

# *Age-Standardized Prevalence of Demographic, Socioeconomic, and Health Characteristics among Prediabetics*

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# Introduction

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- Prediabetes actually more prevalent than diabetes
  - 1 in 3 have prediabetes (86.1 million) vs. 1 in 10 have diabetes (29.1 million)
  - Symptoms & complications reduce quality of life
  - High-risk state for conversion to diabetes
    - 15%-30% of prediabetics -> diabetic in 5 years
  - 1 in 3 diabetic by 2050 if trend continues (2010 CDC Diabetes Projections)
- Goal
  - Improve understanding of prediabetes risk factors & inform prevention strategy
    - Risk factors less-well known/understood

# Research Question

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- **Are there differences in the distribution of risk factors for prediabetes? If so, are they different for diabetes?**
- Same risk factors for diabetes & prediabetes (continuum)
  - Support
  - Relationship (strength/gradient)
    - **Could it be that their relationship to prediabetes is different in pattern, not just in strength?**
- Major risk factors
  - Age, BMI, physical activity, race/ethnicity
- Minor risk factors (non-clinical)
  - Income, waist circumference
- Potential risk factors (characteristics)
  - General health, marital status, sex, educational attainment

# Methodology

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## ○ Data

- NHANES – combined data years 2009-2012 (n = 4,849; 236,315,740)
  - **Exclusion Criteria:**
    - Must have taken all 3 blood glucose tests (a1c, fasting glucose, glucose tolerance)
  - **Sample:**
    - Mean age = 43;
    - Predominantly **white** (66.7%), **male** (51%), **married/living with partner** (54.6%), **US-born** (82.9%), **with some college** (26.9%) or a **college graduate** (26.6%), and **making at or above the median household income** (75.6%)

## ○ Variables

- **Dependent variable:**
  - Age-standardized prediabetes prevalence
- **Independent variables:**
  - Demographics, income & poverty, health, and physical activity & exercise

# Analyses

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- Descriptive Statistics

- Age-standardized prevalence

  - Blood glucose status – prediabetes, diabetes

  - For each IV by Blood Glucose Status

    - Demographics, Income, Physical Activity & Exercise, Diet

- **RQ - Are there differences in the distribution of risk factors for prediabetes? If so, are they different for diabetes?**

  - Goal – Comparing pattern of age-standardized prevalence among prediabetes and diabetes

  - **Is the pattern of prevalence the same for prediabetes as is it for diabetes?**

# Results – Pattern for most risk factors of prediabetes

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- **Are there differences in the distribution of risk factors for prediabetes?**
- Yes, most risk factors show a pattern for prediabetes prevalence
  - Exceptions –
    - **Days of Biking**
    - **Minutes of Vigorous Recreational Activity**

# Results – Some risk factors have different patterns for prediabetes and diabetes.

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- Are there differences in the distribution of risk factors for prediabetes? **If so, is the distribution different for diabetes?**
  - **Evidence for different patterns for 12 of 23 variables studied**

## Same trend P/D

### **Demographics** (excluding R/E, marital status)

- **Sex** – males > females
- **Educational Attainment** – less than HS > more educated groups
- **Nativity** – FB > US-Born

### ○ **Income & Poverty** (excluding hinc, poverty pct)

- **Family Income** – below median income > at or above median income
- **Poverty Status** – below threshold > at or above threshold

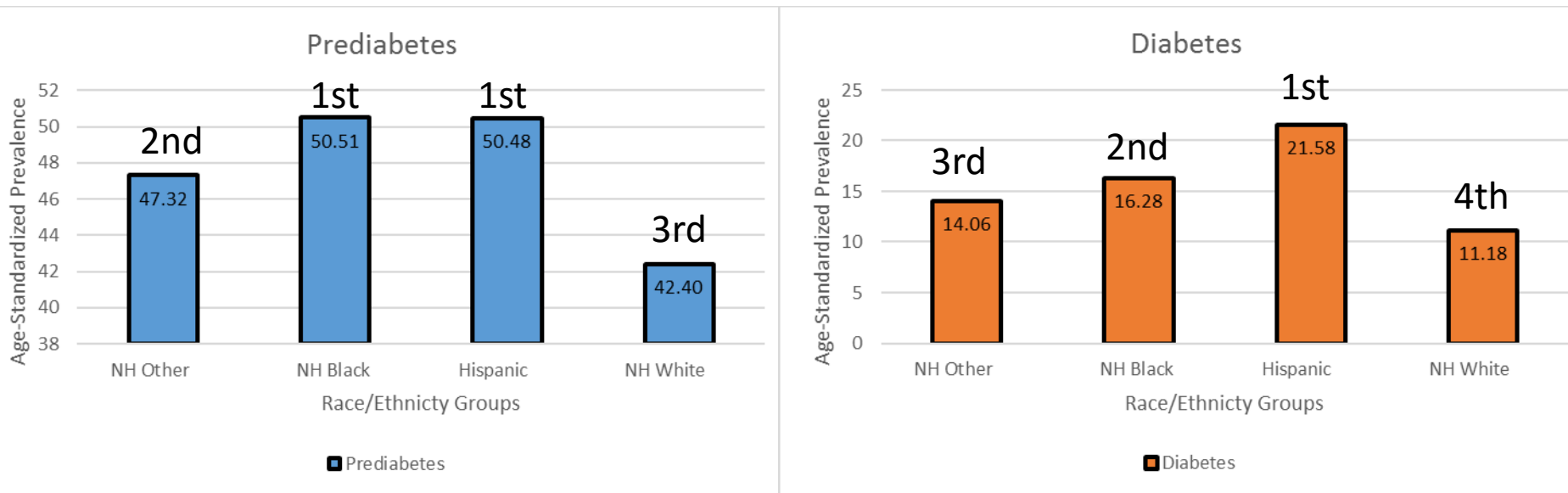
### ○ **Health** (excluding BMI, general health)

- **Health Insurance** – insurance > no insurance
- **Waist Circumference** – overweight > normal

# Race/Ethnicity

\*Rankings reflect the most to least prevalent sub-categories for the disease.

- Ex. 1<sup>st</sup> = most prevalent sub-category



\*\*Age-standardized prevalence shows the percentage of each sub category with that disease.

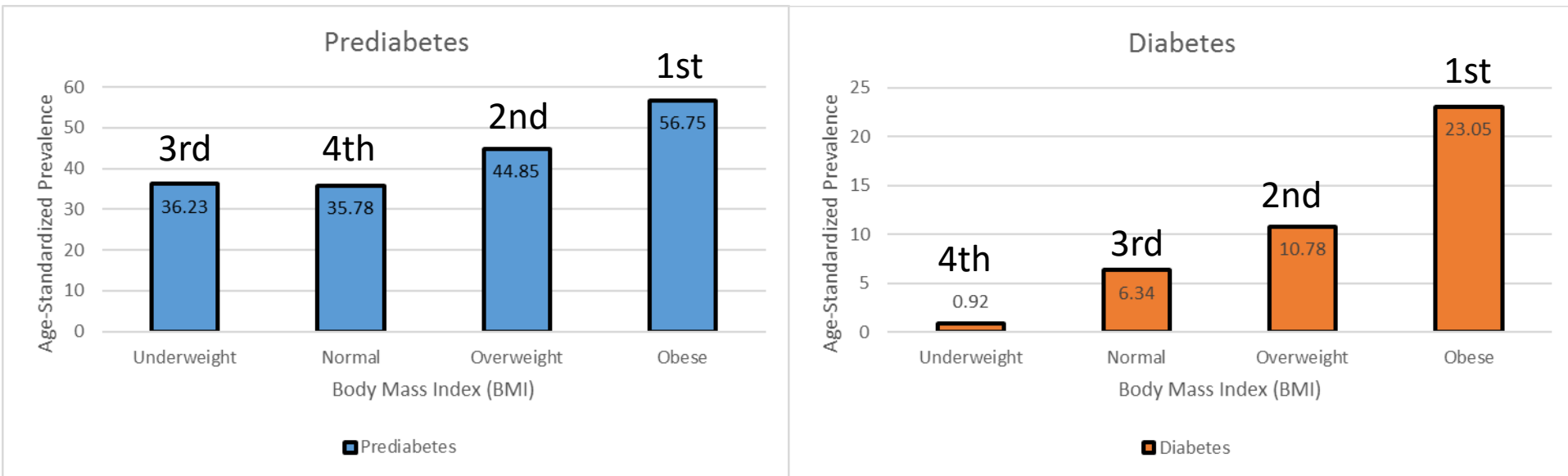
- Ex. Controlling for age, the 42.4% of NH Whites are prediabetic.



# Body Mass Index (BMI)

\*Rankings reflect the most to least prevalent sub-categories for the disease.

- Ex. 1<sup>st</sup> = most prevalent sub-category



\*\*Age-standardized prevalence shows the percentage of each sub category with that disease.

- Ex. Controlling for age, the 36.2% of the underweight are prediabetic.

# Discussion

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- **Are there differences in the distribution of risk factors for prediabetes? If so, are they different for diabetes?**
  - Yes, most variables show a pattern of prevalence.
  - Yes, some risk factors work differently among prediabetics and diabetics.
    - Race/ethnicity, marital status, BMI, General Health
- **Why are these patterns different among prediabetics & diabetics?**
  - Blood glucose seen as a continuum, with worse outcomes/symptoms among diabetics
    - Normal glucose – prediabetes – diabetes
      - Different patterns of risk between prediabetics & diabetics unexpected result

# Discussion, contd.

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- **Race/ethnicity**

- **Differences in access to care** – FB Hisp may have had difficulty accessing healthcare needed to prevent conversion to diabetes compared to US-born Blacks

- **BMI**

- **Treatment of diabetes (insulin + hypoglycemia)** -> far fewer Underweight with diabetes than prediabetes

- **Conclusions**

- There are patterns in the distribution of prediabetes across risk factors
- Risk factors don't always have the same patterns among prediabetics & diabetics
  - Weaker relationships between risk factors & prediabetes vs. diabetes

# Conclusions, Policy Implications, & Future Research

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- Policy Implications

- Targeted prevention strategies should differ for prediabetics & diabetics

- Future Research

- Patterns in diet/diet risk factors for prediabetics & diabetics
- Longitudinal research – dietary patterns that lead to conversion to diabetes over time

# Questions???

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# APPENDICES

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# Prediabetes

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86 million (>1 in 3) are prediabetic

## Symptoms

- None/Some/All
- Diabetes Symptoms & Complications

## Complications

- Cardiovascular disease
- Alzheimer's disease
- Neuropathy

## Risk Factors

- Diabetes – established
- Prediabetes – not well established

# Prediabetes Criterion

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## Impaired Fasting Glucose (IFG)

- Fasting Plasma Glucose test - 100 - 125 mg/dl
- More prevalent than IGT
  - Greater than 50% with IFG also have IGT

## Impaired Glucose Tolerance (IGT)

- OGTT – 75 g glucose, 2 hour/fasting - 140 - 199 mg/dl
- Prevalence
  - About 20-25% with IGT also have IFG

## A1C

- Can be taken anytime/no fasting/average glucose - 5.7%-6.4%
- Prevalence
  - Unknown



# Methodology, contd.

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- Variables, contd.
  - **Independent variables:**
    - *Demographics*
      - **Sex** (male vs. female)
      - **Age** (under 18, 18-34, 35-44, 45-64, 65 and older)
      - **Race/ethnicity** (NH White, NH Black, Hispanic, NH Other)
      - **Educational Attainment** (less than HS, HS, some college, college degree or greater)
      - **Citizenship status** (native-born vs. foreign-born)
      - **Marital status** (married/living with partner, widowed, divorced or separated, single)
    - *Income & Poverty Status*
      - **Annual Household Income, Median** (below median income, at or above median income)
      - **Annual Household Income, Quartiles** (Under \$20k, \$20k-\$34.9k, \$35k-\$74.9k, \$75k or greater)
      - **Family Income, Median** (< median income, >= median income)
      - **Poverty Status, Median** (< poverty threshold, >= median threshold)
      - **Poverty Status, Percentages** (< 130%, 130% to 184%, >= 185% )
    - *Health*
      - **Body Mass Index (BMI)** (underweight, normal weight, overweight, obesity)
      - **Health Insurance** (health coverage vs. no health coverage)
      - **Self-rated General Health Status** (poor to fair, good, very good, excellent)
      - **Waist Circumference** (overweight vs. normal weight)

# Methodology, contd. 2

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## ○ Variables, contd.

### ○ Independent variables:

#### ○ *Physical Activity & Exercise*

- **Minutes of Vigorous Work Activity** (< 120 minutes, >= 120 minutes)
- **Minutes of Moderate Work Activity** (< 120 minutes, >= 120 minutes)
- **Minutes of Vigorous Recreational Activity** (< 60 minutes, >= 60 minutes)
- **Minutes of Moderate Recreational Activity** (< 60 minutes, >= 60 minutes)
- **Minutes of Biking** (< 30 minutes, >= 30 minutes)
- **Days of Biking** (<5 days, >= 5 days)
- **Days of Vigorous Recreational Activity** (<3 days, >= 3 days)
- **Days of Moderate Recreational Activity** (<3 days, >= 3 days)
- **Days of Vigorous Work Activity** (<5 days, >= 5 days)
- **Days of Recreational Work Activity** (<5 days, >= 5 days)
- **Physical Activity Intensity** (moderate intensity, vigorous intensity)
- **Physical Activity Type** (work activity, recreational activity)

# Methodology, contd. 3

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- Variables, contd.
  - **Independent variables:**
    - Diet (Day 1, Day 2)
      - Calories ( $\leq 2000$  vs.  $>2000$  calories)
      - Fat ( $\leq 65$  g vs.  $> 65$  g)
      - Cholesterol ( $\leq 300$  mg vs.  $> 300$  mg)
      - Salt ( $\leq 2000$  mg vs.  $> 2000$  mg)
      - Fiber ( $< 15$  g, 15 to 25 g,  $> 25$  g)
      - Protein ( $\leq 50$  g vs.  $> 50$  g)
      - Carbohydrates ( $\leq 300$  g vs.  $> 300$  g)

Independent Variables	<i>Prediabetes</i>			<i>Abnormal Glucose</i>			<i>Diabetes</i>		
	Estimate	SE	P Value	Estimate	SE	P Value	Estimate	SE	P Value
<b>Demographics</b>									
<i>Race/Ethnicity</i> ***									
NH Other	47.32	3.68	***	49.80	3.70	***	14.06	3.39	***
NH Black	50.51	1.77	***	52.24	1.70	***	16.28	1.59	***
Hispanic	50.48	1.71	***	53.47	1.63	***	21.58	1.75	***
NH White	42.40	1.50	***	44.10	1.49	***	11.18	1.10	***
<i>Sex</i> ***									
Male	51.29	1.52	***	53.10	1.46	***	14.30	1.36	***
Female	38.68	1.23	***	40.90	1.27	***	11.87	0.95	***
<i>Marital Status</i> ***									
Married/ Partner	42.06	1.10	***	43.80	1.12	***	12.32	1.10	***
Wid/Div/Sep	36.59	2.21	***	39.76	2.22	***	15.42	2.03	***
Single	35.39	2.47	***	37.47	2.37	***	9.35	2.23	**
< 20 yrs	10.56	0.97	***	10.67	0.96	***	0.18	0.10	T
<i>Ed Att.</i> ***									
<HS	45.54	1.98	***	47.77	1.77	***	18.02	1.30	***
HS	42.84	1.54	***	45.32	1.59	***	16.44	2.04	***
Some College	39.30	1.81	***	41.10	1.71	***	11.55	1.56	***
College or Greater	36.36	1.30	***	37.82	1.29	***	9.23	1.24	***
Refused	26.39	0.00	.	26.39	0.00	.	0.13	0.10	.
< 20 yrs	10.56	0.97	***	10.67	0.96	***	24.09	0.04	***
Don't Know	0.00	0.00	.	13.04	0.00	.	0.00	0.00	.
<i>Nativity</i> ***									
Native	44.45	1.27	***	46.22	1.25	***	11.78	0.98	***
Foreign	46.82	2.04	***	50.01	1.90	***	17.90	1.68	***
Refused	0.00	0.00	.	0.00	0.00	.	0.00	0.00	.
Don't Know	0.00	0.00	.	26.39	0.00	.	26.39	0.00	***

† p <.10; \*p<0.05; \*\*p<0.01; \*\*\*p<.001; ns = not significant

Independent Variables	<i>Prediabetes</i>			<i>Abnormal Glucose</i>			<i>Diabetes</i>		
	Estimate	SE	P Value	Estimate	SE	P Value	Estimate	SE	P Value
<b>Health</b>									
<i>BMI</i> ***									
Underweight	36.23	6.48	***	36.82	6.57	***	0.92	0.97	.
Normal	35.78	1.78	***	37.08	1.83	***	6.34	1.19	***
Overweight	44.85	2.50	***	46.47	2.45	***	10.78	0.96	***
Obese	56.75	2.19	***	59.23	2.12	***	23.05	2.24	***
Missing Height or Weight	53.01	10.36	***	57.55	10.46	***	13.47	8.31	.
<i>Health Insurance</i> ***									
Has Insurance	51.86	1.99	***	54.19	1.83	***	21.45	1.78	***
No Insurance	43.90	1.21	***	45.67	1.22	***	11.85	0.96	***
Refused	0.00	0.00	.	0.00	0.00	.	0.00	0.00	.
Don't Know	32.53	9.08	***	32.53	9.08	***	0.00	0.00	.
<i>General Health Status</i> ***									
Poor/Fair	55.00	2.60	***	58.28	2.49	***	23.63	2.65	***
Good	48.50	1.43	***	50.44	1.46	***	15.98	1.97	***
Very Good	39.93	1.78	***	41.53	1.77	***	9.15	1.22	***
Excellent	41.02	3.19	***	42.11	3.23	***	6.49	1.70	**
< 12 yrs	39.66	3.33	***	41.40	3.40	***	9.00	2.22	**
<i>Waist</i> ***									
Normal	39.70	1.43	***	41.03	1.39	***	7.36	1.07	***
Overweight	50.35	2.06	***	52.90	2.03	***	17.66	1.34	***
< 12 yrs	39.17	7.72	***	41.77	7.75	***	13.09	3.87	**

† p < .10; \*p < 0.05; \*\*p < 0.01; \*\*\*p < .001; ns = not significant

Independent Variables	<i>Prediabetes</i>			<i>Abnormal Glucose</i>			<i>Diabetes</i>		
	Estimate	SE	P Value	Estimate	SE	P Value	Estimate	SE	P Value
<b>Income &amp; Poverty</b>									
<i>H. Income, Quartiles</i>									
Under 20k	47.20	2.20	***	50.35	2.06	***	16.70	1.70	***
\$20,000-\$34,999	50.12	2.34	***	52.82	2.23	***	18.47	2.16	***
\$35,000-74,999k	47.12	1.74	***	48.69	1.74	***	13.53	1.52	***
\$75,000 or Greater	40.03	1.95	***	41.60	1.94	***	8.70	1.28	***
Refused	47.51	5.66	***	48.95	5.51	***	5.63	2.73	*
Actual Income Unreported	53.97	4.87	***	54.74	4.60	***	30.76	7.27	**
Don't Know	44.62	6.15	***	47.83	5.88	***	12.37	4.21	**
<i>Family Income</i>									
Below Median	48.29	1.27	***	50.63	1.22	***	15.52	1.33	***
Above Median	43.24	1.74	***	45.08	1.69	***	11.78	1.23	***
Refused	47.51	5.54	***	48.48	5.38	***	8.32	2.56	**
Actual Income Unreported	46.49	3.12	***	47.77	3.01	***	8.51	2.85	**
Don't Know	47.60	4.75	***	50.88	4.74	***	16.73	2.75	***
<i>Poverty Half***</i>									
Below Poverty	49.74	1.70	***	52.10	1.66	***	17.45	1.87	***
At or Above Poverty	43.36	1.54	***	45.30	1.54	***	12.33	1.03	***
Actual Income Unreported	47.42	2.79	***	49.50	2.78	***	12.78	1.96	***
<i>Poverty Percentages***</i>									
<130%	48.75	1.56	***	51.06	1.51	***	15.89	1.45	***
130-184%	47.38	1.96	***	49.93	1.87	***	16.97	2.30	***
185% or Greater	42.07	1.83	***	43.81	1.81	***	11.20	1.09	***
Refused	52.12	7.04	***	52.38	6.96	***	8.69	1.62	***
Actual Income Unreported	46.19	3.12	***	47.48	3.01	***	8.37	2.78	**
Don't Know	50.07	8.04	***	54.31	7.74	***	23.27	5.77	**

† p <.10; \*p<0.05; \*\*p<0.01; \*\*\*p<.001; ns = not significant

Independent Variables	Prediabetes			Abnormal Glucose			Diabetes		
	Estimate	SE	P Value	Estimate	SE	P Value	Estimate	SE	P Value
<b>Physical Activity &amp; Exercise</b>									
<i>Min Vigorous Work Activity***</i>									
Below 120 Minutes	39.77	3.28	***	42.62	3.31	***	12.82	3.52	***
Above 120 Minutes	43.17	3.13	***	44.29	2.96	***	8.35	1.64	***
< 12 yrs; < 10 min activity	44.88	1.19	***	46.98	1.18	***	13.46	0.96	***
<i>Min Moderate Work Activity***</i>									
Below 120 Minutes	39.80	1.84	***	41.90	1.86	***	10.67	2.11	***
Above 120 Minutes	47.08	2.02	***	48.80	2.02	***	13.23	1.97	***
< 12 yrs; < 10 min activity	45.88	1.63	***	47.98	1.61	***	13.64	1.16	***
<i>Min Vigorous Rec Activity***</i>									
Below 60 Minutes	38.67	2.92	***	39.84	2.78	***	5.42	1.54	**
Above 60 Minutes	36.71	3.24	***	37.85	3.09	***	3.94	1.26	**
< 12 yrs; < 10 min activity	47.89	1.15	***	50.11	1.16	***	14.85	1.01	***
<i>Min Mod Rec Activity***</i>									
Below 60 Minutes	42.63	1.88	***	44.58	2.01	***	11.34	2.26	***
Above 60 Minutes	43.73	2.52	***	44.99	2.47	***	8.24	1.66	***
< 12 yrs; < 10 min activity	46.61	1.60	***	48.93	1.61	***	15.40	1.26	***
<i>Minutes Biking**</i>									
Below 30 Minutes	46.22	2.70	***	48.78	2.72	***	14.87	3.43	***
Above 30 Minutes	44.62	2.14	***	45.99	2.06	***	11.00	1.83	***
< 12 yrs; < 10 min activity	44.51	1.30	***	46.64	1.31	***	13.07	1.01	***
<i>Days Biking***</i>									
Under 5 Days	44.41	2.58	***	46.38	2.42	***	12.57	2.14	***
5 Days or More	46.42	2.60	***	48.03	2.57	***	11.95	2.50	***
< 12 yrs; < 10 min activity	44.51	1.30	***	46.64	1.31	***	13.07	1.01	***
<i>Days Vig Rec***</i>									
Below 60 Minutes	40.23	5.43	***	41.32	5.56	***	3.48	2.37	.
Above 60 Minutes	37.45	2.47	***	38.67	2.39	***	4.70	1.04	***
< 12 yrs; < 10 min activity	47.88	1.14	***	50.09	1.15	***	14.86	1.01	***
<i>Days Vig Work***</i>									
Under 2 Days	35.30	5.65	***	37.19	5.54	***	6.44	2.98	*
2 Days or More	43.65	2.80	***	45.45	2.79	***	11.12	2.30	***
< 12 yrs; < 10 min activity	44.86	1.19	***	46.96	1.18	***	13.46	0.96	***
<i>Days Mod Work***</i>									
Under 2 Days	37.52	4.83	***	41.58	4.53	***	18.85	5.01	**
2 Days or More	44.10	1.53	***	45.77	1.55	***	11.33	1.23	***
< 12 yrs; < 10 min activity	45.85	1.63	***	47.94	1.60	***	13.56	1.17	***
Don't Know	13.04	0.00	***	39.43	0.00	.	13.04	0.00	.
<i>Days Mod Rec***</i>									
Under 2 Days	48.08	3.41	***	49.47	3.34	***	9.97	2.30	**
2 Days or More	42.00	1.47	***	43.59	1.48	***	9.59	1.30	***
< 12 yrs; < 10 min activity	46.59	1.59	***	48.91	1.61	***	15.40	1.26	***

† p < .10; \*p < 0.05; \*\*p < 0.01; \*\*\*p < .001; ns = not significant

# Criteria for Diseases

<u>Impaired Fasting Glucose (IFG)</u>	<u>Impaired Glucose Tolerance (IGT)</u>	<u>A1C</u>
Normal < 100 mg/dl	Normal < 140 mg/dl	Normal < 5.7%
Prediabetic 100 mg/dl to 125 mg/dl	Prediabetic 140 and 199 mg/dl	Prediabetic 5.7% and 6.4%
Diabetic > 125 mg/dl	Diabetic > 199 mg/dl	Diabetic > 6.4%



# Age as a powerful risk factor

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- Age gradient in diabetes prevalence well-supported
  - Older persons have higher prevalence of diabetes up to a certain point
    - Diabetes prevalence decreases from older-old to oldest-old
      - Greater mortality at older ages -> those remaining alive in oldest-old age groups healthier than those who died earlier
- Some evidence for age gradient in prediabetes
  - Some reports show a gradient, some don't
- Is age impacting how other risk factors affect prediabetes prevalence? Unknown
- Age differences in these risk factors, in general
  - Age differences in
    - Income
    - Educational attainment
    - Marital status
- Important to control for age, to better understand how risk factors impact prediabetes prevalence independent of age

# Results – Same trend P/D, contd.

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- **Physical Activity & Exercise** (min vigorous work activity, min moderate rec activity, days biking, days vigorous rec activity, days moderate work activity, days moderate recreational activity)
  - **Minutes Moderate Work Activity** – above than 120 min > below 120 min
  - **Minutes Vigorous Recreational Activity** – above 60 minutes > below 60 minutes
  - **Minutes Biking** – below 40 minutes > above 30 minutes
  - **Days Vigorous Work** – 2 or more days > under 2 days

# Discussion, contd.

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- **Race/ethnicity**

- (P – NHBs/Hispanic, NHOs, NHWs vs. D – Hispanic, NHBs, NHOs, NHWs)
  - **Differences in access to care** – FB Hispanic may have had difficulty accessing healthcare needed to prevent conversion to diabetes compared to US-born Blacks

- **Marital status**

- (P – Mar/Part, Wid, Single vs. D – Wid, Mar/Part, Single)
- **Social support (spouse) and health consciousness** - prevent conversion to diabetes among marrieds vs. widowed/divorced/separated

- **BMI**

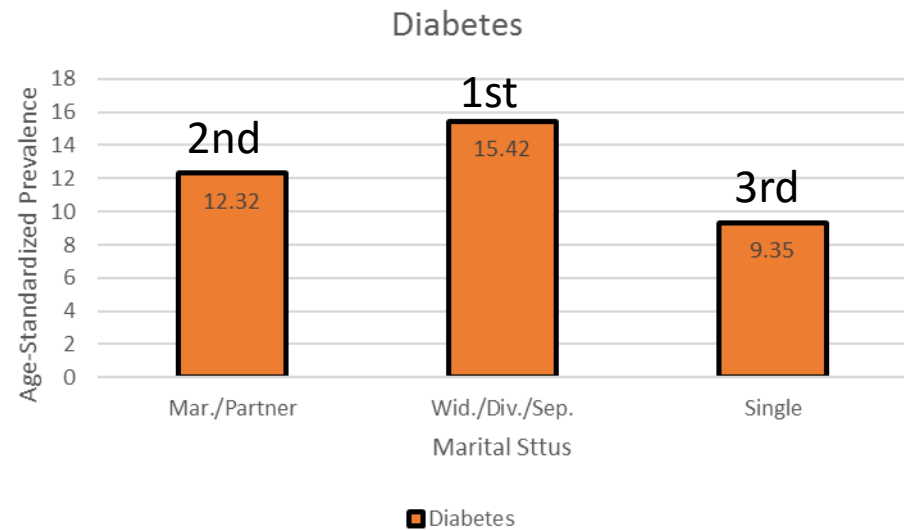
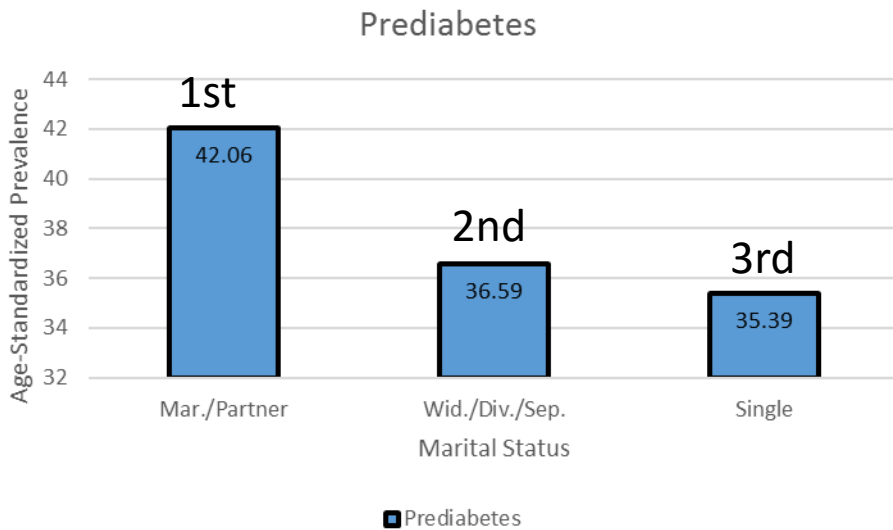
- (P – Obese, Over, Under, Normal vs. D – Obese, Over, Normal, Under)
- **Treatment of diabetes (insulin + hypoglycemia)** -> far fewer Underweight with diabetes than prediabetes

- **General Health**

- (P – Poor/Fair, Good, Exc, VG, vs. D – Poor/Fair, Good, VG, Exc)
  - **Cultural differences in self-reported health tendencies** – Mexicans/Good vs. Excellent; Hispanics #1 in diabetes

# Marital Status

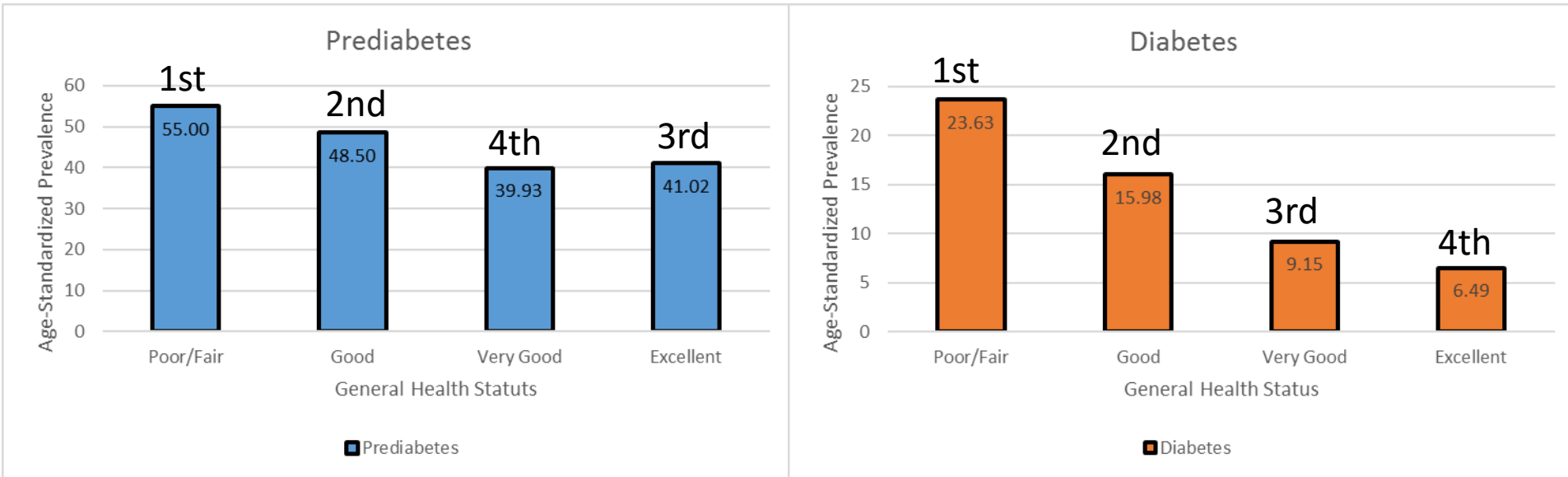
\*Rankings reflect the most to least prevalent sub-categories for the disease.  
- Ex. 1<sup>st</sup> = most prevalent sub-category



\*\*Age-standardized prevalence shows the percentage of each sub category with that disease.  
- Ex. Controlling for age, 35.4% of singles are prediabetic.

# General Health Status

\*Rankings reflect the most to least prevalent sub-categories for the disease.  
- Ex. 1<sup>st</sup> = most prevalent sub-category



\*\*Age-standardized prevalence shows the percentage of each sub category with that disease.  
- Ex. Controlling for age, 41% of those reporting excellent health are prediabetic.