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# Analysis of Diabetes Epidemic update in California

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## Abstract

The overall purpose of this study was to determine the health risk factors and lifestyle choices that are associated with diabetes among the population in California across social, demographic, and economic outcomes, by using the 2017 California Health Interview Survey (CHIS) secondary data. The 2017 CHIS adult data file consists of individual records obtained from the 2017 data collection period of the CHIS 2017-2018 adult survey. CHIS is the nation's largest state-level health survey and one of the largest health surveys in the nation. The UCLA Center for Health Policy Research (UCLA-CHPR) conducts the CHIS in collaboration with the California Department of Public Health and the California Department of Health Care Services. CHIS collects extensive information for all age groups on health status, health conditions, health-related behaviors, health insurance coverage, access to health care services, and other health and health-related issues.

**Keywords:** Diabetes; California; Original Diagnosis; Health Risk Factors; Lifestyle Choices; Minorities; Racial; Hispanic; Black; White

## Introduction

In 2015, about 30.3 million Americans or 9.4% of the population had diabetes according to the American Diabetes Association report [1]. Among these individuals, approximately 1.25 million children and adults have type-1 diabetes. Among the 30.3 million adults with diabetes, about 23.1 million of them were diagnosed, and approximately 7.2 million were undiagnosed. Among the seniors, the percentage of Americans age 65 and older remains high at 25.2% (or 12.0 million seniors) that were undiagnosed. Indeed, diabetes remains the 7th leading cause of death in the U.S., which was shown in 2015 with 79,535 death certificates listing diabetes as the underlying cause of death. A total of 252,806 death certificates listed diabetes as an underlying or contributing cause of death. About 1.5 million Americans are diagnosed with diabetes every year and in 2015 alone, 84.1 million Americans age 18 and older had prediabetes. Studies also found that diabetes may be underreported as a cause of death and that only about 35% to 40% of people with diabetes had diabetes listed anywhere on the death certificate and about 10% to 15% had it listed as the underlying cause of death [2].

The Centers for Disease Control and Prevention reported data from the National Diabetes Statistics in 2017 that the state of the diabetes disease in the U.S. is that it is a serious disease that can often be managed through physical activity, diets, use of insulin and oral medications to lower blood sugar levels. Additionally, people with diabetes are at an increased risk of additional serious health complications, such as vision loss, heart disease, stroke, kidney failure, amputation of toes, feet or legs, and premature death; in fact, as many as 2 out of 5 Americans are expected to develop type 2 diabetes in their lifetime. Most people are not aware of prediabetes condition as a serious health condition. It is a condition where the affected person's blood sugar levels are higher than normal, but not high enough yet to be classified as type 2 diabetes; however, without weight loss, healthy eating and regular moderate physical activity, many people living with prediabetes will eventually develop type 2 diabetes. As reported, new diabetes cases were higher among non-Hispanic blacks and Hispanics, then non-Hispanic whites. Also, new diagnosed cases of type-1 and type-2 diabetes have increased among U.S. youth and nearly 16% adults diagnosed with diabetes were smokers, while nearly 90% were overweight; more than 40% were physically inactive. Therefore, it is evident that more people are developing diabetes during youth, and racial and ethnic minorities continue to develop these conditions at higher rates. At the same time, it is important to note that the proportion of older people is increasing and are more likely to have a chronic disease like diabetes [3].

In 2016, the prevalence of diagnosed type-2 diabetes in the U.S. was 8.6% (about 21 million adults), while the prevalence of diagnosed type-1 diabetes was 0.55% (about 1.3 million adults. According to Morr, non-Hispanic white adults had a higher prevalence of diagnosed type I diabetes compared with Hispanic adults, and non-Hispanic blacks had the highest prevalence of diagnosed type-2 diabetes [4]. American Diabetes Association (ADA) used a prevalence-based approach that combined the demographics of the U.S. population in 2017 with diabetes prevalence, epidemiological data, health care cost, and economic data into a Cost of Diabetes Model. Health resource use and associated medical costs are analyzed by age, sex, race/ethnicity, insurance coverage, medical condition, and health service category [5].

Data sources include national surveys, Medicare standard analytical files, and one of the largest claim's databases for the commercially insured population in the U.S. The result of the analysis of the total cost of diagnosed diabetes is estimated to be $327 billion, including $237 billion in direct medical costs and $90 billion in reduced productivity.

"People with diagnosed diabetes incur average medical expenditures of $16,750 per year, of which $9,600 is attributed to diabetes. People with diagnosed diabetes, on average, have medical expenditures 2.3 times higher than what expenditures would be in the absence of diabetes. Indirect costs include increased absenteeism ($3.3 billion) and reduced productivity while at work ($26.9 billion) for the employed population, reduced productivity for those not in the labor force ($2.3 billion), inability to work because of disease-related disability ($37.5 billion), and lost productivity due to 277,000 premature deaths attributed to diabetes ($19.9 billion)" [2].

From 2012 to 2017, economic costs of diabetes increased by 26% after adjusting for inflation due to the increased prevalence of diabetes and the increased cost per person with diabetes, while the growth in diabetes prevalence and medical costs is primarily among the population aged 65 years and older that was contributing to a growing economic cost to the Medicare program [3].

## Problem of the Study

There are many factors associated with diabetes. In most cases, diabetes among the older population is higher than those without diabetes and consequently annual medical expenditures are much higher (on average) than for the people without diabetes. Typically, older populations lacked the abilities to exercise regularly, leading to obesity and physical inactivity which hinders this group's ability to escape diabetes; and extra weight sometimes causes insulin resistance, which is common in people with type 2 diabetes. Type-1 diabetes occurs when the immune system, the body's system for fighting infection attacks and destroys the insulin producing beta cells of the pancreas. Scientists think type-1 diabetes is caused by genes and environmental factors, such as viruses, that might trigger the disease.

The purpose of this study was to determine the health risk factors and lifestyle choices that are associated with diabetes among the population in California across the social, demographic, and economic outcomes, by using the California Health Interview Survey data [6]. Diabetes Mellitus (DM) is a generalized term used to define multiple diseases with different etiologies that are characterized by chronic hyperglycemia (high blood glucose levels) resulting from insufficient synthesis, secretion or signaling of insulin, a hormone produced by the pancreas [7]. In California alone, over 2.3 million adults report having been diagnosed with diabetes, which represents one out of every 12 adults and the vast majority of diabetes cases in California are type-2, which represents about 1.9 million adults. The prevalence increases with age-one out of every six adult Californians aged 65 and above have type-2 diabetes-and is higher among ethnic/racial minorities and Californians with low education attainment and/or family income. Compared with non-Hispanic Whites, Hispanics and African Americans have twice the prevalence of type-2 diabetes and are twice as likely to die from their disease [8].

The California Department of Public Health (CDPH) has a number of ongoing activities that support the primary prevention of diabetes through the promotion of healthy eating, increased physical activity, tobacco cessation, and the prevention and control of one's weight and obesity. Secondary prevention activities focus on evidence-based strategies to prevent or delay the onset of complications among Californians diagnosed with type-2 diabetes. CDPH is establishing a statewide network of evidence-based lifestyle change programs that are designed to prevent the development of type-2 diabetes among people at highest risk and prevent or delay the onset of complications among people diagnosed with type-2 diabetes [8].

## Research Data

The California Health Interview Survey (CHIS) is conducted every two years through a population based telephone survey. CHIS data and results are used extensively in federal and state governments, public agencies, hospital, community clinics, etc. The design of this study is descriptive and quantitative in nature and the researcher utilized this method because the variables that were selected from the secondary data set are categorical variables. The results from this study will be further used to improve the quality of health care in California.

In this study, data collected from the 2016-2017 California Health Interview Survey (CHIS) was used to investigate the diabetes epidemic among the adult population and in an effort to improve accuracy while using cell phone coverage of California residents, CHIS 2017 included a sample of likely residents (based on zip code), who may have out-of-state cell phone numbers, to better capture recent imports to the state. The CHIS is a population based survey that is conducted every two years in all 58 counties in the state of California. The analytical approach was used because the variables used are from a secondary data set of categorical variables. The CHIS sample is representative of California's non-institutionalized population living in households. CHIS data and results are used extensively by federal and state agencies, local public health agencies and organizations, advocacy and community organizations, other local agencies, hospitals, community clinics, health plans, foundations, and researchers.

These data are used for analyses and publications to assess public health and health care needs, to develop and advocate policies to meet those needs, and to plan and budget health care coverage and services. CHIS 2017 data were collected between June and December, 2017. As in previous CHIS cycles, weights are included with the data files and are based on the State of California's Department of Finance population estimates and projections, adjusted to remove the population living in group quarters (such as nursing homes, prisons, etc.) and thus not eligible to participate in CHIS. When the weights are applied to the data, the results represent California's residential population during that year for the age group corresponding to the data file in use (adult, adolescent, or child).

Data collected included variables on race and ethnicity; the geographic scope of the study is for the entire state of California. Surveys are conducted separately for adults aged 18 and over, adolescents aged 12 through 17, and children 11 years and younger. Frequency analysis, cross tabulation, percentages, statistics, and Chi-square testing allowed the researcher to use the predictor variables which are children/adolescents and adult/parent in the household, to determine how it influenced the outcome variable.

The collaborating agencies of this data are UCLA Center for Health Policy Research, California Department of Health Care Services and California Department of Public Health. Various sections of the CHIS 2016 questionnaire will be used. Section A and G consist of demographic information, Section B includes health conditions, Section C includes various health behaviors, and Section K includes socio-economic background questions.

The 2016 CHIS survey includes a large minority population of Latinos, Asians, Native Americans, and Pacific Islanders. Data is collected from a random telephone survey that asks questions on a large scope of health topics. For the purpose of this research, the participants are adult males and females only. All categories of the seven races were used to identify a comparison of the diabetes disease among races.

**Research Questions and Statistical Analysis**

Type-1 diabetes results from the body's failure to produce insulin and is usually diagnosed in children and young adults while Type-2 diabetes results from insulin resistance and is the most common form of diabetes. Several questions from the survey were reviewed and analyzed to come up with two concluding hypothesis that define the overall result of the study. Some of the questions reviewed for this study were:

- Other than during pregnancy, has a doctor ever told you that you have diabetes or sugar diabetes?
- Other than during pregnancy, has a doctor ever told you that you have pre-diabetes or borderline diabetes?
- How old were you when a doctor first told you that you have diabetes?
- Were you told that you had type-1 or type-2 diabetes?
- Are you now taking insulin?
- Do you now take diabetic pills to lower your blood sugar?
- During the past 12 months, have you had to visit a hospital emergency room because of your diabetes?
- Did you visit a hospital emergency room for your diabetes because you were unable to see your doctor?
- What is the main reason why you did not have health insurance? Data Analysis and Findings

The statistical software used to conduct the analysis of the data was IBM SPSS Version 26.0. Cross-tabulation of the dependent and independent variables was completed to examine the prevalence of CHF diagnosis by insurance type and ethnicity/race. Correlation tests were run to determine if any significant correlations between the variables existed in the target population. Lastly, Chi-Square tests were used to analyze the independent variable to determine if there was a statistically significant association with the dependent variable. Each independent variable was tested separately. Statistical significance was determined by deeming a value of $p<0.5$ as a statistically significant association; and a total of 21153 participated in the study.

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- Were you told that you had type 1 or type 2 diabetes?
- Are you now taking insulin?
- Do you now take diabetic pills to lower your blood sugar?
- During the past 12 months, have you had to visit a hospital emergency room because of your diabetes?
- Did you visit a hospital emergency room for your diabetes because you were unable to see your doctor?
- What is the main reason why you did not have health insurance?

**Hypothesis Testing**

**The first hypothesis: $H_0$:** No significant relationship exists between the gender and the age when first told participants had diabetes. A Chi-spare test was used to determine significance with a p value of < .05.

**The second hypothesis: $H_0$:** No significant differences exist whether one visited the emergency room for diabetes in past 12 months or had to visit a hospital emergency room because of their diabetes. A Chi-spare test was also used to determine significance with a p value of < .05.

Cases were filtered out where they were they were told they only had diabetes during pregnancy regarding the related question if other than during pregnancy if a doctor has ever told the participant that they have diabetes or sugar diabetes. About 2514 (12.2%) indicated that yes they were told, as opposed to a total of 17909 (86.9%) who stated no. The total number of those who reported at borderline or with pre diabetes were 208 (1.1%). However, in answer to the question related to other than during pregnancy, if a doctor has ever told them they have pre-diabetes or borderline diabetes, only 3,310 (16%) indicated yes, while a total of 17113 (82.9%) said no. Those who indicated not applicable, totaled to just 208 (1.1%), respectfully. Table 1 below provided respondents answers to the question of when a doctor first told the participant that they have diabetes.

| Table 1 Age At Time of Original Diagnosis | | |
|---|---|---|
| **Age of Original Diagnosis** | **Frequency** | **Percent** |
| Inapplicable | 18516 | 87.5 |
| 18 and Under | 91 | 0.4 |
| 19-29 | 150 | 0.7 |
| 30-39 | 303 | 1.4 |
| 40-49 | 514 | 2.4 |
| 50-59 | 758 | 3.6 |
| 60-69 | 538 | 2.5 |
| 70-79 | 221 | 1 |
| 80 and Over | 62 | 0.3 |
| Total (N=21153) | 21153 | 100 |

**Table 1:** How old were you when a doctor first told you that you have diabetes.

The Chi-square value of $\chi^2$ = 18.504, p-value=0.01 proved that there is a relationship between the gender and the age when the participants were first told they had diabetes. Table 2 below further explained why there is a relationship between the gender and the age when first told they had diabetes.

| Table 2 Age At Time of Original Diagnosis By Gender | | | |
|---|---|---|---|
| **Age of Original Diagnosis** | **Male** | **Female** | **Total** |
| 18 and Under | 37 | 54 | 91 |
| 19-29 | 62 | 88 | 150 |
| 30-39 | 120 | 183 | 303 |
| 40-49 | 248 | 266 | 514 |
| 50-59 | 380 | 378 | 758 |
| 60-69 | 255 | 283 | 538 |
| 70-79 | 116 | 105 | 221 |
| 80 and Over | 23 | 39 | 62 |
| Total (N=2637) | 1241 | 1396 | 2637 |

**Table 2:** Age first told the respondents they have diabetes by gender.

The first hypothesis attempted to analyze if there is a significant relationship existing between the gender and the age when first told the participants had diabetes. The question "Were you told that you had type-1 or type-2 diabetes?" from the 2016 CHIS questionnaire was asked only to respondents who were identified as adults 18 years and older. IBM SPSS statistical software was used to analyze the respondents who answered the question. A Chi-square test was used to determine significance with a p value of < .05. The question considered was to determine if the participants were told that they have type-1 or type-2 diabetes; the majority of the participants, 87.9% (18586) indicated that the question is not applicable to them and only 1.3% (269) said that they were told that they had type-1 diabetes, while about 10.9% (2298) indicated that they were told they had type-2 diabetes. The analysis suggested that there is a relationship between the type of diabetes and the age when first told they had diabetes. The Chi-square value of $\chi^2$ = 349.083, p-value=0.000 suggested that there is a statistically significant relationship and there is a relationship between the type of diabetes and the age when first told they had diabetes. Looking at the table 3 below, there is not a relationship between the type of diabetes and gender and therefore the Chi-square value of $\chi^2$ = 0.287, p-value=0.592 is not significantly different.

| Table 3 Age At Time of Original Diagnosis By Type of Diabetes | | | | | | |
|---|---|---|---|---|---|---|
| **Age of Original Diagnosis** | **Type 1** | **Type I %** | **Type 2** | **Type 2 %** | **Total** | **Total %** |
| 18 and Under | 57 | 2.20% | 30 | 1.20% | 87 | 3.40% |
| 19-29 | 35 | 1.40% | 107 | 4.20% | 142 | 5.50% |
| 30-39 | 40 | 1.60% | 245 | 9.50% | 285 | 11.10% |
| 40-49 | 39 | 1.50% | 462 | 18% | 501 | 19.50% |
| 50-59 | 51 | 2.00% | 696 | 27.10% | 747 | 29.10% |
| 60-69 | 29 | 1.10% | 500 | 19.50% | 529 | 20.60% |
| 70-79 | 16 | 0.60% | 202 | 7.90% | 218 | 8.50% |
| 80 and Over | 2 | 0.10% | 56 | 2.20% | 58 | 2.30% |
| Total (N=2567) | 269 | 10.50% | 2298 | 89.50% | 2567 | 100% |

**Table 3:** What age are you first told you had Diabetes by type of Diabetes.

The second hypothesis of the study suggested that no significant differences exist whether one visited the emergency room for diabetes in 12 months or had to visit a hospital emergency room because of their diabetes. Majority of the participants about 87.5% (18516) indicated that this question is not applicable to them. About 2299 (10.9%) indicated yes and while a total of 338 (1.6%) indicated no; the Chi-square value of $\chi^2 = 0.305$, p-value=0.581 suggested that there is not a relationship between whether one has visited the emergency room for diabetes in the last 12 months and gender. Table 4 below also demonstrated that there is a relationship between whether one has visited the emergency room for diabetes in the last 12 months and age first told they had diabetes. A Chi-spare test value of $\chi^2 = 30.502$, p-value=0.000 suggested that there is a statistical significant and there is a relationship.

| Table 4 Age At Time of Original Diagnosis By Medical Providers Care Plan Development | | | | | | |
|---|---|---|---|---|---|---|
| **Age of Original Diagnosis** | **Yes** | **Yes %** | **No** | **No %** | **Total** | **Total %** |
| 18 and Under | 77 | 3.00% | 10 | 2.40% | 87 | 3.40% |
| 19-29 | 111 | 4.30% | 31 | 1.20% | 142 | 5.50% |
| 30-39 | 258 | 10.10% | 27 | 1.10% | 285 | 11.10% |
| 40-49 | 450 | 15.50% | 51 | 2.00% | 501 | 19.50% |
| 50-59 | 662 | 25.80% | 85 | 3,3% | 747 | 29.10% |
| 60-69 | 467 | 18.20% | 62 | 2.40% | 529 | 20.60% |
| 70-79 | 179 | 7.00% | 39 | 1.50% | 218 | 8.50% |
| 80 and Over | 44 | 1.70% | 14 | 0.50% | 58 | 2.30% |
| Total (N=2567) | 2248 | 87.60% | 319 | 12.40% | 2567 | 100% |

**Table 4:** Age first told you have diabetes by medical provider's care plan

CHIS 2017 also oversampled residents under 65 to increase the ability to reach households with children and teens. There were a total of 21,153 adults age 18 and older who participated in the survey. Chi-square analysis was used in an attempt to analyze if there is a significant relationship between the gender and the age, when participants were first told they had diabetes and if significant differences exist whether one visited the emergency room for diabetes in the past 12 months or had to visit a hospital emergency room because of their diabetes. There were limitations to the study, as many participants failed to participate answering the survey questions fully or did not complete the survey. A further study is recommended at a national level to look more closely at underlying causes of the persistence of diabetes in the U.S.

## Conclusion

The overall response rates for CHIS 2017 are composites of the screener completion rate (i.e., success in introducing the survey to a household and randomly selecting an adult to be interviewed) and the extended interview completion rate (i.e., success in getting one or more selected persons to complete the extended interview). For CHIS 2017, the landline/list sample household response rate was 9.3% (the product of the screener response rate of 13.2% and the extended interview response rate at the household level of 70.3%). The cell sample household response rate was 6.5%, incorporating a screener response rate of 10.0% household-level extended interview response rate of 65.2%. Within the landline and cell phone sampling frames for 2017, the extended interview response rate for the landline/list sample varied across the adult (61.0 percent) population, the adult interview response rate for the cell sample was 66.6%, the child rate was 63.9%, and the adolescent rate was 20.3% in 2017. Multiplying these rates by the screener response rates used in the household rates above gives an overall response rate for each type of interview for each survey year. As in previous years, household and person level response rates vary by sampling stratum.

After all follow-up attempts to complete the full questionnaire were exhausted, adults who completed at least approximately 80% of the questionnaire (i.e., through Section K which covers employment, income, poverty status, and food security), were counted as "Complete." Some responses in the employment and income series, or public program eligibility and food insecurity series were missing from those cases that did not complete the entire interview. They were imputed to enhance the analytic utility of the data. Proxy interviews were conducted for any adult who was unable to complete the extended adult interview for themselves, in order to avoid biases for health estimates of chronically ill or individuals with disabilities. Eligible selected persons were re-contacted and offered a proxy option. In CHIS 2017, either a spouse/partner or adult child completed a proxy interview for 3 adults. A reduced questionnaire, with questions identified as appropriate for a proxy respondent, was administered.

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