Income, employment and diabetes

Minnesota
Department *of* Health

DIABETES UNIT

Income, employment, and diabetes

Minnesota Department of Health
Diabetes Program
PO Box 64882, St. Paul, MN 55164-0882
(651) 201-5429
www.health.state.mn

Upon request, this material will be made available in an alternative format such as large print, Braille or audio recording. Printed on recycled paper.

Contents

Executive Summary
INCOME, EMPLOYMENT AND DIABETES IN MINNESOTA

More than 7 percent of Minnesota adults report having diabetes. However, that percentage is not spread evenly across people with different incomes. Looking closely at income and employment for people with diabetes, we find that working-age adults (18 to 64) who live in households earning less than $35,000 a year are two-and-a-half times as likely to report having diabetes as those with incomes higher than $35,000.

- Households earning less than $35,000 a year are not uncommon. About 1 in every 4 adults in Minnesota lives in a household earning less than $35,000.

- More than 80 percent of adults 18-64 years old belonging to households earning less than $35,000 would be considered to be living in poverty or to have low incomes (incomes less than two-times the Federal Poverty Level).

Did low income come first or diabetes? We cannot tell from our data. However, the scientific literature suggests that having low income or socioeconomic status in childhood or mid-life can contribute to developing diabetes. On the other hand, the scientific literature demonstrates that working-age adults with diabetes are more likely to exit the workforce, retire early, and to have less earnings than their counterparts without diabetes. Our Minnesota data show more than one in three working-age adults living with diabetes is not working, which may mean he/she is unable to work, retired, or chose not to work, compared to one in ten who do not have diabetes, a difference that is not explained entirely by the older age of adults with diabetes.

What can we do to make things better?

- **Shape programs that help all people with diabetes manage their disease. Improve access and eliminate barriers to full participation among people who have low incomes.**
  - Embrace worksite wellness programs that may reach around half of working-age adults with diabetes.
  - Ensure that programs offered through employers are accessible to adults who are working, but earning low incomes (<200 percent of Federal Poverty Level)
  - Since more than thirty-three percent of adults 18-64 years of age who are living with diabetes are not working, engage sectors beyond employers to address the need of people with diabetes.
  - Eliminate co-pays and other cost-related barriers to program participation, especially among Minnesota adults who are not working and are, thus, more likely to have low incomes.

- **Invest in diabetes prevention** ranging from building environments that support healthy eating and physical activity, to improving food access and affordability, and offering research-tested programs designed to help people at increased risk for developing type 2 diabetes to lower their risk.
  - Employers, insurers, and communities all can support diabetes prevention. Worksite-related programs may reach up to two-thirds of the working-age population without diabetes.

- o For existing and new programs, remove cost-related barriers like co-pays to program participation for people with low incomes and make programs available to employees without insurance.

- o Specifically, support efforts to make the National Diabetes Prevention Program accessible to all eligible adults regardless of their income level.

- **Address broader issues associated with poverty** -- lack of employment or under employment, housing, food security, health coverage and educational opportunity and their intersection with race/ethnicity. Ensuring equitable access to these resources for all Minnesotans will contribute to efforts to prevent and better manage diabetes in Minnesota.

Background

UNDERSTANDING RELATIONS BETWEEN INCOME, EMPLOYMENT STATUS AND DIABETES

Socioeconomic status (SES) is strongly linked to health. SES shapes health and health shapes SES. An extensive literature exists describing these patterns and these patterns are echoed across countries as well as among populations within them.[1] Key papers describing national and Minnesota data show that individuals who have lower educational attainment or lower incomes tend to experience more heart disease and diabetes and to exhibit behaviors correlated with risk of these diseases.[2,3] Many minority racial and ethnic groups have lower average incomes and educational attainment than the white majority; many of these minority racial and ethnic groups also experience poorer health outcomes than whites.[2,3]

In this report we build on the foundation laid in the Advancing Health Equity in Minnesota report[3], describing in more detail patterns between income and diabetes for adults and working-age adults. We extend the work by exploring associations between income, diabetes, and employment among working-age adults to inform diabetes prevention and diabetes management programs, particularly for those who live on low incomes.

Describing income in a meaningful way is challenging. First, there are challenges in obtaining income data. Income is a sensitive topic and often many people do not share their income data with researchers. Researchers have to decide what to do with missing data. Instead of removing the missing data, we decided to see how much the missing data could potentially change our findings in this report.

Second, researchers are often limited by the data source and how it asked about income. Income represented simply as dollars earned over a period of time is somewhat helpful. It is more meaningful to describe income relative to its ability to provide for life's needs. A natural way to do this is to express income relative 1) to the number of people supported by it and 2) to a standard amount that expresses a degree of purchasing power. Often, income data are presented as a percentage of the Federal Poverty Level, a threshold used to determine eligibility for many benefits programs like Supplemental Nutrition Assistance Program (SNAP) and Medicaid. The main survey we use in these analyses, the Behavioral Risk Factor Surveillance System, captures household income in broad categories; it is not described in terms of Federal Poverty Level, a strong limitation. We conduct additional analyses with the American Community Survey, which collects a closely related family income variable, and we describe the meaning of family income in terms of Federal Poverty Level to put the data in meaningful context.

Over the last 20-30 years, new cases of diabetes have grown rapidly among adults under 65 years of age.[4] These younger adults who develop diabetes have a long time to live with the condition. Efforts to prevent and effectively manage diabetes must place emphasis on these younger adults and ensure people have access to resources and services that can help them to lead long, healthy lives. The second half of this report focuses exclusively on working-age

adults (aged 18-64 years), in part, because of the implications of diabetes development at a younger age. It also focuses on this group because income may mean different things for adults under 65 years of age as compared to adults 65 and older. First, working-age adults are likely to rely on employer-based insurance coverage or self-coverage for their health care needs; insurance costs may require a significant portion of income and/or use of insurance may be strongly shaped by income level, especially in cases where large deductibles or copays must be paid to trigger insurance coverage. Unlike adults 65 years or older who have nearly universal health insurance coverage through Medicare, those under 65 years do not necessarily have consistent coverage. Second, working-age adults are likely to have dependents or others living with them who need to be cared for with earned income. This means that absolute, dollar for dollar income may be similar across groups, but the ability of those dollars to meet life's needs may change because younger adults likely have more individuals to support using those funds.

Our analysis focusing on adults 18-64 years of age allows us to go beyond descriptions of diabetes and income and into the complex relationships between diabetes, employment and income. While we only scratch the surface, the data that emerge describe the relationships and can inform efforts to more effectively implement programs to address the needs of working-age adults who are at high-risk for developing diabetes or who already have diabetes.

Diabetes & Demographics

Diabetes prevalence is associated with certain demographic and socio-economic factors including low household income (less than $35,000)

TABLE 1. Percentage of Minnesota Adults Who Have Diabetes by Demographic and Socioeconomic Characteristics (BRFSS, 2013)[5]

Demographic or Socioeconomic Characteristic	% of Minnesota adults who have diabetes[1]	95% Confidence Interval[#]
Overall	7.4	(6.6-8.2)
Age*		
18-44 years	1.8	(1.2-2.3)
45-64 years	9.2	(7.8-10.7)
65+ years	18.3	(15.5-21.2)
Gender		
Male	7.8	(6.7-9.0)
Female	7.0	(5.9-8.1)
BMI category*		
Low or normal (<25)	2.9	(2.0-3.9)
Overweight (25-29.9)	5.9	(4.6-7.1)
Obese (≥30)	16.8	(14.5-19.1)
Household Income*		
Less than $15,000	**9.7**	**(6.9-12.5)**
$15,000 – less than $25,000	**14.2**	**(11.1-17.3)**
$25,000 – less than $35,000	**12.0**	**(8.2-15.8)**
$35,000 – less than $50,000	8.2	(6.2-10.3)
$50,000 or greater	4.1	(3.3-5.0)
Do not know or missing[+]	7.2	(5.0-9.3)
Education*		
Less than high school	13.7	(9.7-18.3)
High school graduate	9.3	(7.6-11.0)
Attended college/trade school	7.0	(5.8-8.3)
Graduated college/trade school	4.3	(3.4-5.2)
Insurance status		
Has insurance	7.8	(6.9-8.6)
Does not	5.1	(2.8-7.5)

[5]Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013, are weighted percentages and diabetes includes both type 1 and type 2 diabetes

*percentages for each sub-category are different at $p<0.001$; if no asterisk p > 0.05

[+]See Appendix 1 for sensitivity analysis showing the minimal potential impact of missing data on the association between income and diabetes.

[#]See Appendix 7 for a definition of a 95% Confidence Interval.

Adults with household incomes less than $35,000 per year are more likely to have diabetes.

8

This table shows the percentage of Minnesota adults who have diabetes and how this varies by demographic characteristics or socioeconomic status. These data are collected from an annual telephone survey conducted in Minnesota as a part of the Behavioral Risk Factor Surveillance System or BRFSS. Overall, 7.4 percent of Minnesota adults have diabetes, but rates are higher if adults are older, overweight/obese, completed less education, or have household incomes less than $35,000.

Income-related Patterns Persist

Higher diabetes rates associated with income remain even when we take into account other diabetes risk factors like age and education.

TABLE 2. Demographic and Socioeconomic Characteristics and Percentage of Minnesota Adults Who Have Diabetes Among Adults with Incomes Less than $35,000 and Income $35,000 or More (BRFSS[5], 2013)

	Percentage of adults in each category who have diabetes[1]	Percentage of adults in each category who have diabetes[1]
	Income less than $35,000	Income $35,000 or more
Demographic or Socioeconomic Characteristic	% (95% Confidence Interval)	% (95% Confidence Interval)
Overall	12.5 (10.5-14.4)	5.0 (4.2-5.9)
Age*		
18-44 years	3.2 (1.8-4.6)	1.1 (0.5-1.6)
45-64 years	20.6 (15.8-25.3)	6.0. (4.7-7.3)
65+ years	21.6 (16.8-26.3)	16.5 (12.2-20.8)
Gender		
Male	12.5 (9.7-15.3)	5.8 (4.6-7.0)
Female	12.4 (9.6-15.2)	4.3 (3.2-5.3)
Education*		
Less than high school	18.9 (12.0-25.9)	NR
High school graduate	13.2 (10.1-16.3)	7.3 (4.9-9.7)
Attended college/trade school	10.2 (7.5-12.9)	5.6 (4.1-7.0)
Graduated college/trade school	7.1 (3.5-10.8)	3.7 (2.8-4.6)
Insurance status		
Has insurance	13.8 (11.5-16.1)	5.2 (4.4-6.1)
Does not	7.5 (3.4-11.5)	NR

[5] Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013, are weighted percentages and diabetes includes both type 1 and type 2 diabetes *$P<0.001$, the percentages for each sub-category of a demographic or socioeconomic characteristic are not the same

NR = not reportable due to small cell sizes (<50 observations) or coefficient of variation ≥30%.

Income often is associated with characteristics like age and education that are also linked to diabetes prevalence, BMI and other variables. Income and the other variables may actually be measuring the same or strongly related things in part or entirely. For example, part or all of the

association between income and diabetes could be due to educational status since higher educational attainment is linked to greater ability to obtain higher paying jobs.

To begin to understand how much of what we are seeing in the association between income and diabetes prevalence might be due to other factors, we examined the proportion of people in each income category who live with diabetes and are in the same age group, the same gender, had the same educational attainment, or had similar insurance status. Within each demographic group in the table below, people with incomes less than $35,000 are more likely to have diabetes than people with incomes above $35,000.

Household Income

About 1 million Minnesota adults (one in four adults) live in households that earn <$35,000 per year.

Minnesota adults living in households with incomes less than $35,000 are more likely to be living with diabetes than adults living in households with higher incomes. About one-quarter of all adults report household incomes less than $35,000.
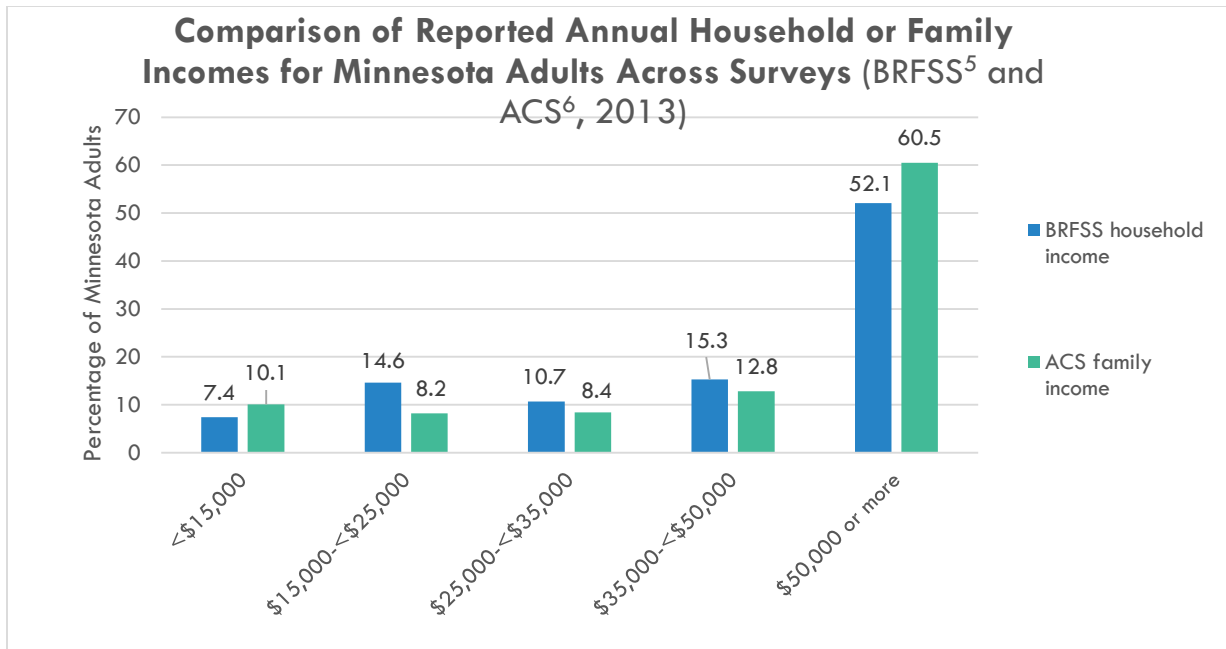
FIGURE 1
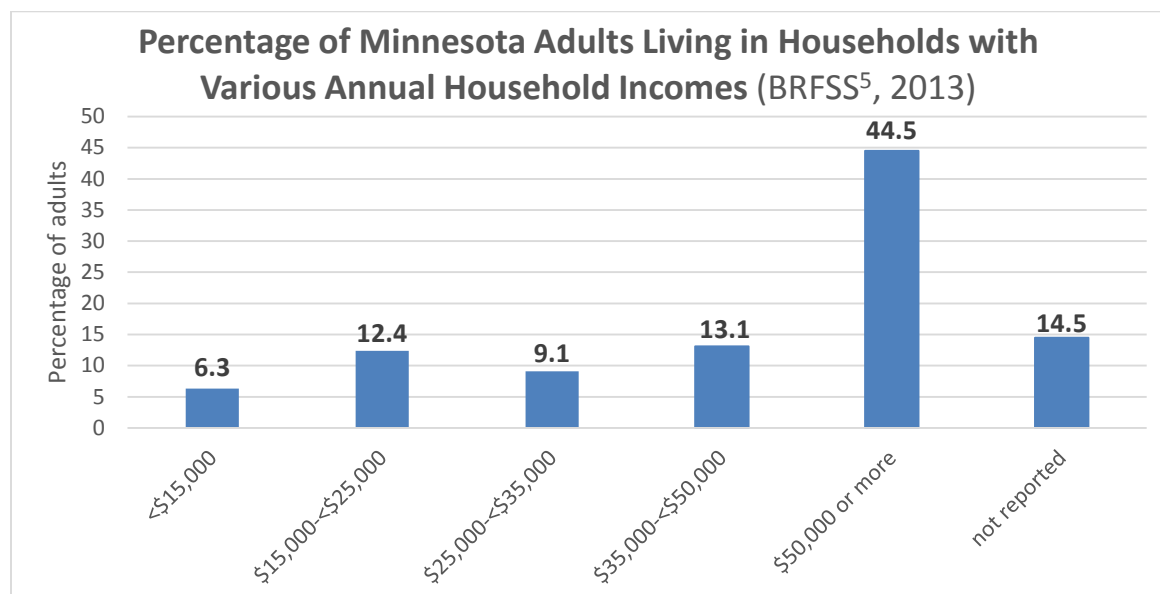
Percentage of Minnesota Adults Living in Households with Various Annual Household Incomes (BRFSS[5], 2013)

[5]Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013 and are weighted percentages

We find the same pattern in data from the American Community Survey (ACS) 2013 for Minnesota (Table 3). The ACS asked about family income. In some cases, family income is the same as household income. When multiple families live in one home, family income is only a part of household income.

FIGURE 2

Comparison of Reported Annual Household or Family Incomes for Minnesota Adults Across Surveys (BRFSS[5] and ACS[6], 2013)

[5]Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013 and are weighted percentages

[6]Data are from the American Community Survey, Minnesota 2013 as accessed through IPUMS-USA, University of Minnesota, www.ipums.org. Note that the IPUMS variable used to assess family income also includes single adults unlike most ACS family variables.

Both surveys tell us the similar stories: about 1 million adults in Minnesota live in households earning less than $35,000 per year.

Poverty & Low Income

Most adults living in families with incomes of less than $35,000 per year are living in poverty or have low incomes.

How far income goes towards paying the bills depends on the number of people in the family. Federal Poverty Level (FPL) is a threshold initially designed to assess whether or not families of a certain size had the resources to meet the basic necessities of life. FPL is also used to assess whether or not an individual or family is eligible for benefits like health insurance coverage, subsidies or Supplemental Nutrition Assistance Program (SNAP-ED) benefits. Based on family income relative to FPL, individuals and families can be classified as:

Poor or living below the poverty level: individual or family income less than 100 percent FPL

Low income: individual or family income between 100 percent of FPL and 199 percent of FPL (or nearly twice FPL), many of whom are also working and may be referred to as the working poor.

The BRFSS survey we have used to look at patterns between income and diabetes does not allow us to assess poverty or low income using the FPL definition, but the ACS does. The table

below shows percentage of adults who are poor or living on low income at each level of family income.

TABLE 3. Relationships between two descriptors of Income: Poor or Low Income based on the Federal Poverty Level and Annual Family Income (ACS, IPUMS data, 2013)[6]

Annual Family Income Categories	Percentage Classified as Poor or Low Income (0-199% FPL) (95% CI) Est. Population	Percentage Classified as 200% FPL and Above (95% CI) Est. Population
$0-$14,999	41.7% (40.7-42.8) 404,100	0% (0) 0
$15,000-$24,999	31.1% (30.2-32.1) 301,500	0.9% (0.8-1.0) 26,900
$25,000-$34,999	13.4% (12.7-14.1) 129,600	6.9% (6.6-7.2) 209,300
$35,000-$49,999	8.8% (8.2-9.4) 84,900	14.1% (13.7-14.5) 428,600
$50,000 and above	5.0% (4.6-5.5) 48,400	78.2% (77.7-78.6) 2,379,200

[6]Data are from the American Community Survey, Minnesota 2013 as accessed through IPUMS-USA, University of Minnesota, www.ipums.org Note that the IPUMS variable used to assess family income also includes single adults unlike most ACS family variables.

See Appendix 2 for more information on how poverty definitions are related to household income level

Using <$35,000 annual household income category from BRFSS as a proxy for low income seems reasonable based on the ACS data.

Family income of <$35,000 captures 86 percent of adults who live below the poverty level or on low income.

Only about 8 percent of adults who fall into the family income category of 200 percent of Federal Poverty Level or above earn <$35,000.
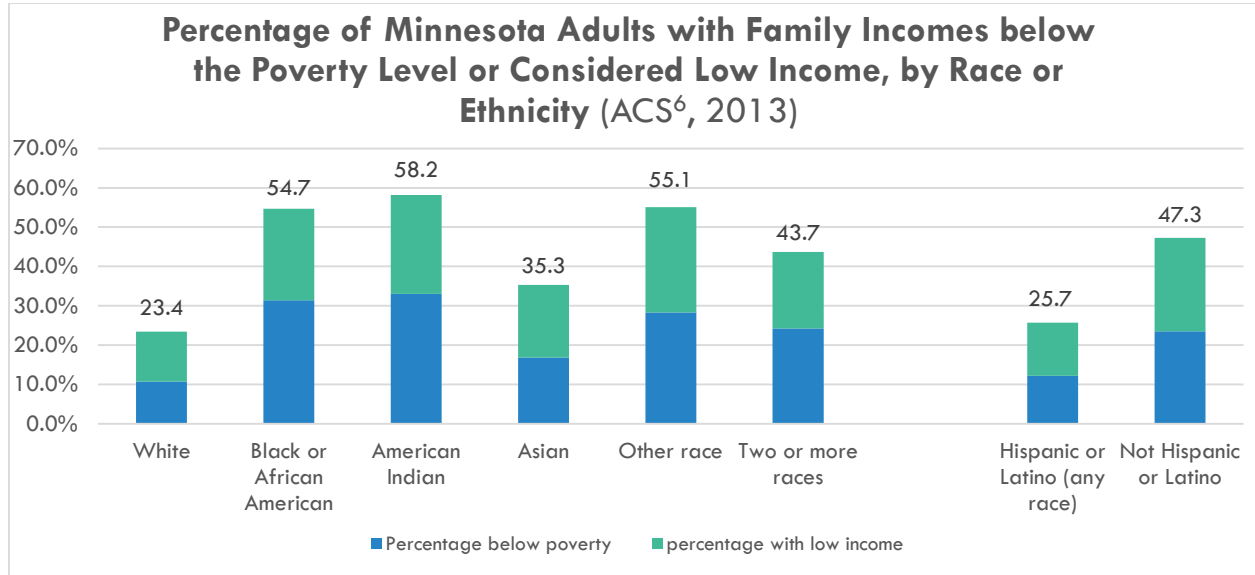
While we cannot create the same table for BRFSS data, we expect that it would estimate similar or, perhaps, slightly higher numbers of adults at a particular income level are living on low incomes since the BRFSS household income variable could be higher than family income.

Race, Ethnicity & Low Income

Adults of color in Minnesota are more likely to be poor or have low incomes and to live in families that earn <$35,000 per year.

While the scope of this report does not allow us to explore factors contributing to poverty or that strongly intersect with it, one final point regarding poverty and low income needs mentioning – it does not affect all Minnesotans equally. The figures below show that Black or African American, and American Indian adults are twice as likely to live in poverty or with low incomes as compared to White adults in Minnesota.
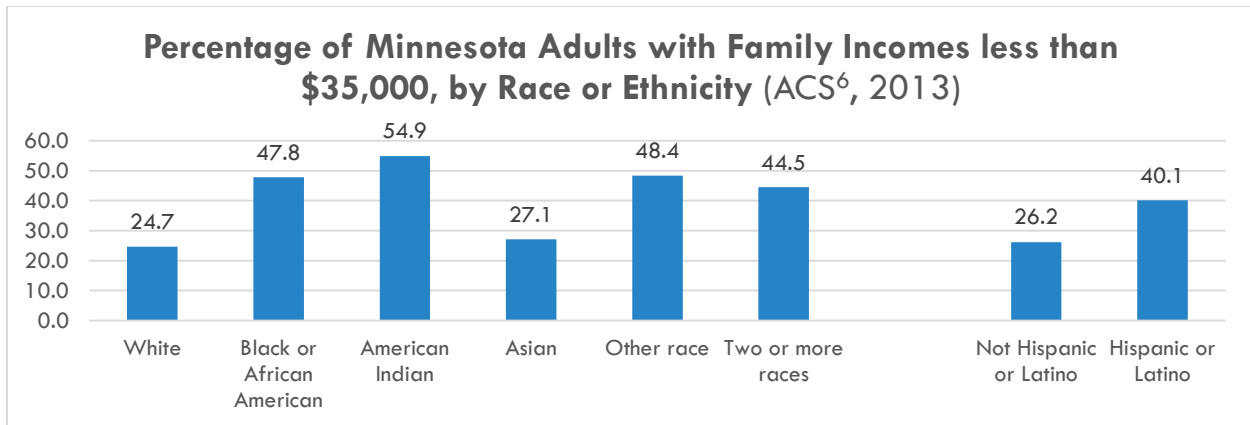
FIGURE 3

Percentage of Minnesota Adults with Family Incomes below the Poverty Level or Considered Low Income, by Race or Ethnicity (ACS[6], 2013)

[6]Data are from the American Community Survey, Minnesota 2013 as accessed through IPUMS-USA, University of Minnesota, www.ipums.org. Note that the IPUMS variable used to assess family income also includes single adults unlike most ACS family variables.

We see similar differences in family income by race-ethnicity when we compare the percentages of adults with family incomes less than $35,000, our proxy for living in poverty or on low incomes.

FIGURE 4

Percentage of Minnesota Adults with Family Incomes less than $35,000, by Race or Ethnicity (ACS[6], 2013)

White: 24.7
Black or African American: 47.8
American Indian: 54.9
Asian: 27.1
Other race: 48.4
Two or more races: 44.5
Not Hispanic or Latino: 26.2
Hispanic or Latino: 40.1

[6]Data are from the American Community Survey, Minnesota 2013 as accessed through IPUMS-USA, University of Minnesota, www.ipums.org. Note that the IPUMS variable used to assess family income also includes single adults unlike most ACS family variables.

Note: The category Black or African American includes individuals who were born in the U.S. as well as those born in other countries.

Low Income & Diabetes

What does it mean that low income and diabetes are associated in our data?

Unfortunately, we cannot use these data to talk about causes because our data are only a snap-shot in time. Simply put, we have a "chicken or the egg problem" with this data. We do not know which came first, lower income or developing diabetes. Put another way:

Do people who have lower income tend to develop diabetes at a higher rate?

Do people with diabetes have health problems that limit their ability to work leading to lower incomes?

Or, might it be both?

Our Behavioral Risk Factor Surveillance System (BRFSS) data cannot answer this question since we ask about diabetes and income at the same time only at one point in time for a particular person. A brief, non-comprehensive survey of the literature suggests low income may, in some cases, come before diabetes development, but also that having diabetes increases the likelihood of leaving the workforce early, which can lead to lower income.

Many, but not all follow-up studies found suggest that people who have low incomes or low socioeconomic status (SES) variables associated with income, such as employment status, educational attainment, personal wealth, and occupation, are more likely to develop diabetes.

Studies reporting associations between income/SES and diabetes tend to report them for women, but only some[7,8,9] and not all[10,11,12,13,14] report the association for men. Furthermore, income and SES during childhood and adulthood may each exert their own effect on risk of diabetes.[7,10,11,13,15]

Other studies demonstrate that having diabetes can negatively affect workforce participation and income.

A multinational study showed that adults with diabetes are 30 percent more likely to leave the workforce early than adults who do not have diabetes; the US estimate was 40 percent.[16] Consistent with this finding, two detailed follow-up studies of adults younger than 65 years of age found a higher prevalence (two to four times greater) of diabetes among adults who were no longer in the labor force and adults who had changed jobs at the end of the follow-up period.[17,18] People with diabetes were more likely to report that they stopped working due to poor health or were working under disability status.[19] A recent review article showed people with diabetes miss more days of work due to illness, have repetitive sick periods, and tend to use more sick leave per year, all of which may have financial consequences to the individual.[20] A study examining labor consequences of diabetes among US women suggests that having type 2 diabetes, the most common form, reduces the probability of being employed by more than 40 percent and that the wage losses compared to healthy counterparts may be as high as $19,655 per year.[21]

Even if we do not know which came first, a deeper look into patterns related to income, work and health outcomes can inform efforts to develop programs that address the needs of lower-income adults who are more likely to live with diabetes.

Diabetes & Employment

Working-age adults (18-64 years of age) are most likely to rely on employment to support their costs of living. Is diabetes prevalence among Minnesota's working-age adults greater for those with household incomes less than $35,000?

From our data, we know that adults with lower incomes in Minnesota have higher diabetes prevalence. The literature tells us that having diabetes could lead to an earlier exit from the workforce and reduced income. What patterns do we see in our Minnesota data between income, employment and diabetes prevalence?

To ask the question, we need to focus on adults in our dataset who are of working-age or who are between 18 and 64 years of age. We also should focus in on adults who are most likely to be working. Most adults are eligible for Social Security and Medicare starting at age 65, so 64 years of age becomes a reasonable upper bound for our work.

We re-examined the association between household income and diabetes prevalence for Minnesota adults aged 18-64 years. Among adults 18-64 years old with household incomes less than $35,000, the percentage living with diabetes is three times higher than among adults of the same age who have household incomes of $35,000 or more. The pattern we started exploring holds in this younger subgroup of 18-64 year old adults.

TABLE 4. Percentage of Minnesota Adults 18-64 Years of Age Who Have Diabetes by Income (BRFSS 2013)[5]

Demographic or Socioeconomic Characteristic Associated with Diabetes	% of Minnesota adults who have diabetes (18-64 yrs)[1]	95% Confidence Interval
Overall *(N=9,147)*	5.2	(4.4-5.9)
Household income*		
<$35,000	9.3	(7.3-11.4)
$35,000 or greater	3.4	(2.8-4.1)

[5] Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013, are weighted percentages and diabetes includes both type 1 and type 2 diabetes *P<0.001, the percentages for each sub-category of a demographic or socioeconomic characteristic are not the same

See Appendices 3-6 to see the results of previous analyses re-run on only adults 18-64 years of age.

Even among working-age adults, lower household income (less than $35,000) is associated with a greater percentage of adults who have diabetes.

The <$35,000 household income category includes about 84 percent of the working-age adults 18-64 years of age who are living in poverty (<100 percent of FPL) or in low income families (100-199 percent of FPL). About 23.5 percent or an estimated 770,000 working-age adults in Minnesota are living in poverty or low income families. Our less than $35,000 household income variable will describe patterns for at least 650,000 of them.

Ability to Work

Among working-age adults (18-64 years), many who have diabetes are not working because they cannot find work or are unable to work.

Comparing employment status of working-age adults who have diabetes to working-age adults who do not have diabetes can help us to understand associations between income and diabetes. This information can also help inform development of programs to provide support to working-age adults who have diabetes.

Working-age adults who have diabetes were more than two times as likely to be in the not-working category (colored light yellow) as compared to working-age adults who did not report having diabetes. Adults who have diabetes were more likely to report being unable to work or being retired. Less than 50 percent of working-age adults with diabetes were employed for wages (blue), whereas 67 percent (or two of every three) adults without diabetes were employed for wages. Around 33 percent of adults who have diabetes are not working (light yellow), while 12 percent of adults without diabetes are not working. Working-age adults who have diabetes are older on average than working-age adults without diabetes. Adjusting results for age differences between groups, adults who have diabetes are still more likely to be unable to work than adults without diabetes.

FIGURE 5. Employment Classification for Adults 18-64 Years of Age Who Have Diabetes (BRFSS, 2013)[5]

Working – All groups with blue colored fill
Not Working – All groups with yellow colored fill
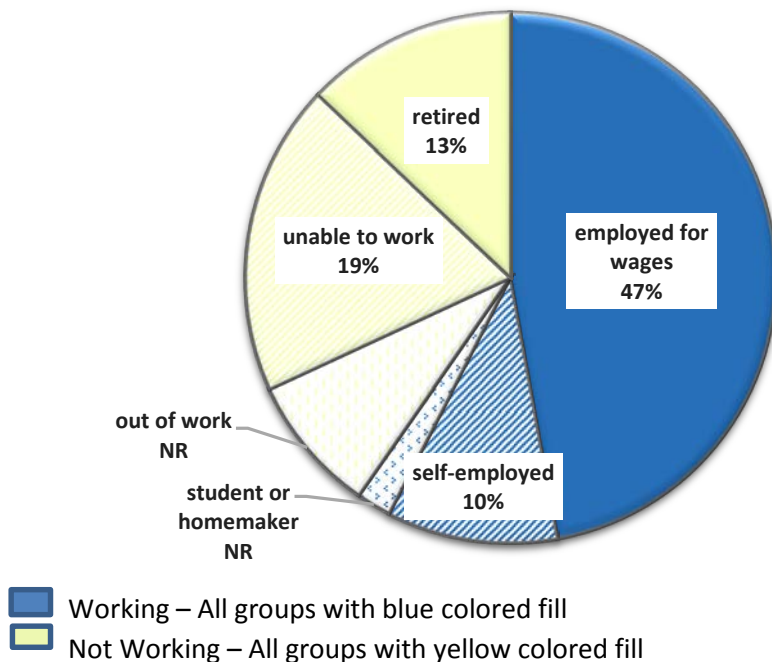
* NR = not reportable due to small cell sizes (<50 observations) or coefficient of variation ≥30%.

FIGURE 6. Employment Classification for Adults 18-64 Years of Age Who Do Not Have Diabetes (BRFSS, 2013)[5]
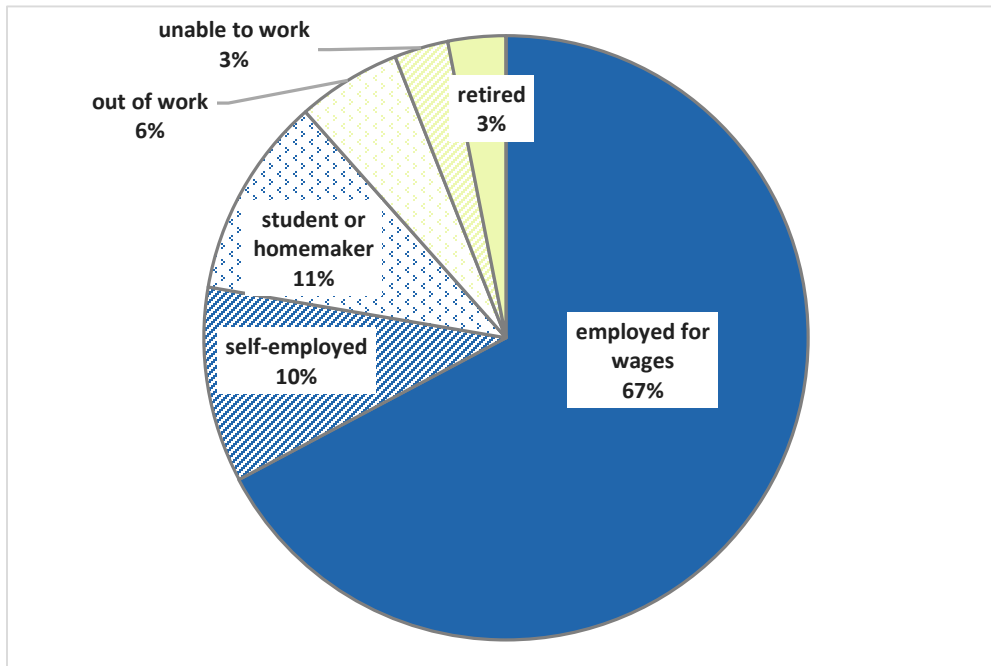
Working – All groups with blue colored fill
Not Working – All groups with yellow colored fill

[5] Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013, are weighted percentages and diabetes includes both type 1 and type 2 diabetes NR = not reportable due to small cell sizes (<50 observations) or coefficient of variation ≥30%.

Data are available for multiple years combined, which permit values in all categories to be reported. Please contact the Diabetes Program at MDH_diabetes@health.state.mn for more information.

N=65 observations are missing for self-reported work status (approximately 1.2% of total observations.)

When data were adjusted for gender and age, which may differ between adults who have diabetes and adults who do not have diabetes, we still found certain categories of not working were associated with higher odds of having diabetes. An individual who was out of work had 2.4 times the odds of having diabetes (95% Confidence Interval (95% CI): 1.1-5.0) as compared to a working-age adult employed for wages. Similarly, the odds of an adult who was unable to work having diabetes was 7.4 (95% CI: 4.5-12.3) or 6 times higher than an adult who was employed for wages. There were too few retirees among adults who did not have diabetes to examine if, even accounting for age, there are more retirees among working age adults with diabetes than those without diabetes.

These data can be used to help shape strategies for diabetes management and diabetes prevention. Assuming strategies would not depend on insurance coverage or that all employees are insured by the employer, employer-based programs to address diabetes could reach about half of working-age (18-64 year-old) Minnesota adults living with diabetes. Other approaches are needed to make resources accessible to those who are self-employed or not working, which could include efforts to support early retirees. For efforts that would help to prevent diabetes,

employer-based strategies could reach 67 percent of 18-64 year-old adults who do not have diabetes; however, reaching this percentage of working-age adults would require employers provide the benefit to all employees and not just those who have provider-sponsored insurance.

Ability to Work & Household Income

People who are working are less likely to have incomes less than $35,000 than those who are not working, but many still live on low incomes.

Adults responding to the BRFSS survey were three times as likely to report household incomes of less than $35,000 if they reported not working as compared to those who were working. Employment status and income level are strongly associated in this dataset. This is a reminder against interpreting this data to say that only lower income led to a higher diabetes prevalence. Low income may have occurred after a person developed diabetes, which could have influenced his/her ability to work.

TABLE 7. Percentage of Adults 18-64 Years of Age with Household Income less than $35,000 by Self-Reported Working Status (BRFSS, 2013)[5]

Self-reported work status	% of Minnesota adults in working category who have household income less than $35,000[1]	95% Confidence Interval
Working		
Employed for wages	22.8%	(21.0-24.5%)
Self-employed	24.4%	(19.8-29.0%)
Not-working		
Out of work	62.1%	(53.9-70.3%)
Unable to work	78.0%	(70.7-85.1%)

[5] Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013, are weighted percentages and diabetes includes both type 1 and type 2 diabetes For additional information on patterns between employment status (full or part-time) are provided in Appendix B.

These data and the data in the pie charts show that lower income, lack of employment or the ability to work, and diabetes are all linked. Efforts to address diabetes care and prevention among adults with low incomes need to keep in mind the cost to individuals; these adults are among the Minnesotans who least can afford to shoulder the economic burden of treatment and prevention.

Nearly one in four employed working-age adults reports household incomes less than $35,000.

Employment Status & Diabetes

Knowing what percentage of adults in each employment category have diabetes can help target efforts to improve diabetes care and self-management.

To round out our exploration of the links between income, work status, and diabetes, we examine the proportion of 18-64 year old adults living with diabetes in each employment category. Diabetes is least common among adults in this age group who are self-employed or employed for wages. The percentage who have diabetes among those out of work is very poorly estimated by our data, but appears lower than for retirees or those who report being unable to work.

Overall, 5.2 percent of adults 18-64 years of age have diabetes in Minnesota. The percentage is between two and six times higher among working-age adults who are retired or unable to work, consistent with reports in the literature.[11,17,18]

TABLE 8. Percentage of Adults 18-64 Years of Age who have Diagnosed Diabetes, by Work Status (BRFSS, 2013)[5]

Self-reported work status[1]	% of Minnesota adults in this category with diabetes[1]	95% Confidence Interval
Employed for wages or self-employed	3.8 %	(3.1-4.5%)
Student or homemaker	NR	-
Retired*	18.0%	(11.9-24.0%)
Out of work	7.4%+	(3.2-11.7%)
Unable to work*	25.6%	(17.9-33.2%)

[5] Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013, are weighted percentages and diabetes includes both type 1 and type 2 diabetes There was no significant difference between employed for wages (3.6%. [95% CI: 2.8-4.3]) and self-employed (5.2% [95% CI: 2.9-7.4])

NR = not reportable due to small cell sizes (<50 observations) or coefficient of variation ≥30%.

+denotes sample size below threshold of 50 (n=46); rates may be unstable.

*P<0.05, the percentages are different than employed for wages or self-employed

Data are available for multiple years combined, which permit values in all categories to be reported and more precise estimates. Please contact the Diabetes Program at MDH_diabetes@health.state.mn for more information.

Among working-age adults, the highest percentage of adults living with diabetes is found among retirees and adults who report being unable to work.

Conclusions

This report opened by describing associations between multiple demographic and socio-economic variables and the proportion of adults who have diabetes in Minnesota. We found adults who lived in households earning less than $35,000 per year, our proxy for low income were two and a half times more likely to report having diabetes than people with incomes more than $35,000.

The income effect persisted even after accounting for other factors, so we dug deeper to describe patterns between income, work status and diabetes among Minnesota working-age adults. Focusing in on this group is important because this group is most likely to rely on employment, instead of programs like Social Security and Medicare available to adults 65 years and older, to provide for their basic health care needs. We report that:

- More than 33 percent of working-age adults (18-64 years of age) who have diabetes are not working, in comparison to about 10 percent of working-age adults who do not have diabetes.

- Low income is much more common among working-age adults who are not working, but still, nearly one in four working adults in this age group lives in a household with low income. This is true whether we use household income less than $35,000 annually or formal definitions of low income.

- Diabetes is more common among working-age adults who are retired or unable to work.

These data can be used to inform efforts to develop programs for diabetes management and prevention especially among working-age populations. Below are key points related to income that need to be considered when developing specific strategies to improve diabetes management and prevention of type 2 diabetes in Minnesota.

- Employer-based diabetes management programs are necessary, but not sufficient. Managing the existing burden of diabetes through employers or worksites may reach about half of adults between 18-64 years old living with diabetes if the strategies are open to all employees regardless of insurance status. Currently in Minnesota, less than 80 percent of full-time workers take up employer-sponsored insurance, and only about 40 percent of part-time employees do.[22]

- Complementary efforts would be needed to reach adults with diabetes who are not employed for wages.

- Diabetes prevention efforts, like the National Diabetes Prevention Program, offered through worksite wellness programs or employer-based approaches could be more promising and reach around two-thirds of the working-age population without diabetes, so long as all employers participate and broadly offer opportunities to employees.

- Direct efforts to the populations in need, efficiently.

    o Design programs to meet the needs of working-age adults who are retired or who are unable to work will address around half of adults who have diabetes. Incomes tend to be lower among adults who are not working.

    o Focusing diabetes management and prevention activities on working-age adults with lower incomes (e.g. less than $35,000) is an efficient way to direct resources to individuals more likely to have and develop diabetes.

- Many adults live on low-incomes, including nearly one in four employed adults, underscoring the need for program implementation that is sensitive to the costs that individuals are asked to bear

such as co-pays, transportation to programs, etc. In fact, a recent report from the Kaiser Family Foundation reports that 55 percent of households with incomes between 100 and 250 percent of FPL do not have enough money to pay mid-range insurance deductibles.[23]

The strategies listed above are essential, but not sufficient. Our progress in addressing diabetes disparities also hinges on addressing income and educational inequalities among groups who have higher rates of diabetes and not viewing poverty in isolation.

▪ Tackle poverty itself as well as issues that contribute to it or travel with it-- lack of employment or under employment housing, food security and health coverage and their intersection with race/ethnicity. Ensuring equitable access to these resources for all Minnesotans will contribute to efforts to prevent and better manage diabetes in Minnesota.

Bibliography

1. World Health Organization. 2014. Equity, social determinants and public health programmes. Editors: Blas E and Kurup AS. Geneva, Switzerland. http://whqlibdoc.who.int/publications/2010/9789241563970_eng.pdf?ua=1

2. Braveman PA, Cubbin C, Egerter S, Williams DR, and Pamuk E. Socioeconomic Disparities in Health in the United States: What the Patterns Tell Us. *Amer J Pub Health* 100(S1):S186-96.

3. Minnesota Department of Health. 2014. *Advancing Health Equity in Minnesota, report to the Legislature*. Published 2/1/2014 Accessed at http://www.health.state.mn.us/divs/chs/healthequity/ahe_leg_report_020414.pdf (3/27/2015)

4. Geiss LS, Wang J, Cheng YJ, Thompson TJ, Barker L, Li Y, Albright AL, Gregg EW. 2014. Prevalence and incidence trends for diagnosed diabetes among adults aged 20 to 79 years, United States, 1980-2012. *JAMA* 312(12):1218-26.

5. (MDH analyses) Centers for Disease Control and Prevention (CDC). Behavioral Risk Factor Surveillance System Survey Data. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2013. http://www.cdc.gov/brfss/annual_data/annual_2013.html

6. Data are from the American Community Survey, Minnesota 2013 accessed through: Steven Ruggles, J. Trent Alexander, Katie Genadek, Ronald Goeken, Matthew B. Schroeder, and Matthew Sobek. *Integrated Public Use Microdata Series: Version 5.0* [Machine-readable database]. Minneapolis: University of Minnesota, 2010.

7. Maty SC, Everson-Rose, SA, Haan MN, Raghunathan TE, And Kaplan GA. 2005. Education, income, occupation and the 34-year incidence (1965-99) of Type 2 diabetes in the Alameda County Study. *Int J Epidemiol.* 34(6):1274-81.

8. Espelt A, Kunst AE, Palència L, Gnavi R, and Borrell C. 2011. Twenty years of socio-economic inequalities in type 2 diabetes mellitus prevalence in Spain, 1987-2006. *Eur J Pub Health* 22(6):765-71.

9. Robbins JM, Vaccarino V, Zhang H, Kasi SV. 2005. Socioeconomic status and diagnosed diabetes incidence. *Diab Res and Clin Pract.* 68(3):230-6.

10. Smith BT, Lynch JW, Fox CS, Harper S, Abrahamowicz M, Almeida ND, Loucks EB. 2011. Life-course socioeconomic position and type 2 diabetes mellitus: The Framingham Offspring Study. *Am J Epidemiol.* 173(4):438-47.

11. Insaf TZ, Strogatz DS, Yucel RM, Chasan-Taber L, Shaw BA. 2014. Associations between race, lifecourse socioeconomic position and prevalence of diabetes among US women and men: results from a population-based panel study. *J Epidemiol Community Health* 68(4):318-25.

12. Imkampe AK, Guilford MC. 2010. Increasing socio-economic inequality in type 2 diabetes prevalence- Repeated cross-sectional surveys in England 1994-2006. *Eur J Public Health* 21(4):484-90.

13. Demakakos P, Marmot M, Steptoe A. 2012. Socioeconomic position and the incidence of type 2 diabetes: the ELSA study. *Eur J Epidemiol.* 27(5):367-78.

14. Pikhartova J, Blane D, Netuveil G. 2014. The role of childhood social position in adult type 2 diabetes: evidence from the English Longitudinal Study of Ageing. *BMC Public Health* 14:505.

15. Stringhini S, Batty GD, Bovet P, Shipley MJ, Marmot MG, Jumari M, Tabak AG, Kivimäki M. 2013. Association of lifecourse socioeconomic status with chronic inflammation and type 2 diabetes risk: the Whitehall II prospective cohort study. *PLoS Medicine* 10(7):e1001479.

16. Rumball-Smith J, Barthod D, Nandi A, and Heymann J. 2014. Diabetes Associated With Early Labor-Force Exit: A Comparison of Sixteen High-Income Countries. *Health Affairs* 33(1):110-15.

17. Pilkington, RM. 2014. Thesis: Baby Boomers and Generation X in Australia: health differences and the influence of work and workplace, with a focus on obesity. University of Adelaide, School of Medicine, p. 1-161 (published September 2014: https://digital.library.adelaide.edu.au/dspace/handle/2440/87311)

18. Shultz KS, Wang M. 2007. The Influence of Specific Physical Health Conditions on Retirement Decisions. *Int J Aging Hum Deve.l* 65(2):149-61.

19. Tunceli K, Bradley CJ, Nerenz D, Williams LK, Pladevall M, Lafata JE. 2005. The Impact of Diabtes on Employment and Work Productivity. *Diab Care* 28(11):2662-67.

20. Breton MC, Guénette L, Amiche MA, Kayibanda JF, Grégoire JP, Moisan J. 2013. Burden of Diabetes on the Ability to Work: A systematic review. *Diab Care* 36(3):740-9.

21. Minor T. 2011. The effect of diabetes on female labor force decisions: new evidence from the National Health Interview Survey. *Health Econ*. 20(12):1468-86.

22. Planalp C, Sonier J, Fried B. 2015. State-Level Trends in Employer-Sponsored Health Insurance. Minneapolis, MN: State Health Access Data Assistance Center. http://www.shadac.org/files/shadac/publications/SHADAC_ESI_Report_2015_Jan28.pdf (accessed 3/27/2015)

23. Altman D. 2015. Health-Care Deductibles Climbing Out of Reach. *Wall Street Journal.* March 3, 2015. http://blogs.wsj.com/washwire/2015/03/11/health-care-deductibles-climbing-out-of-reach/

Appendix 1

The missing income data are not likely to change our interpretation of how income is related to diabetes prevalence.

We conducted a crude sensitivity analysis to determine the effect of recoding all missing data as either income <$35,000 or income $35,000 or greater, the two extreme cases regarding missing data. Reality is probably somewhere in between. There were still significant differences in the prevalence of diabetes by income, regardless of how the data were recoded.

APPENDIX TABLE 1. Sensitivity Analysis of the Effect of Missing Income Data on Estimates of the Percentage of Minnesota Adults with Diabetes by Income (BRFSS[5], 2013)

Demographic or Socioeconomic Characteristic Associated with Diabetes	Percent of non-weighted observations	Weighted % of Minnesota adults with diabetes[1]	95% Confidence Interval
Overall *(N=14,340)*	100	7.4	(6.6-8.2)
Household income			
<$35,000	27.8	12.5*****	(10.5-14.4)
$35,000 or greater	57.5	5.1	(4.2-5.9)
Don't know or missing (referred to as missing)	14.5	7.2	(5.0-9.3)
A. Recode missing to low household income			
<$35,000+missing	40.9	**10.6***	(9.1-12.1)
$35,000 or greater	56.1	5.1	(4.2-5.9)
B. Recode missing to <u>not</u> low household income			
<$35,000	26.5	12.5*****	(10.5-14.4)
$35,000 or greater + missing	70.8	5.5	(4.7-6.3)

*denotes p<0.01

[5]Data are from the Behavioral Risk Factor Surveillance Survey, Minnesota, 2013, and limited to adults who answered the diabetes diagnosis question (only 18 did not answer it, <0.1% of the sample)

Appendix 2

Family income, and definitions of poverty and low income are related for Minnesota adults.

We determined the percentage of adults at each family income level who would be classified as 1) poor, 2) having low incomes, and 3) would be categorized as neither. All adults in families earning less than $15,000 per year would be classified as living in poverty or having low income. Nearly all adults in the $15,000-$24,999 per year category would also fall into these two categories. For family incomes between $25,000 and $34,999, about 40 percent of adults would be classified as living below the poverty level or on low incomes. The cut-off of <$35,000 was chosen because of associations with diabetes prevalence and this cut-off providing the best balance between capturing most of the adults living in poverty or low income in our low income proxy versus having some degree of misclassification of people as having low incomes.

APPENDIX TABLE 2. Percentage of Adults Living at Each Family Income Classified as Living Below Poverty or on Low Incomes (ACS[6], 2013)

	Poor <100% FPL (95% CI)	Low Income 100-199% FPL (95% CI)	Not Low Income ≥200% FPL (95% CI)	Total	Percentage of Adults in this Family Income Category (95% CI) Est. population
0-$14,999	84% (82.7-85.2)	16% (14.8-17.3)	0%	100%	10.1% (9.8-10.4) 404,100
$15,000-$24,999	13.8% (12.6-15.0)	78% (76.5-79.4)	8.2% (7.3-9.2)	100%	8.2% (7.9-8.5) 328,400
$25,000-$34,999	3.8% (3.2-4.5)	34.4% (32.8-36.0)	61.8% (60.1-63.4)	100%	8.4% (8.2-8.7) 338,900
$35,000-$49,999	0.3% (0.2-0.4)	16.3% (15.3-17.3)	83.5% (82.4-84.5)	100%	12.8% (12.5-13.1) 513,500
$50,000 and above	0%	2% (1.8-2.2)	98% (97.8-98.2)	100%	60.5% (60.0-61.0) 2,427,600
All Incomes					100% 4,012,500

[6]Data are from the American Community Survey, Minnesota 2013 as accessed through IPUMS-USA, University of Minnesota, www.ipums.org

Appendix 3

The same demographic and socioeconomic characteristics are still associated with diabetes among working-age adults, even after stratifying by income.

APPENDIX TABLE 3. Demographic and Socioeconomic Characteristics associated with Having Diabetes among Adults 18-64 Years of Age, by Income (BRFSS[5], 2013)

	Percentage of adults in each category who have diabetes[1]	Percentage of adults in each category who have diabetes[1]
	Income <$35,000	Income ≥$35,000
Demographic or Socioeconomic Characteristic	% (95% Confidence Interval)	% (95% Confidence Interval)
Overall	9.3 (7.3-11.4)	5.0 (4.2-5.9)
Age*		
18-44 years	3.2[+] (1.8-4.6)	1.1[+] (0.5-1.6)
45-64 years	20.6 (15.8-25.3)	6.0. (4.7-7.3)
Gender		
Male	9.1 (6.3-12.0)	4.1 (3.1-5.2)
Female	9.5 (6.5-12.5)	2.7 (1.9-3.5)
Education*		
Less than high school	NR	NR
High school graduate	8.6 (5.4-11.7)	4.3 (2.6-6.0)
Attended college/trade school	8.7 (5.9-11.5)	4.1 (2.8-5.4)
Graduated college/trade school	NR	2.7 (1.9-3.6)
Insurance status		
Has insurance	10.0 (7.6-12.4)	3.5 (2.8-4.21)
Does not	7.7[+] (3.4-11.7)	NR

[5]Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013 and are weighted percentages

+Denotes number of observations below the reporting threshold of 50 (n of at least 40)

*$P<0.001$, the percentages for each sub-category of a demographic or socioeconomic characteristic are not the same

Appendix 4

About one million working-age Minnesota adults (one in four adults) live in households that earn <$35,000 per year.

Minnesota adults living in households with incomes <$35,000 are more likely to be living with diabetes than adults living in households with higher incomes. About one-quarter of all adults report household incomes <$35,000.

APPENDIX FIGURE 4
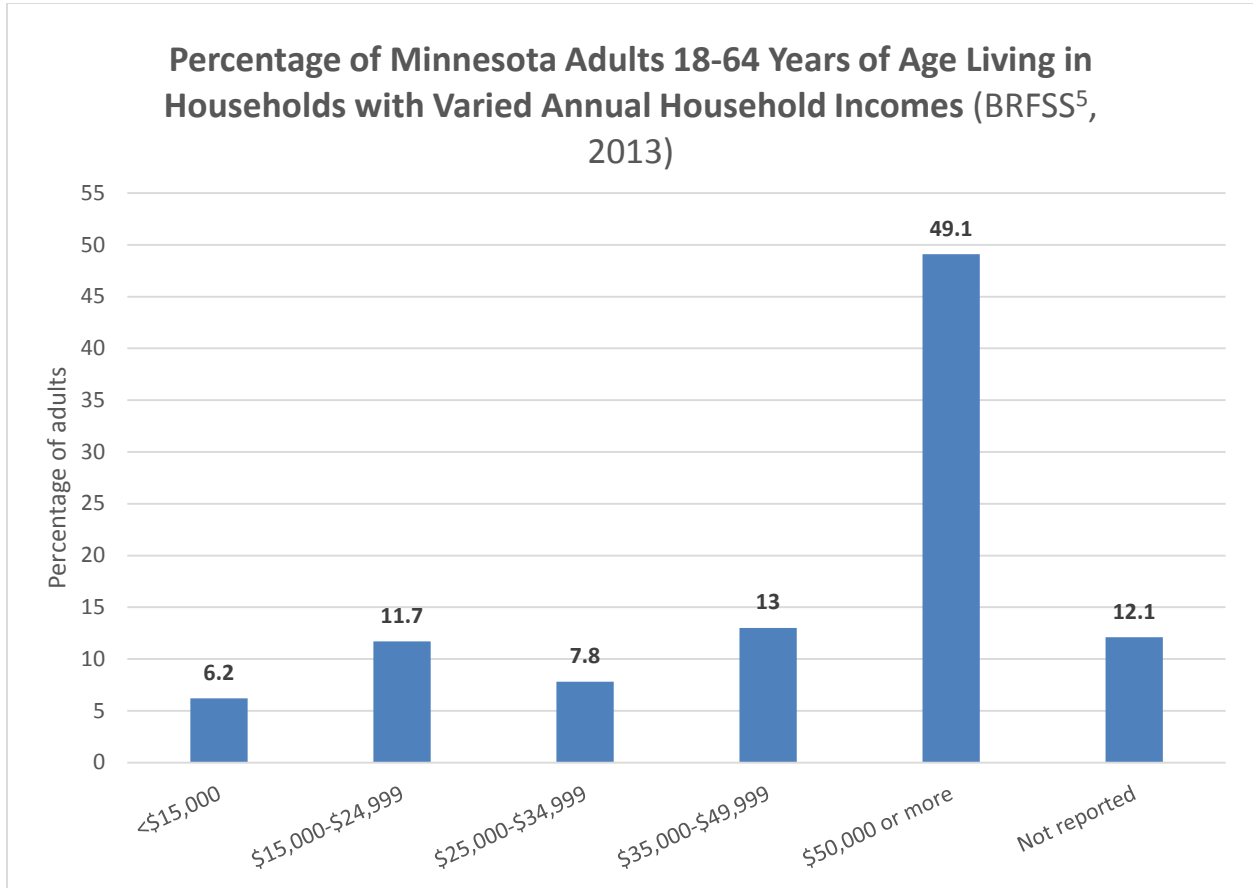
Percentage of Minnesota Adults 18-64 Years of Age Living in Households with Varied Annual Household Incomes (BRFSS[5], 2013)

[5]Data are from the Behavioral Risk Factor Surveillance System, Minnesota, 2013 and are weighted percentages

Not reported = individual refused to provide household income or did not know it

We find the same pattern in data from the American Community Survey (ACS) 2013 for Minnesota (Table 3). The ACS asked about family income. In some cases, family income is the same as household income. When multiple families live in one home, family income is only a part of household income.

Appendix 5

More than four in five adults 18-64 years of age who are living in poverty or on a low income have family incomes <$35,000.

APPENDIX TABLE 5. Relationships between Two Descriptors of Income among Adults 18-64 Years of Age: Poor or Low Income based on the Federal Poverty Level and Annual Family Income (ACS, IPUMS data, 2013)[6]

Family Income Categories	$0-$14,999 (95% CI) Est. population 18-64 yrs	$15,000-$24,999 (95% CI) Est. population 18-64 yrs	$25,000-$34,999 (95% CI) Est. population 18-64 yrs	$35,000-$49,999 (95% CI) Est. population 18-64 yrs	$50,000 and above (95% CI) Est. population 18-64 yrs
As a Percentage of Federal Poverty Level					
Poor or Low Income (0-199% FPL)	42.0% (40.7-43.2) 324,500	27.3% (26.2-28.4) 211,300	14.1% (13.3-15.0) 109,300	10.6% (9.9-11.4) 81,900	6.0% (5.4-6.6) 46,300
Not Low Income (≥200% FPL)	0.0% (0) 0	0.4% (0.4-0.5) 10,800	5.4% (5.1-5.7) 135,400	12.0% (11.6-12.4) 300,600	82.2% (81.8-82.7) 2,067,700

[6]Data are from the American Community Survey, Minnesota 2013 as accessed through IPUMS-USA, University of Minnesota, www.ipums.org

While the <$35,000 category does include some adults 18-64 years of age who have incomes 200% of the Federal Poverty Level or greater, it is only about 6 percent of all 18-64 year old Minnesotans who earn 200 percent of FPL or more.

Appendix 6

A family income cut-off of <$35,000 is a good balance between capturing as many people living on low incomes as possible and not having too many who earn incomes that are not low included.

Trying to model data is challenging. We used a household income cut-off of <$35,000 as a balance between picking the low income cut-off that captured the most people who lived below poverty or have low incomes, and trying to ensure that as few people as possible who earned higher incomes were included in our low income category.

APPENDIX TABLE 6 Proportion of Adults 18-64 Years of Age in Each Income Category Classified as Poor or Low Income (ACS, IPUMS data, 2013)[6]

Family Income	Poor <100% FPL (95% CI)	Low Income 100-199% FPL (95% CI)	Not Low Income ≥200% FPL (95% CI)	Total	Percentage of Adults 18-64 years in Family Income Category (95% CI) Est. population
0-$14,999	89.0% (87.7-90.2)	11.0% (9.8-12.3)	0.0%	100%	9.9% (9.5-10.2) 324,500
$15,000-$24,999	19.9% (18.2-21.8)	75.2% (73.2-77.1)	4.9% (4.0-5.9)	100%	6.8% (6.5-7.0) 222,100
$25,000-$34,999	4.9% (4.0-5.9)	39.8% (37.7-41.9)	55.3% (53.2-57.4)	100%	7.4% (7.2-7.7) 244,700
$35,000-$49,999	0.4% (0.2-0.6)	21.1% (19.8-22.4)	78.6% (77.2-79.9)	100%	11.6% (11.3-12.0) 382,600
$50,000 and above	0%	2.2% (2.0-2.4)	97.8% (97.6-98.0)	100%	64.3% (63.8-64.8) 2,113,900
All Incomes					100% 3,287,800

[6]Data are from the American Community Survey, Minnesota 2013 as accessed through IPUMS-USA, University of Minnesota, www.ipums.org

We included adults who reported household incomes of $25,000-$34,999 in our low income category to maximize the number of adults who were likely to be classified as poor or living on low incomes in our low income variable. Based on the ACS data we would expect about 45 percent would fall into this category based on family income. Since BRFSS contains the income data we actually used and is based on household income, which may be higher than family income, the proportion of adults who would be classified as poor or low income may even be greater.

Appendix 7

Definition of a 95% Confidence Interval

A confidence interval provides a range of likely values for a particular number or statistic coming from a survey sample like our Minnesota Behavioral Risk Factor Surveillance System.

The Minnesota Behavioral Risk Factor Surveillance System asks questions of a randomly selected group of about 10,000-15,000 adults across the state each year – roughly a number the size of city of Grand Rapids- to estimate the response to the question if we could survey every Minnesota adult. Because of this process, we might expect a little noise in our data because not every group of 10,000 people will answer each question exactly the same way. A confidence interval helps us to understand the variability around the number we get from our survey sample of 10,000 to 15,000 adults.

The 95% Confidence Interval means that if the same survey was repeated 100 times in a row to a different group of 10,000-15,000 Minnesota adults, the range of numbers that make up the confidence interval will contain the percentage we would get if we asked every Minnesota adult the question almost all of the time. The confidence interval will contain the value 95 times out of the 100 times we asked different groups of people the same question.