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Prediabetes in California: Nearly Half of California Adults on Path to Diabetes

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"More than 13 million California adults—nearly half of the state's adult population—are estimated to have prediabetes."

SUMMARY: In California, more than 13 million adults (46 percent of all adults in the state) are estimated to have prediabetes or undiagnosed diabetes. An additional 2.5 million adults have diagnosed diabetes. Altogether, 15.5 million adults (55 percent of all California adults) have prediabetes or diabetes. Although rates of prediabetes increase with age, rates are also high among young adults, with one-third of those ages 18-39 having prediabetes. In addition, rates of prediabetes are disproportionately high among young adults of color, with more than one-third of Latino, Pacific Islander, American Indian, African-American, and multiracial Californians ages 18-39 estimated to have prediabetes. Policy efforts should focus on reducing the burden of prediabetes and diabetes through support for prevention and treatment.

Diabetes, particularly type 2 diabetes, is a significant and growing health problem that affects both adults and children and can cause a number of serious complications, including blindness, kidney disease, cardiovascular disease, amputation, and premature death. Nationally, the prevalence of diabetes among adults has nearly tripled over the past 30 years.[1] In 2014, 29.1 million people in the U.S., or 9.3 percent of the population, had diabetes (including 8.1 million with undiagnosed diabetes).[2] In California, the prevalence of diabetes among adults increased by 35 percent between 2001 and 2012.[3]

Prediabetes, also referred to as impaired glucose tolerance or impaired fasting glucose, is a condition in which blood glucose levels are higher than normal but not high enough for a diagnosis of diabetes. People with prediabetes have a much higher risk of developing type 2 diabetes, as well as an increased risk for cardiovascular disease. Results from the Diabetes Prevention Program (DPP) clinical trial indicated that

among those with prediabetes, increased physical activity, improvements in diet, and weight loss can prevent or delay the onset of diabetes significantly more than placebo or medication.[4] Results also indicated that medication, while effective, is not as effective as lifestyle changes.

Nationally, more than one in three adults is estimated to have prediabetes, and 90 percent of these individuals are not aware that they have the condition.[2] Between 1999 and 2010, the prevalence of prediabetes among adults in the U.S. increased from 29 percent to 36 percent.[5] Moreover, between 1999 and 2008, the prevalence of diabetes and prediabetes among adolescents in the U.S. rose dramatically, from 9 percent to 23 percent.[6] Without intervention efforts, up to 30 percent of people with prediabetes will develop type 2 diabetes within five years, and up to 70 percent will develop diabetes within their lifetime.[7] There are very effective interventions available, including lifestyle modification programs recognized by the CDC's National Diabetes Prevention

Exhibit 1

Percent of Adults Diagnosed with Diabetes and Estimated to Have Prediabetes by Age Group, California, 2013-14

Age	Diabetes %	Prediabetes %
18-39	2%	33%
40-54	9%	49%
55-69	16%	60%
70+	20%	59%
All California Adults	**9%**	**46%**

Source: 2013-14 California Health Interview Survey

Note: Estimates of prediabetes are based on predictive models developed using 2009-2012 NHANES data and applied to CHIS 2013-14 data. Prediabetes estimates include adults with undiagnosed diabetes. Nationally, approximately 3.9 percent of adults have undiagnosed diabetes. Confidence intervals for estimates presented in this table are available here: *http://healthpolicy.ucla.edu/publications/search/pages/detail.aspx?PubID=1472.*

> *"Not only does diabetes increase the risk of serious medical complications, but it is also extremely costly to families, businesses, health care plans, states, and the nation."*

Program, that can prevent or delay the progression from prediabetes to diabetes.[4]

The current trends in diabetes and prediabetes are troubling because of the associated human and financial costs. Not only does diabetes increase the risk of serious medical complications, but it is also extremely costly to families, businesses, health care plans, states, and the nation. Nationally, diabetes was estimated to cost $245 billion in 2012, including $176 billion in direct medical costs and $69 billion in lost productivity.[8] In California, the total cost of diabetes was estimated to be more than $27 billion, with $19 billion of that spent on direct medical care for diabetes and $8 billion on the indirect costs associated with the disease.[8] In addition, undiagnosed diabetes is estimated to cost California $2.8 billion and prediabetes $5.3 billion in direct medical care.[9]

This study used data from the 2013-14 California Health Interview Survey (CHIS) and the National Health and Nutrition Examination Survey (NHANES) to estimate the prevalence of prediabetes in California. NHANES 2009-2012 data were used to build and test a statistical model predicting prediabetes, defined by hemoglobin A1c and fasting plasma glucose (blood tests commonly used to diagnose diabetes and prediabetes).

This predictive model was then applied to CHIS data to produce California-specific estimates of the prevalence of prediabetes and undiagnosed diabetes (herein referred to as prediabetes when reporting California estimates). The percentage of California adults with undiagnosed diabetes is expected to comprise a relatively small proportion of the prediabetes estimates presented. Nationally, less than 4 percent of adults have undiagnosed diabetes. This policy brief describes the estimated prevalence of prediabetes, including undiagnosed diabetes, statewide as well as by age, race and ethnicity, and county.

Prediabetes in California

One-Third of Young Adults in California Have Prediabetes

In California, more than half of adults (55 percent) have either prediabetes or diabetes. This includes 2.5 million adults, or 9 percent of the state's adult population, who have diagnosed diabetes. In addition, nearly half of adults (46 percent) are estimated to have prediabetes. This represents more than 13 million California adults. Prediabetes prevalence increases with age, rising from 33 percent among adults ages 18-39 to 49 percent among those ages 40-59 (Exhibit 1). Prevalence then levels off at approximately 60 percent among adults 55 and older.

Percent of Adults Estimated to Have Prediabetes by Race or Ethnicity and Age Group, California, 2013-14

Exhibit 2

Race and Ethnicity	Age Group				
	18-39	40-54	55-69	70+	All Adults
Latino	36%	51%	55%	51%	44%
Pacific Islander	43%	54%	76%	53%	55%
American Indian	38%	52%	65%	70%	51%
Asian	31%	45%	53%	58%	42%
African-American	38%	56%	61%	57%	50%
White	29%	49%	63%	61%	48%
Multiracial	37%	51%	58%	52%	45%
California	**33%**	**49%**	**60%**	**59%**	**46%**

Source: 2013-14 California Health Interview Survey

Note: Estimates of prediabetes are based on predictive models developed using 2009-2012 NHANES data and applied to CHIS 2013-14 data. Prediabetes estimates include adults with undiagnosed diabetes (approximately 3.9 percent of adults nationally). Confidence intervals for estimates presented in this table are available here: *http://healthpolicy.ucla.edu/publications/search/pages/detail.aspx?PubID=1472.*

Prediabetes Higher Among Adults of Color

Prediabetes disproportionately affects certain racial and ethnic groups. In California, at least half of Pacific Islanders (55 percent), American Indians (51 percent), and African-Americans (50 percent) are estimated to have prediabetes (Exhibit 2). Among young adults, more than one-third of Latinos (36 percent), Pacific Islanders (43 percent), American Indians (38 percent), African-Americans (38 percent), and those of multiple races (37 percent) are estimated to have prediabetes.

Prediabetes Varies by County

The prevalence of prediabetes varies from county to county among California adults. Because age is a particularly strong risk factor for diabetes and prediabetes, Exhibit 3 displays estimates of county-level prediabetes prevalence broken out by age group. High rates among young adults are particularly concerning, because the risk of complications from diabetes increases significantly the longer one has the condition. Among adults ages 18-39, the prevalence of prediabetes ranged from 26 percent in Lake County to 40 percent in both Kings and Imperial counties (Exhibit 3). Among this younger age group, five counties had rates below 30 percent (Lake, San Benito, Butte, San Francisco, and San Luis Obispo), and five had rates over 37 percent (Tulare, Merced, San Joaquin, Kings, and Imperial). Among all adults, rates ranged from 43 percent in Sutter and Butte counties to 54 percent in Nevada County and the combined counties of Tuolumne, Calaveras, Amador, Inyo, Mariposa, Mono, and Alpine. This regional variation is likely due to a number of factors, including differences in demographic, social, economic, and environmental characteristics.

"High rates among young adults are particularly concerning, because the risk of complications from diabetes increases significantly the longer one has the condition."

Exhibit 2

Percent of Adults Estimated to Have Prediabetes by County or County Group and Age, California, 2013-14

County or County Group	18-39	40-54	55-69	70+	All Adults
			Age Group		
Northern and Sierra Counties	**31%**	**50%**	**61%**	**60%**	**48%**
Butte	28%	52%	62%	53%	43%
Shasta	30%	52%	62%	54%	50%
Humboldt	32%	47%	67%	67%	48%
Del Norte, Siskiyou, Lassen, Trinity, Modoc, Plumas, Sierra	32%	48%	64%	63%	49%
Mendocino	30%	44%	66%	65%	48%
Lake	26%	43%	58%	58%	46%
Tehama, Glenn, Colusa	34%	58%	47%	59%	46%
Sutter	32%	51%	48%	58%	43%
Yuba	33%	55%	58%	57%	48%
Nevada	33%	46%	66%	71%	54%
Tuolumne, Calaveras, Amador, Inyo, Mariposa, Mono, Alpine	36%	53%	64%	60%	54%
Greater Bay Area	**32%**	**48%**	**62%**	**62%**	**47%**
Santa Clara	32%	43%	62%	65%	46%
Alameda	34%	51%	58%	64%	47%
Contra Costa	33%	44%	61%	62%	47%
San Francisco	28%	51%	66%	55%	44%
San Mateo	31%	48%	67%	65%	47%
Sonoma	33%	53%	61%	60%	49%
Solano	32%	48%	61%	50%	45%
Marin	31%	48%	61%	67%	50%
Napa	33%	48%	66%	65%	48%
Sacramento Area	**31%**	**50%**	**63%**	**60%**	**47%**
Sacramento	31%	51%	63%	58%	46%
Placer	31%	47%	61%	63%	47%
Yolo	32%	51%	59%	57%	44%
El Dorado	32%	49%	67%	62%	50%
San Joaquin Valley	**36%**	**50%**	**60%**	**57%**	**47%**
Fresno	37%	45%	68%	65%	49%
Kern	34%	58%	51%	49%	45%
San Joaquin	39%	46%	67%	58%	48%
Stanislaus	34%	54%	58%	52%	45%
Tulare	38%	41%	56%	56%	44%
Merced	38%	55%	51%	55%	46%
Kings	40%	49%	58%	60%	48%
Madera	32%	55%	63%	49%	45%
Central Coast	**33%**	**51%**	**61%**	**58%**	**46%**
Ventura	32%	53%	59%	61%	47%
Santa Barbara	33%	50%	64%	56%	47%
Santa Cruz	30%	45%	66%	61%	45%
San Luis Obispo	29%	52%	63%	57%	46%
Monterey	37%	48%	54%	50%	45%
San Benito	27%	53%	58%	62%	47%
Los Angeles	**33%**	**48%**	**57%**	**56%**	**44%**
Los Angeles	33%	48%	57%	56%	44%
Other Southern California	**33%**	**51%**	**60%**	**61%**	**46%**
Orange	31%	49%	62%	61%	46%
San Diego	32%	50%	62%	59%	46%
San Bernardino	35%	51%	52%	64%	45%
Riverside	34%	54%	63%	62%	48%
Imperial	40%	53%	43%	41%	44%
California	**33%**	**49%**	**60%**	**59%**	**46%**

Source: 2013-14 California Health Interview Survey

Note: Estimates of prediabetes are based on predictive models developed using 2009-2012 NHANES data and applied to CHIS 2013-14 data. Prediabetes estimates include adults with undiagnosed diabetes (approximately 3.9 percent of adults nationally). Confidence intervals for estimates presented in this table are available here: *http://healthpolicy.ucla.edu/publications/ search/pages/detail.aspx?PubID=1472.*

Conclusions and Recommendations

More than 13 million California adults—nearly half of the state's adult population—are estimated to have prediabetes. This suggests that more effort is needed to address the prevention of diabetes and the detection of and intervention for prediabetes statewide. Health promotion and disease prevention efforts such as maintaining a healthy weight, consuming healthy foods and beverages, limiting intake of sugar and other simple carbohydrates, and being more physically active all reduce the risk of developing type 2 diabetes. To aid in the prevention of diabetes, particularly among those with prediabetes, policymakers should consider the following:

- *Support diabetes prevention efforts.* Most people with prediabetes do not know they have the condition. Providing coverage for and ensuring the regular medical practice of appropriate screening can identify people with prediabetes while it is still possible to prevent the onset of type 2 diabetes. In addition, insurance coverage for and referral to recognized diabetes prevention programs can remove critical barriers to education and care for people with prediabetes and can facilitate lifestyle changes that can prevent diabetes.

- *Promote community and workplace environments that support healthy eating.* Local and state policy initiatives can improve the food and beverage environment by increasing access to fruits and vegetables, decreasing marketing of unhealthy options, encouraging large institutions such as hospitals to follow healthy food procurement guidelines, developing educational strategies to assist consumers in making more informed food and beverage choices, and ensuring the availability of safe and low-cost drinking water.

- *Promote built environments that encourage regular physical activity.* Lack of physical activity is a significant risk factor for diabetes, and further policies should be developed to facilitate active living—for example, creating safe environments for walking and biking, providing access to safe parks and other places for recreation and physical activity, and offering worksite programs to facilitate regular physical activity for adults of all ages.

- *Support adequate access to quality primary and specialty care.* At-risk individuals need to have adequate and sufficient access to quality health care services. Lack of continuous health insurance coverage and insufficient benefits packages create significant financial barriers to accessing primary and specialty care services. In addition, increased access to recognized diabetes-prevention lifestyle modification programs has been shown to be particularly beneficial for adults with prediabetes.

"Most people with prediabetes do not know they have the condition."

Data Sources and Methods

The findings in this brief are based on data from the 2013-14 California Health Interview Survey (CHIS). CHIS 2013-14 completed interviews with more than 40,000 households that included 40,240 adults, drawn from every county in the state. Interviews were conducted in English, Spanish, Chinese (both Mandarin and Cantonese), Korean, Vietnamese, and Tagalog. California estimates of diabetes prevalence are based on self-report. Adults were asked whether they had ever been diagnosed with diabetes by a doctor. Those who responded "yes" were classified as having diabetes.

Estimates of prediabetes are statistically modeled. Data from the 2009-2012 National Health and Nutrition Examination Survey (NHANES) were used to build and test predictive models of blood glucose levels above cutoffs associated with prediabetes. NHANES is a cross-sectional survey that provides a nationally representative sample of the noninstitutionalized population. NHANES participants completed a household interview as well as a physical examination that included a blood sample. Predictive models were developed for the adult population (18 and older) using data from the NHANES fasting subsample. Cutoffs associated with prediabetes were applied to hemoglobin A1c (HbA1c) and fasting plasma glucose (FPG) values in NHANES: HbA1c of 5.7 percent or above, or FPG of 100 or above. People who reported having been diagnosed with diabetes were classified as having diabetes.

The predictive model was developed using Generalized Boosted Regression Models (GBM) implemented in R.[10] This iterative, machine-learning algorithm increases in complexity until it minimizes out of training-sample predictive error, which was assessed using tenfold cross-validation. The NHANES predictive model displayed good predictive ability: Pseudo R-squared = 0.304 and Coefficient of Discrimination = 0.301. These metrics are taken from the cross-validation and represent the prediction for cases not used in the training. Models predicted blood glucose levels above prediabetes cutoffs. As a result, estimates of prediabetes include

adults with undiagnosed diabetes. However, those with undiagnosed diabetes are expected to represent a relatively small proportion of the prediabetes estimates presented here. Variance was estimated using multiple imputation. Confidence intervals for estimates presented in this publication are available here: *http://healthpolicy.ucla.edu/publications/search/pages/detail.aspx?PubID=1472.*

For consistency with earlier estimates, the National Center for Health Statistics applies regression equations to fasting glucose values collected after 2005. The current analysis does not involve comparison with earlier estimates. Therefore, fasting glucose values are based on the current laboratory measurement methods and have not been adjusted to be comparable to values collected in previous NHANES cycles. Based on our analysis of 2009-2012 NHANES data using HbA1c and FPG values not adjusted for comparability with earlier NHANES cycles, approximately 42 percent of U.S. adults 18 and over have prediabetes, and an additional 3.9 percent have undiagnosed diabetes. The predictive model developed in NHANES was applied to CHIS 2013-14 data to produce California-specific estimates of the prevalence of prediabetes (which include undiagnosed diabetes). Although the California prediabetes estimates include undiagnosed diabetes, the proportion with undiagnosed diabetes is expected to be relatively small, given that nationally less than 4 percent of adults have undiagnosed diabetes.

The California Health Interview Survey is a collaboration of the UCLA Center for Health Policy Research, the California Department of Public Health, the California Department of Health Care Services, and the Public Health Institute. For funders and other information on CHIS, visit *www.chis.ucla.edu*.

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Endnotes

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