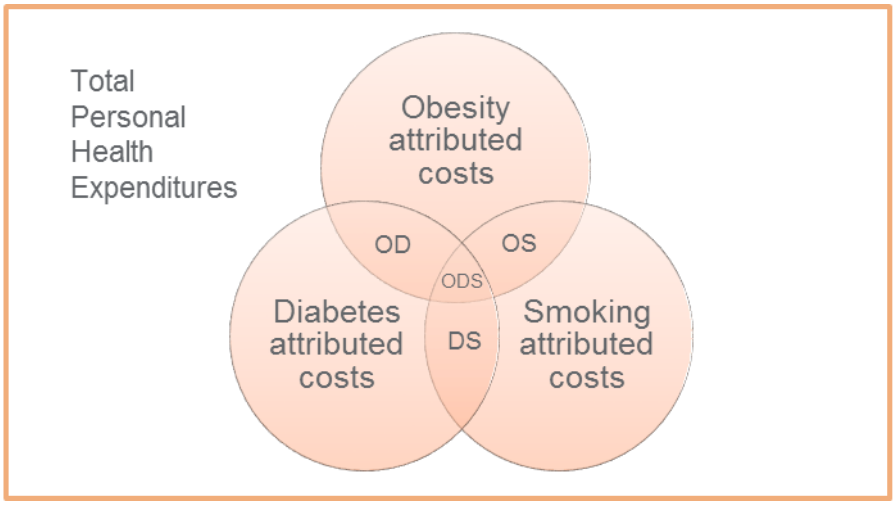
count to calculate the per-employee condition-attributed premium costs. For example, the excess employer paid premium for obesity is $390 per employee. Per employee premiums for diabetes and smoking are higher at $675 for diabetes and $571 for smoking.

Dividing the condition-attributable premiums cost by the employed population with the condition produced estimates of the condition specific attributable premium per employee with that condition. Because the number of employed people exceeds that of employed people with a given condition, the employer paid excess premiums per employee with a given condition are much higher: $1,159 per obese employee, $7,268 per diabetic employee, and $2,332 per smoking employee.

Methodology for Accounting for Overlapping Costs in Calculating Savings from All Three Conditions Combined

This total overall savings are calculated as the sum of the savings from reducing the prevalence of all three conditions, removing any possible double-counting due to the potential inclusion of the savings multiple times for those who have more than one of the three conditions. That is, because obesity, diabetes, and smoking are not mutually exclusive, there is double counting when attributing cases of prevalence. For example, there is a positive correlation between obesity and the Type II diabetes. Hence, the reduction in obesity, may lead to a reduction in diabetes prevalence and diabetes costs. **Exhibit 3** shows the overlap between attributed costs for each condition. The overlapped areas are costs that have been double counted. From the figure we know that areas OD, OS, DS have been counted twice and area ODS has been counted three times.

Exhibit 3: Illustration of Cost Overlap between Obesity, Diabetes, and Smoking



To address the problem with double counting in estimating the cost-savings from reducing the prevalence of all three conditions, we are accounting for the cost overlaps by following these steps.

First, we calculate the adjustment factor to obtain the total adjusted medical costs:

$$Adj\ Attributable\ Fraction = 1 - \left(\left[1 - \left(\frac{Obesity - attributable\ \$}{Total\ Medical\ \$}\right)\right] * \left[1 - \left(\frac{Diabetes - attributable\ \$}{Total\ Medical\ \$}\right)\right] * \left[1 - \left(\frac{Smoking - attributable\ \$}{Total\ Medical\ \$}\right)\right]\right)$$

The total medical expenditures for Indiana are estimated based on the SHEA data for period 2009 to 2014 published by CMS, Office of the Actuary.[31] To predict the total medical expenditures in 2017, we apply the average growth rate in medical expenditures between 2009 and 2014 to the 2014 expenditures. Costs attributable to obesity, diabetes, and smoking are the estimated attributed medical costs associated with each condition. The total adjusted attributed medical costs are:

$$Total\ Adjusted\ Attributable\ Medical\ Costs, \$ = Total\ Medical\ Costs, \$ * Adj\ Attributable\ Fraction$$

Next, we calculate an adjustment ratio:

$$Adjustment\ Ratio = \frac{Adjusted\ Attributed\ Medical\ Costs, \$}{UnAdjusted\ Attributable\ Medical\ Costs, \$}$$

The adjustment ratio for each condition can only be calculated for direct medical costs for which we know the total medical expenditures incurred by the state's employed population. The "adjustment ratio" is then applied to the total raw attributable medical costs summed from the original attributable medical costs from all three conditions to derive the adjusted total attributable medical cost due to the three conditions. These are the medical cost that can be attributed to the three outcomes simultaneously. Due to lack of the estimates for conditions attributable indirect costs, we made an assumption that the same adjustment ratio is applicable for all indirect costs and calculated the adjusted total productivity losses due to absenteeism, presenteeism, and premature mortality similarly.

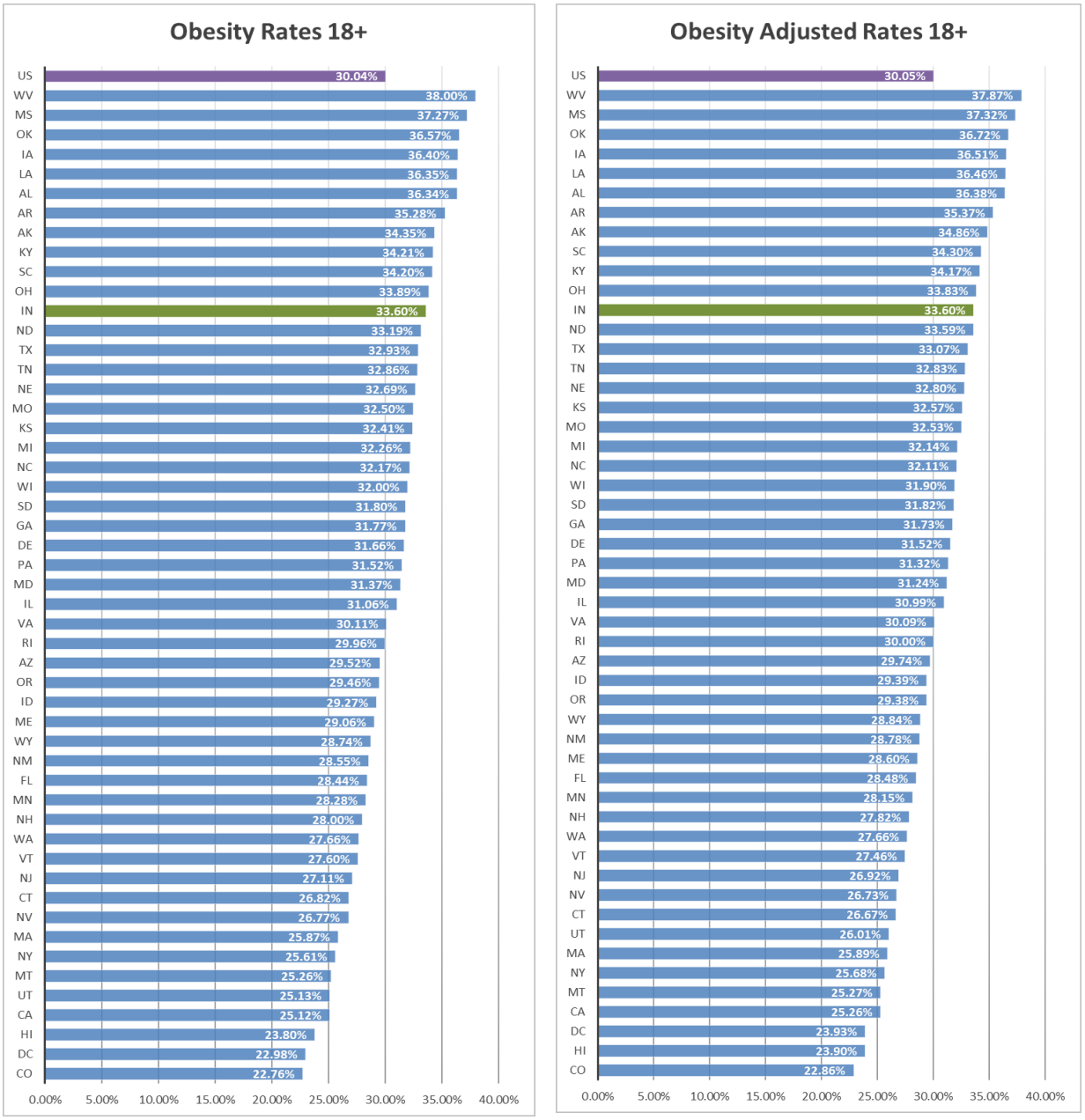
To calculate the savings associated with the "what-if" scenario, we apply the same methodology to the scenario which assumes an X% reduction in the total costs for each outcome. The difference between the adjusted costs under the status-quo and the adjusted costs under the X% reduction yields the total savings from an adjustment of all three outcomes simultaneously.

III. Results

Prevalence Estimates in Indiana

Exhibits 4-6 show the unadjusted and adjusted prevalence rates among the adult population by state. For obesity (**Exhibit 4**), Indiana has the 12th highest rates (both unadjusted and age-sex adjusted) across states. The adjusted obesity rate among the Indiana adult population is 33.6%, roughly 10% higher than the U.S. average of 30.05%. The structure of the Indiana population is similar to the U.S. population and, therefore, the adjusted rates are similar to the unadjusted rates.

Exhibit 4: Unadjusted and Adjusted obesity prevalence rates among adult population by state (2017)



For diabetes (**Exhibit 5**), Indiana has the 12th highest rate for unadjusted prevalence and the 11th highest rate for age-sex adjusted rates. The adjusted diabetes rate among the Indiana adult population is 11.8%, roughly 8% higher than the U.S. average of 10.8%.

Exhibit 5: Unadjusted and Adjusted diabetes prevalence rates among adult population by state (2017)

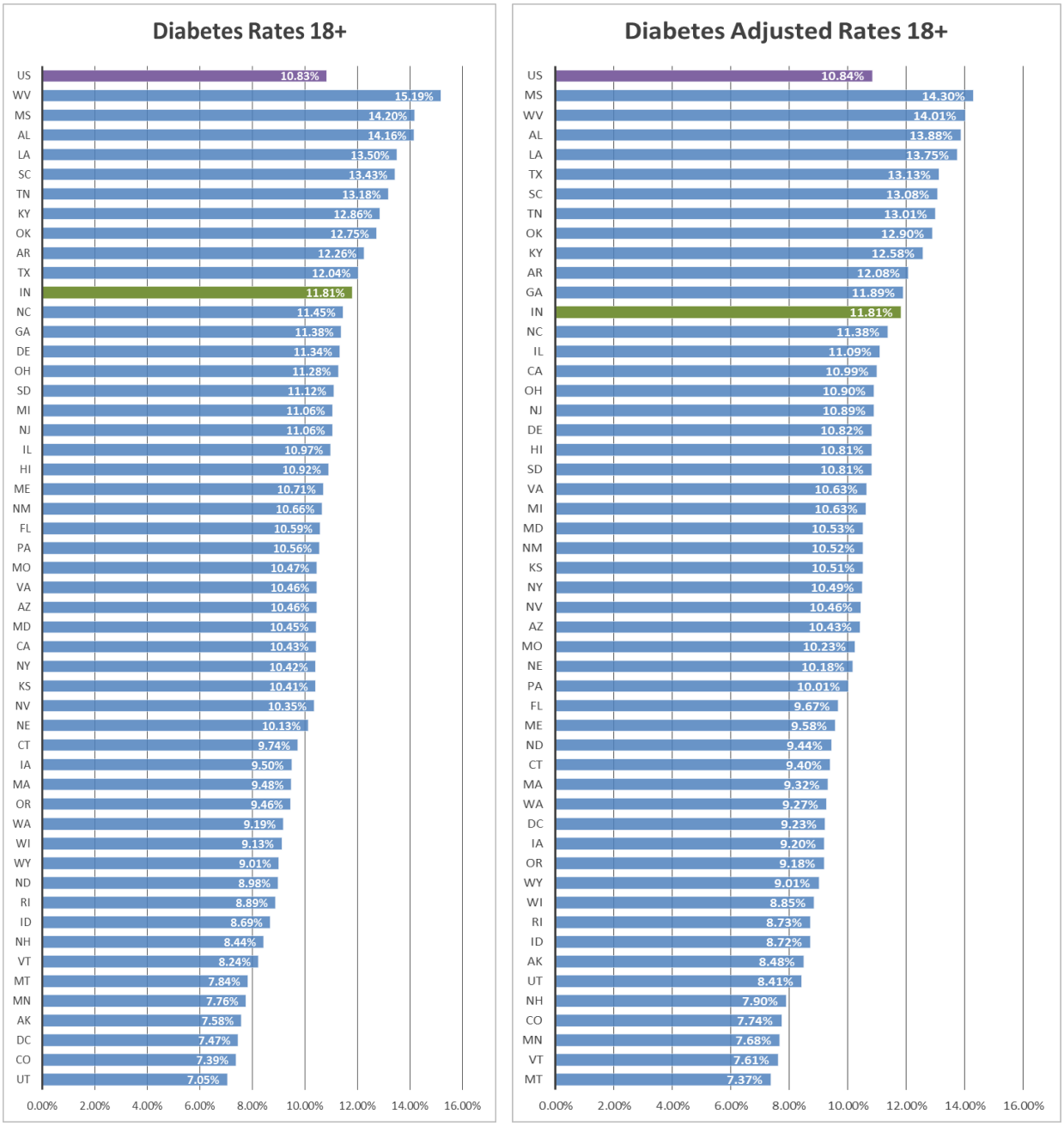


Exhibit 6 shows Indiana's ranking for smoking – Indiana is ranked as the 7th highest rate in the nation (both unadjusted and age-sex adjusted rates). The adjusted smoking rate among Indiana adult population is 21.9%, roughly 25% higher than the U.S. average of 16.4%.

Exhibit 6: Unadjusted and Adjusted smoking prevalence rates among adult population by state (2017)

Condition Specific Cost Estimates

Exhibit 7 below shows the total excess costs for Indiana in 2017. For Indiana population the total excess direct medical cost under the status-quo prevalence are $2.7 billion for obesity, $5.2 billion for diabetes, and $3.0 billion for smoking. The direct medical cost for employed population are

smaller, but also are the highest for diabetes ($2.3 billion), followed by smoking ($1.9 billion), and obesity ($1.3 billion).

Among the three conditions, obesity is associated with the largest losses in productivity in employed population due to both presenteeism and absenteeism ($2.8 billion and $1.1 billion, respectively). The productivity losses associated with diabetes are $982 million and $171 million respectively for presenteeism and absenteeism, and $367 million and $411 million for smoking. While future earnings' losses associated with premature mortality are similar for obesity and diabetes ($1.7 billion and $1.7 billion, respectively), they are much higher for smoking ($2.5 billion). Finally, from the perspective of Indiana employers, the insurance premiums attributable to each condition are the highest for diabetes ($1.9 billion), followed by smoking ($1.6 billion), and obesity ($1.1 billion). The employee paid premiums are much smaller at $640 million, $541 million, and $370 million for diabetes, smoking, and obesity, respectively.

Exhibit 7: Total excess cost in millions (2017 $) for Indiana total population (medical cost only) and employed population under the status-quo prevalence

Condition	Sex	Total Population Direct Medical Cost	Employed Presentee-ism	Employed Absentee-ism	Employed Direct Medical Cost	Employed Premature Mortality	Employed Total Excess Cost	Employed Insurance Premium (Employer Paid)	Employed Insurance Premium (Employee Paid)
Obesity	Female	$1,443	$1,016	$397	$593	$467	$2,473	$502	$165
	Male	$1,290	$1,816	$709	$714	$1,228	$4,466	$624	$205
	All	**$2,733**	**$2,832**	**$1,106**	**$1,307**	**$1,695**	**$6,939**	**$1,126**	**$370**
Diabetes	Female	$2,918	$321	$64	$1,079	$369	$1,833	$869	$285
	Male	$2,262	$661	$107	$1,183	$1,286	$3,237	$1,080	$355
	All	**$5,181**	**$982**	**$171**	**$2,262**	**$1,655**	**$5,070**	**$1,949**	**$640**
Smoking	Female	$1,411	$151	$170	$789	$460	$1,570	$735	$241
	Male	$1,578	$216	$241	$1,123	$2,082	$3,661	$913	$300
	All	**$2,989**	**$367**	**$411**	**$1,912**	**$2,542**	**$5,232**	**$1,648**	**$541**

Exhibit 8 shows the excess cost per employed person with a given condition. The total average excess cost per employed obese person is $7,410. The total costs are much higher among male $8,591 (compared to $5,954 for female). The largest portion of these costs constitute productivity losses due to presenteeism ($2,915 per employed worker with obesity), losses due to premature mortality ($1,744), and direct medical costs ($1,612). The excess insurance premiums paid by employers are $1,159 per employed obese worker and the excess insurance premiums paid by employee are $381, with a small difference across genders.

Among the three conditions, the total excess costs per employed diabetic are the highest – $16,800, with nearly half of them being the direct medical costs. While the total excess costs per diabetic are higher among male ($18,354 compared to $14,545 among female), the direct medical costs per person with diabetes are higher among female ($10,018 compared to $7,426). Productivity losses due to premature mortality of $6,172 per diabetic worker is the second largest component of the total excess costs. These losses are much higher among male – $8,405 per male diabetic employee

compared to $3,207 for female diabetic employee. In comparison to presenteeism, which is associated with $1,648 excess costs per diabetic employee, the excess productivity losses due to absenteeism are trivial (i.e., $287 per employee with diabetes). Finally, the total excess health insurance premiums are $9,656, of which employers pay $7,268 per employee and employees pay $2,388.

Exhibit 8: Excess cost (2017 $) per employed person with condition

Condition	Sex	Employed Presentee-ism	Employed Absentee-ism	Employed Direct Medical Cost	Employed Premature Mortality	Employed Total Excess Cost	Employed Insurance Premium (Employer Paid)	Employed Insurance Premium (Employee Paid)
Obesity	Female	2,322	906	1,658	1,068	5,954	1,147	377
	Male	3,401	1,327	1,564	2,299	8,591	1,169	384
	All	**2,915**	**1,138**	**1,612**	**1,744**	**7,410**	**1,159**	**381**
Diabetes	Female	1,101	220	10,018	3,207	14,545	7,544	2,479
	Male	2,171	352	7,426	8,405	18,354	7,060	2,320
	All	**1,648**	**287**	**8,693**	**6,172**	**16,800**	**7,268**	**2,388**
Smoking	Female	519	581	2,706	1,578	5,384	2,518	827
	Male	519	581	2,706	5,017	8,823	2,200	723
	All	**519**	**581**	**2,706**	**3,597**	**7,403**	**2,332**	**766**

As shown in **Exhibit 8**, under the status-quo prevalence of smoking, the total smoking related excess cost is $7,403 per smoking employee. This estimate is similar to the total obesity excess costs of $7,410 per obese employee. Similar to other conditions, the excess cost of smoking for male employees are higher than for female employees with the same condition. The largest portion of the excess costs are productivity losses due to premature mortality ($3,597 per smoking employee) and the direct medical costs ($2,706 per smoking employee). The excess productivity losses due to presenteeism are similar to the excess costs of absenteeism ($519 and $581 per smoking employee, respectively). As described in the "Methods" section, these two components of indirect costs are assumed to have the same excess costs across genders due to lack of availability of the cost estimates by gender. The excess insurance premium per employee who smoke are higher than those per obese employee and smaller than those per employed diabetic. For example, the excess employer paid insurance premium is $2,332 per smoking employee (with a higher premium for smoking female employee). The employee paid excess premium is $766 per smoking employee.

"What-if" Scenario Savings

As mentioned earlier, reducing the risk-adjusted obesity, diabetes, and smoking rates among Indiana adult population by 10%, 8%, and 25% to match the U.S. average prevalence would mean a reduction of 97,156, 21,452, and 176,674 Indiana employees with obesity, diabetes, or who are smoking, respectively.

Exhibit 9 shows the estimated savings that is associated with this "what-if" scenario. When looking at the impact of prevalence reduction for each condition independently, the total savings (excluding premiums) for Indiana employed population associated with a 10% reduction in obesity

prevalence are $693.9 million (in 2017 dollars). The reduction in the direct medical costs among the employed population is $130.7 million (savings in the overall population are even higher at $273.3 million). The reduction in obesity prevalence, results in the indirect costs savings among employed of $563.2 million, of which $283.2 million is associated with presentism costs reductions, $110.6 million with absenteeism, and $169.5 million reduction in future earnings loss from premature mortality. The overall savings in insurance premiums paid by both employees and employers are $149.6 million, with savings to employers being $112.6 million while savings in premiums paid by employees are $37.0 million.

Relative to a status-quo, total savings (excluding premiums) among employed Indiana population associated with an 8% decrease in diabetes prevalence are $405.6 million. Most of these savings are from reductions in the direct medical costs ($180.9 million) and reductions in future earning losses due to premature mortality ($132.4 million). Savings in employer paid insurance premiums are also substantial: $155.9 million, of which $86.4 million are savings for male employees and $69.5 million for female employees. Savings in employee paid insurance premiums are $51.2 million.

Finally, a 25% reduction in smoking prevalence in Indiana, yields the total savings (excluding premiums) among the employed population of $1,308 million. These savings are primarily due to costs reductions among employed male ($915.4 million versus $392.6 million for female). The two largest components of savings are savings in costs due to premature mortality ($635.5 million) and the direct medical costs ($478 million). While the savings in direct medical costs among employed population are concentrated in male population ($280.7 million for male versus $197.3 in female population), savings in the direct medical costs for total Indiana population of $747.2 million are more comparable between male and female ($394.4 million and $352.8 million, respectively). Savings to employees for employer paid insurance premiums are $411.9 million and savings in the employees paid premiums are $135.3 million.

Exhibit 9: Detailed savings in million (2017 $) from reducing the prevalence of obesity, diabetes, and smoking in Indiana by 10%, 8%, and 25% to match U.S. averages

Condition	Sex	Total Population Direct Medical Cost Savings	Employed Presentee-ism Savings	Employed Absentee-ism Savings	Employed Direct Medical Cost Savings	Employed Premature Mortality Savings	Employed Total Savings (excluding premium)	Employed Insurance Premium Savings (Employer Paid)	Employed Insurance Premium Savings (Employee Paid)
Obesity	Female	$144.3	$101.6	$39.7	$59.3	$46.7	$247.3	$50.2	$16.5
	Male	$129.0	$181.6	$70.9	$71.4	$122.8	$446.6	$62.4	$20.5
	All	**$273.3**	**$283.2**	**$110.6**	**$130.7**	**$169.5**	**$693.9**	**$112.6**	**$37.0**
Diabetes	Female	$233.5	$25.7	$5.1	$86.3	$29.5	$146.6	$69.5	$22.8
	Male	$181.0	$52.9	$8.6	$94.6	$102.9	$259.0	$86.4	$28.4
	All	**$414.5**	**$78.6**	**$13.7**	**$180.9**	**$132.4**	**$405.6**	**$155.9**	**$51.2**
Smoking	Female	$352.8	$37.9	$42.4	$197.3	$115.1	$392.6	$183.6	$60.3
	Male	$394.4	$53.9	$60.3	$280.7	$520.5	$915.4	$228.3	$75.0
	All	**$747.2**	**$91.8**	**$102.7**	**$478.0**	**$635.5**	**$1,308.0**	**$411.9**	**$135.3**
Overall (Adjusted)	Female	$694.8	$157.0	$82.9	$326.1	$182.0	$748.0	$288.5	$94.8
	Male	$669.9	$274.2	$132.9	$424.8	$709.5	$1,541.5	$358.6	$117.8
	All	**$1,364.6**	**$431.3**	**$215.8**	**$750.9**	**$891.5**	**$2,289.5**	**$647.1**	**$212.6**

If the prevalence rates in Indiana simultaneously decrease by 10%, 8%, and 25% for obesity, diabetes, and smoking to match the respective U.S. averages of 30.05%, 10.84%, and 16.44%, the total savings (excluding premiums) among employed population adjusted for prevalence overlaps would be $2.3 billion. These estimates account for the overlaps in conditions and provide the savings estimate that excludes the possibility of double counting savings. As shown in **Exhibit 9**, overall savings in indirect costs are $431.3 million for presenteeism and $215.8 million for absenteeism. A reduction in future earning losses due to premature mortality represent the largest source of savings at $891.5 million. Across genders, the total savings are larger among male adult population, primarily because of a much larger reduction in losses due to premature mortality ($709.5 million vs $182.0 million) and the direct medical costs ($424.8 million vs $326.1 million).

Relative to the status-quo scenario, the overall savings in insurance premiums are $859.7 million. Savings to employers associated with a decrease in employer paid premiums are $647.1 million and savings in employee paid premiums are $212.6 million.

IV. Discussion

Indiana's composite health ranking has deteriorated over the years. In 2017, Indiana ranked in the top 15 states that have the highest obesity, diabetes, and smoking prevalence rates. According to a recent Richard M. Fairbanks Foundation-funded report[32], the estimated economic costs of obesity alone in 2017 in the state of Indiana was $8.5 billion. Obesity-attributable medical spending accounts for a total of 9.1% of total U.S. medical spending and obesity itself accounts for about 5.3%.[33] The U.S. nationwide costs of diabetes are also substantial ($327 billion in 2017, of which nearly two thirds are the direct medical costs).[34] Given the burden that these conditions create on the health care, as well as the negative impact on employee productivity, it would be informative to understand not only the overall economic impact of these three conditions, but also in the assessment of savings that may be achieved if the prevalence of these health conditions were reduced.

In this study, we estimate the economic burden in the form of direct and indirect costs attributable to these health conditions among Indiana's employed population given the status-quo prevalence rates in Indiana in 2017 as observed from the BRFSS data. We find that the excess direct medical costs for Indiana employed population are $1.3 billion for obesity, $2.3 billion for diabetes, and $1.9 billion for smoking. (The excess direct medical costs for total Indiana population are $2.7 billion for obesity, $5.2 billion for diabetes, and $3.0 billion for smoking.) The total indirect costs due to productivity losses among the employed population are $5.6 billion for obesity, $2.8 billion for diabetes, and $3.3 billion for smoking. While the direct medical costs are excess spending due to a condition that insurance plans and patients have to bear, ultimately these excess spending costs are paid by Indiana employers and employees in the form of higher health insurance premiums. The estimated total excess premiums paid by employers and employees due to these conditions are $1.5 billion, $2.6 billion, and $2.2 billion for obesity, diabetes, and smoking, respectively. The excess employer paid insurance premiums are $1.1 billion for obese employees, $1.9 billion for diabetic employees, and $1.6 billion for smoking employees.

Additionally, we assess the cost savings that would occur if Indiana reduces its prevalence rates to the U.S. average. The savings for Indiana employed population associated with such a reduction is $693.9 million (excluding savings in premiums) and $149.6 million (employer and employee paid premium) for obesity assuming a 10% reduction of obesity rate in Indiana to match the national

average (i.e., from 33.6% to 30.05%). The savings associated with such a reduction is $405.6 million (excluding savings in premiums) and $207.1 million (employer and employee paid premium) for diabetes assuming an 8% reduction of diabetes rate in Indiana to match the national average (from 11.8% to 10.8%). The savings associated with such a reduction is $1.3 billion (excluding savings in premiums) and $547.2 million (employer and employee paid premium) for smoking assuming a 25% reduction of smoking rate in Indiana to match the national average (from 21.9% to 16.4%).

The costs associated with each condition being reduced to the average national level are not directly additive due to correlations across these health conditions in the underlying population. For example, obesity and diabetes are likely to be correlated and many individuals that are obese may also be diabetic. Accounting for the overlaps in prevalence, we estimate a total savings of $2.3 billion (excluding premiums) for Indiana employed population. These costs savings consist of a $750.9 million reduction in the direct medical costs, a $431.3 million reduction in productivity losses due to presenteeism, a $215.8 million reduction in productivity losses due to absenteeism, and an $891.5 million reduction in future earnings lost due to premature mortality. The savings in insurance premiums are $859.7 million, of which $647.1 million are premiums paid by employers and $212.6 million premiums paid by employees.

This study relies on a variety of data sources due to a lack of single source of data for each health condition. Therefore, there are a number of limitations. First, per capita costs due to smoking are from the national literature and are not Indiana-specific. However, if there is no reason to believe that an Indiana employee is significantly different from an average employee in the country, our cost-savings estimates would not be biased. Second, there is no single data source to calculate average premium paid by employers in Indiana by plan type (HDHP vs. non-HDHP, single vs. family coverage), premium differentials by plan type. Therefore, multiple data sources are used to derive estimates. Third, we assume that the proportion of condition-attributed premium over total premium are the same as the attributable-fraction of direct medical costs over total personal health expenditures in Indiana employee population. Finally, obesity and smoking may contribute to excess diabetes costs, and that is not separately accounted for, beyond the existing adjustment for the overlap in prevalence rates.

Conclusion

Medical spending attributable to obesity, smoking, and diabetes are big drivers of the health care expenditures in the U.S. Obesity and smoking are health risk factors that are highly driven by lifestyle and diabetes is a costly chronic condition and a risk factor in itself for more severe complications such as heart disease, stroke, end-stage renal disease, among others. All three conditions are preventable and would have significant impact on all the stakeholders, especially employers who are the largest bearer of the consequences in the forms of excess insurance premiums paid for employees and the lost productivity due to these conditions and their comorbidities. The savings estimated from a "what-if" scenario shown in this report supports a strong business case for Indiana employers to invest in their employees' health and wellness.

[1] Last accessed on 10/30/2019: https://www.americashealthrankings.org/explore/annual/measure/Overall/state/IN.

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[11] We compared the BRFSS estimates with the Census estimates, concluding that the breakdown of national population by age groups and Indiana population by age groups are similar in two data sources. For the methodological consistency, we used BRFSS data in our calculations.

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[14] Karah Mantinan, Corwin Rhyan, Julia Fantacone, George Miller. The Obesity Epidemic in Marion County and Indiana: Causes, Consequences, and a Critical Review of Solutions to Address It, Richard M. Fairbanks Foundation-funded report, 2018, available at: https://www.rmff.org/wp-content/uploads/2019/03/20190307-Obesity-ObesityReport2019-AltarumRMFFObesityReportFINAL.pdf. Detailed data was obtained via personal communication with the report's authors.

[15] Diabetes State Burden Toolkit. Last access on 10/11/19: https://nccd.cdc.gov/Toolkit/DiabetesBurden/Home/Index.

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[17] Diabetes attributable mortality from all-cause and cardio vascular disease was calculated using the AF approach. The AF approach combined information on the prevalence of diabetes, the relative risk of death for persons with diabetes relative to persons without diabetes, and the total number of deaths in the entire population.

[18] An average inflation rate during this period (2013 to 2017) was 1.28%. The inflation calculator last accessed on 10/30/2019: http://www.in2013dollars.com/2013-dollars-in-2017

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[22] It is noted that across studies these estimates range up to 4% and they took a conservative approach by applying a 1% estimate of lost productivity due to smoking.

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[26] An average inflation rate during this period (2010 to 2017) was 1.69%. The inflation calculator last accessed on 10/31/2019: http://www.in2013dollars.com/2010-dollars-in-2017?amount=100.

[27] An average inflation rate during this period (2009 to 2017) was 1.68%. The inflation calculator last accessed on 10/31/2019: http://www.in2013dollars.com/2009-dollars-in-2017?amount=100.

[28] Last accessed on 10/17/19: https://www.shadac.org/sites/default/files/ESI_Fact_Sheets_October2018/IN_Oct18.pdf.

[29] Requested from IPUMS on 7/30/19 from: https://usa.ipums.org/usa-action/variables/group?id=insurance.

[30] Due to lack of a better source, we relied on two online resources that compare premiums between HDHP and non-HDHP plans offered by specific health care provider: (i) https://blog.wealthfront.com/high-deductible-health-plan/ and (ii) https://thefinancebuff.com/hmo-ppo-vs-high-deductible-hdhp-hsa.html. Last accessed on 8/15/2019.

[31] Last accessed on 10/17/19: https://www.cms.gov/research-statistics-data-and-systems/statistics-trends-and-reports/nationalhealthexpenddata/nhe-fact-sheet.html.

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