The Protective Role of Physical Recreation Activities on Diagnosed and Undiagnosed Diabetes

National Health and Nutrition Examination Survey (NHANES) 2017-2018

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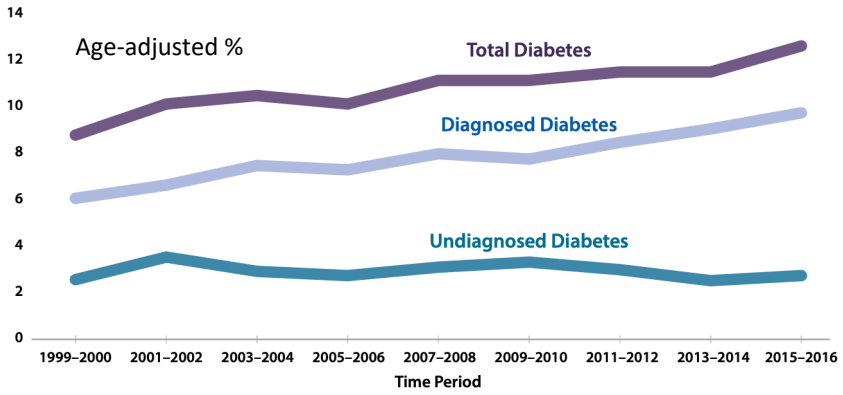
Introduction

Background

- In 2018, 34.1 million adults aged 18 years or older—or 13.0% of all US adults—had diabetes ; 7.3 million adults aged 18 years or older who met laboratory criteria for diabetes were not aware of or did not report having diabetes (undiagnosed diabetes). This number represents 2.8% of all US adults and 21.4% of all US adults with diabetes.
- Physical activity has long been recognized as playing a role in the prevention of type 2 diabetes (T2D) and previous meta-analyses revealed this protection effect can be modified by race/ethnicity.



Source : 1999-2016 NHANES , National Diabetes Statistics Report, 2020

Data Source : Observational, Cross-sectional data collected from National Health and Nutrition Examination Survey (NHANES) 2017-2018 ; 5852 U.S. adults (age 18 or older) with self-reported diabetes outcome or HbA1c (Glycohemoglobin) testing result on record included in the analysis.

Purpose of this Study: To evaluate **the protective effect of Physical Recreation Activities (PRA)** on total diabetes (incl. diagnosed and undiagnosed) and meanwhile examine the **effect modification of race-ethnicity** on PRA and diabetes outcome.

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Outcome and Primary Exposure

Outcome : Diabetes (incl. diagnosed and undiagnosed)

- Diagnosed diabetes was defined by positive responses to the question: ‘‘Have you ever been told by a doctor that you have diabetes?’’
- Undiagnosed diabetes was defined HbA1c (Glycohemoglobin) >= 6.5%.

Primary Exposure: Physical Recreation Activities

- Defined based on positive responses to either of the following two questions: In a typical week

  1) do any vigorous-intensity sports, fitness, or recreational activities that cause large increases in breathing or heart rate like running or basketball for at least 10 minutes continuously?

  2) do any moderate-intensity sports, fitness, or recreational activities that cause a small increase in breathing or heart rate such as brisk walking, bicycling, swimming, or volleyball for at least 10 minutes continuously?

Covariates

Demographics

- **Age (years)**
  - 18-39 / 40-61 / 62+
- **Race/Ethnicity (Potential EM)**
  - NH White
  - NH Black
  - NH Asian/Other
  - Hispanic Origin
- **Gender**
- **Annual Household Income ($)**
  - 0-20K / 20-55K/55-100K+
- **Health Insurance**

Clinical Characteristics

- **BMI (kg/m^2)**
  - Underweight (<18.5)
  - Normal weight(18.5-24.9)
  - Overweight (25-29.9)
  - Obese (>=30)
- **Hypertension**
  - Defined as a mean diastolic blood pressure >=80 mmHg or a mean systolic blood pressure >=130 mmHg (average of 3 readings of DBP and SBP)
- **Depression**
  - Derived from total depression score
  - Min/Mild 0-9; Mild/Severe 10-27

Data Summary

- The prevalence of total diabetes is **20.6%** among 5852 adults (**15.4%** if population-weighted).
- The study group are aged 50 on average and with a nearly-balanced gender mix.
- Missing rate 0 - 12.6% (acceptable)

FIGURE 1. Prevalence of Diabetes (NHANES 2017-2018)

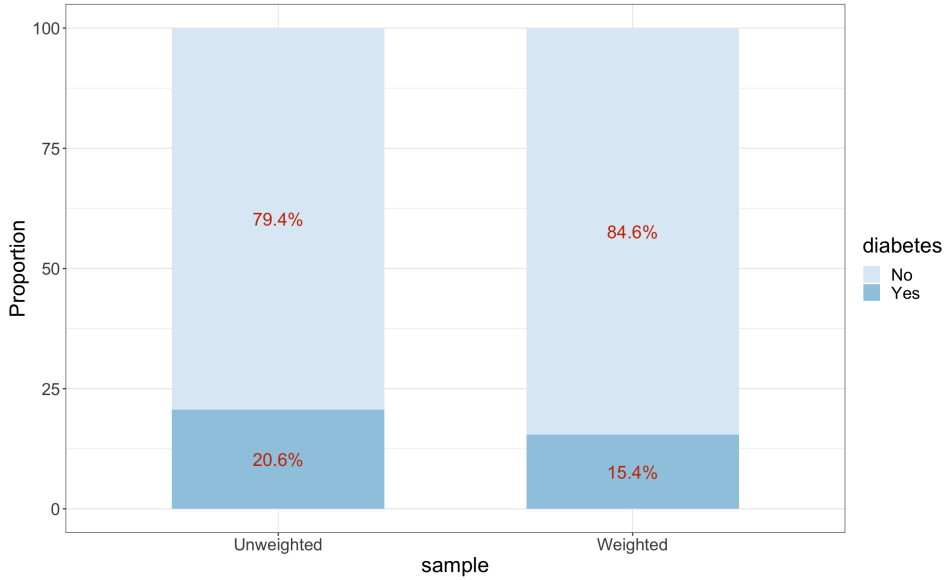

TABLE 1. Demographic and Clinical Characteristics (NHANES 2017-2018 , N=5852)

Variables (Continuous)	Range	Mean(SD)	N-miss
Age (years)	18.00 - 80.00	49.89 (18.77)	
BMI, Kg/m ^{2}	14.20 - 86.20	29.69 (7.44)	422
Diastolic blood pressure, mmHg	0.00 - 134.00	72.09 (13.08)	737
Systolic blood pressure, mmHg	72.00 - 238.00	125.79 (20.09)	737
Depression Score	0.00 - 28.00	3.01 (4.43)	

Variables (Categorical)		N (%)	N-miss
Diabetes			
	Yes	1203 (20.60)	
	No	4649 (79.40)	
Physical Recreational Activity			
	Yes	2735 (46.70)	
	No	3117 (53.30)	
Overall Diet			2
	Poor/Fair	1932 (33.00)	
	Good	2290 (39.10)	
	Very good/Excellent	1628 (27.80)	
Race/Ethnicity			
	NH White	2031 (34.70)	
	Hispanic Origin	1332 (22.80)	
	NH Asian/Other	1146 (19.60)	
	NH Black	1343 (22.90)	
Gender			
	Male	2839 (48.50)	
	Female	3013 (51.50)	
Annual Household Income, $			613
	0-20K	1010 (19.30)	
	20-55K	2117 (40.40)	
	55-100+K	2112 (40.30)	
Health Insurance			19
	Uninsured	892 (15.30)	
	Insured	4941 (84.70)	

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Bivariate Analysis

(Chi-squared Test)

The strong predictors are *Physical Recreational Activity, Overall Diet, BMI, Hypertension, Depression, Age, Race/Ethnicity, Gender,* and *Health Insurance*. Nevertheless, all variables would be included in the variable selection to avoid omission of important risk factors.

TABLE 2. Risk Factors by Diabetes Status (NHANES 2017-2018 , N=5852)

		DIABETES			
		Yes	No		
N(%)	* Reference Level	1203 (20.60)	4649 (79.40)	N = 5852	P-value
Physical Recreational Activity					< 0.001
	No*	771 (64.1)	2346 (50.5)		
	Yes	432 (35.9)	2303 (49.5)		
Overall Diet				missing = 2	0.049
	Poor/Fair	421 (35.0)	1511 (32.5)		
	Good*	480 (39.9)	1810 (38.9)		
	Very good/Excellent	302 (25.1)	1326 (28.5)		
BMI, kg/m ^{2}				missing = 422	< 0.001
	Underweight	2 (0.2)	97 (2.3)		
	Normal Weight*	159 (14.1)	1213 (28.2)		
	Overweight	329 (29.2)	1395 (32.4)		
	Obese	637 (56.5)	1598 (37.1)		
Hypertension				missing = 737	< 0.001
	No*	450 (42.0)	2321 (57.4)		
	Yes	622 (58.0)	1722 (42.6)		
Depression					< 0.001
	Min/Mild*	1061(88.2)	4260 (91.6)		
	Mild/Severe	142(11.8)	389 (8.4)		

		DIABETES			
		Yes	No		
N(%)	* Reference Level	1203 (20.60)	4649 (79.40)	N = 5852	P-value
Age (in years)					< 0.001
	18-39*	82 (6.8)	1890 (40.7)		
	40-61	438 (36.4)	1579 (34.0)		
	62+	683 (56.8)	1180 (25.4)		
Race/Ethnicity					0.020
	NH White*	375 (31.2)	1656 (35.6)		
	Hispanic Origin	275 (22.9)	1057 (22.7)		
	NH Asian/Other	250 (20.8)	896 (19.3)		
	NH Black	303 (25.2)	1040 (22.4)		
Gender					0.012
	Male*	623 (51.8)	2216 (47.7)		
	Female	580 (48.2)	2433 (52.3)		
Annual Household Income, $				missing = 613	0.090
	0 - 20K*	213 (19.8)	797 (19.1)		
	20 - 55K	459 (42.7)	1658 (39.8)		
	55 - 100+K	402 (37.4)	1710 (41.1)		
Health Insurance				missing = 19	< 0.001
	Uninsured*	125 (10.4)	767 (16.6)		
	Insured	1075 (89.6)	3866 (83.4)		

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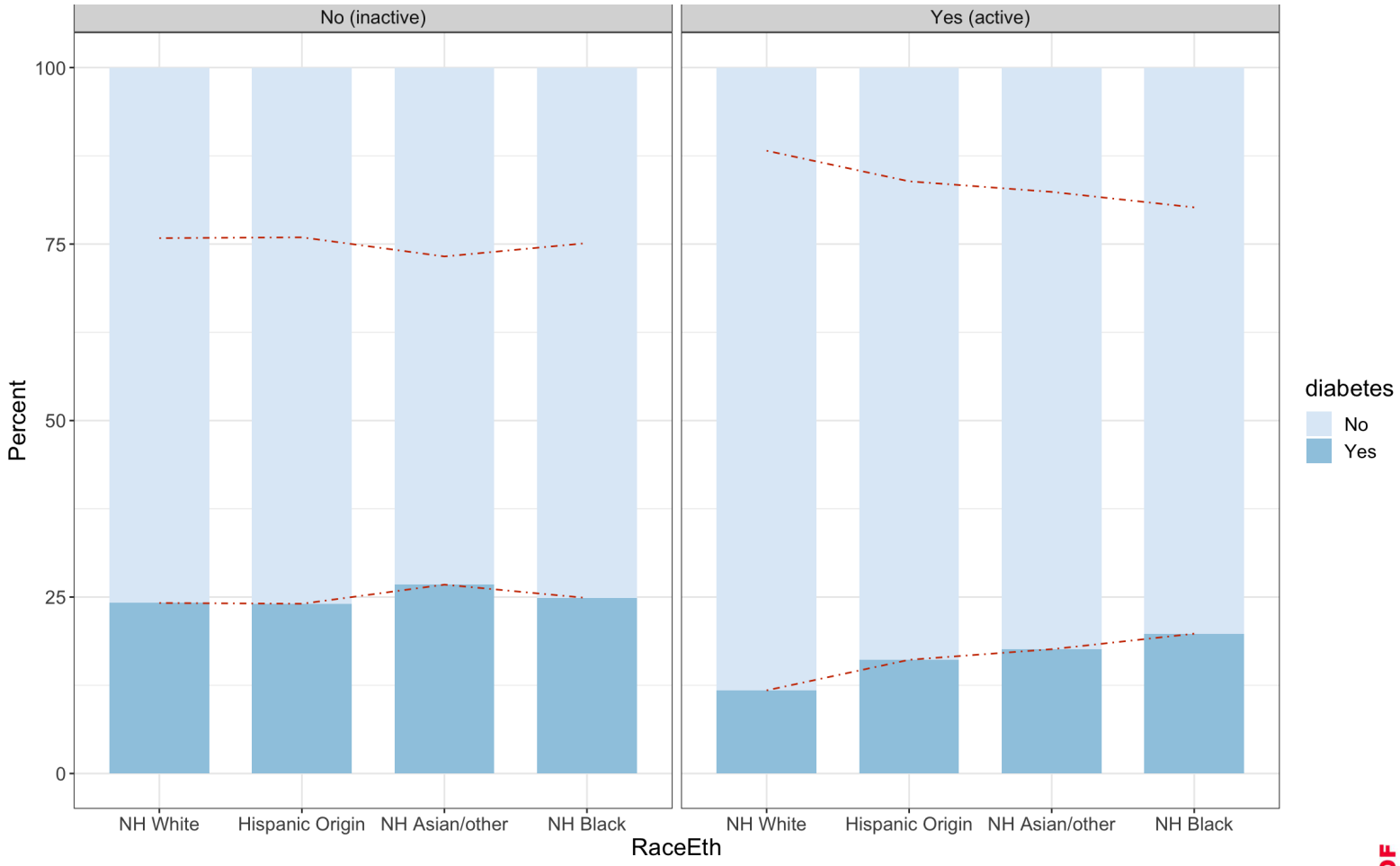
Bivariate Analysis (Continued)

Unparallel crude subgroup curves indicate the differences in prevalence of diabetes among race groups vary by PRA status.

i.e. ***Race/Ethnicity*** appears to be an **Effect Modifier** for Physical Recreation Activity on Diabetes outcome.

FIGURE 2. Prevalence of Diabetes Among Race/Ethnicity Groups by Physical Recreation Activity



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Multi-variate Analysis

(Ordinary Logistic Regression Model)

- Variable selection : Stepwise, Significance threshold $\alpha = 0.05$
- Software : R-Studio version 3.6.2
- Base model includes ***PRA, Diet, BMI, HBP, Depression, Age, Race/Ethnicity, Gender, Health Insurance,*** and ***PRA by Race/Ethnicity*** interaction

TABLE 3. Multivariate Analysis : Risk Factors Associated with Diabetes (Logit Model, NHANES 2017-2018)

	MODEL 1: Base Model (Unweighted)				**MODEL 2 :** Reduced Model (Unweighted)				**MODEL 3:** Reduced Model (Svy-Weighted)				**MODEL 4:** Final Model (Svy-Weighted)			
Predictors	**Est.**	**OR**	**95% CI**	**p**	**Est.**	**OR**	**95% CI**	**p-value**	**Est.**	**OR**	**95% CI**	**p-value**	**Est.**	**OR**	**95% CI**	**p-value**
(Intercept)	-3.985	0.02	0.01 – 0.03	<0.001	-3.885	0.02	0.01 – 0.03	<0.001	-3.801	0.02	0.01 – 0.04	0.043	-3.894	0.02	0.01 – 0.03	<0.001
pa [Yes]	-0.663	0.52	0.38 – 0.69	<0.001	-0.574	0.56	0.43 – 0.74	**<0.001**	-0.667	0.51	0.36 – 0.73	0.169	-0.453	0.64	0.51 – 0.80	**0.018**
diet [Poor/Fair]	0.106	1.11	0.92 – 1.34	0.269												
diet [Very good/Excellent]	-0.136	0.87	0.71 – 1.07	0.186												
bmi_cat [underweight]	-1.422	0.24	0.04 – 0.81	0.054	-1.609	0.20	0.03 – 0.66	**0.028**	0.614	1.85	0.26 – 12.98	0.648	0.617	1.85	0.26 – 13.46	0.575
bmi_cat [overweight]	0.421	1.52	1.20 – 1.94	0.001	0.437	1.55	1.25 – 1.93	**<0.001**	0.465	1.59	1.14 – 2.22	0.222	0.483	1.62	1.15 – 2.29	0.051
bmi_cat [Obese]	1.142	3.13	2.49 – 3.97	<0.001	1.190	3.29	2.67 – 4.07	**<0.001**	1.340	3.82	2.64 – 5.52	**0.089**	1.359	3.89	2.68 – 5.65	**0.002**
hbp [Yes]	0.042	1.04	0.89 – 1.23	0.611												
depressed [Mod/Severe]	0.260	1.30	1.00 – 1.68	0.05	0.326	1.39	1.10 – 1.75	**0.006**	0.334	1.4	1.05 – 1.87	0.265	0.330	1.39	1.04 – 1.87	0.092
age_cat [40-61]	1.758	5.80	4.41 – 7.74	<0.001	1.779	5.92	4.61 – 7.71	**<0.001**	1.602	4.96	4.02 – 6.13	**0.043**	1.587	4.89	3.96 – 6.04	**<0.001**
age_cat [62+]	2.663	14.34	10.81 – 19.28	<0.001	2.695	14.80	11.51 – 19.28	**<0.001**	2.462	11.73	7.67 – 17.92	**0.056**	2.436	11.43	7.54 – 17.32	**<0.001**
RaceEth [Hispanic Origin]	0.285	1.33	1.01 – 1.75	0.043	0.285	1.33	1.04 – 1.70	**0.024**	0.056	1.06	0.80 – 1.41	0.766	0.232	1.26	0.98 – 1.63	0.149
RaceEth [NH Asian/other]	0.674	1.96	1.45 – 2.65	<0.001	0.698	2.01	1.53 – 2.65	**<0.001**	0.418	1.52	1.03 – 2.25	0.285	0.676	1.97	1.44 – 2.68	**0.013**
RaceEth [NH Black]	0.326	1.39	1.06 – 1.82	0.019	0.224	1.25	0.98 – 1.60	0.075	0.143	1.15	0.89 – 1.49	0.473	0.410	1.51	1.19 – 1.90	**0.026**
RIAGENDR [Female]	-0.286	0.75	0.64 – 0.88	<0.001	-0.242	0.78	0.68 – 0.91	**0.001**	-0.271	0.76	0.61 – 0.96	0.258	-0.266	0.77	0.61 – 0.97	0.092
income [20-55K]	0.139	1.15	0.92 – 1.43	0.212												
income [55-100K+]	0.154	1.17	0.93 – 1.47	0.189												
HIQ011 [Insured]	0.038	1.04	0.80 – 1.36	0.774												
pa [Yes] *RaceEth [Hispanic Origin]	0.526	1.69	1.08 – 2.66	0.023	0.387	1.47	0.97 – 2.22	0.066	0.444	1.56	1.09 – 2.22	0.246	(REMOVED)			
pa [Yes] *RaceEth [NH Asian/other]	0.576	1.78	1.14 – 2.79	0.012	0.438	1.55	1.02 – 2.35	**0.039**	0.577	1.78	0.76 – 4.18	0.411	Working (Rao-Scott+F) LRT			
pa [Yes] *RaceEth [NH Black]	0.531	1.70	1.10 – 2.62	0.016	0.530	1.70	1.14 – 2.53	**0.009**	0.636	1.89	1.11 – 3.22	0.257	p= 0.39029			
Observations	4581				5430				5430				5430			
R^2 Tjur	0.161				0.161				0.162 / -4549.256				0.160 / -1139.754			
Prob. of having diabetes for ref. group	plogis(-3.98495) = 0.0183				plogis(-3.88495) = 0.0201				plogis(-3.8009) = 0.0219				plogis(-3.8936) = 0.0200			

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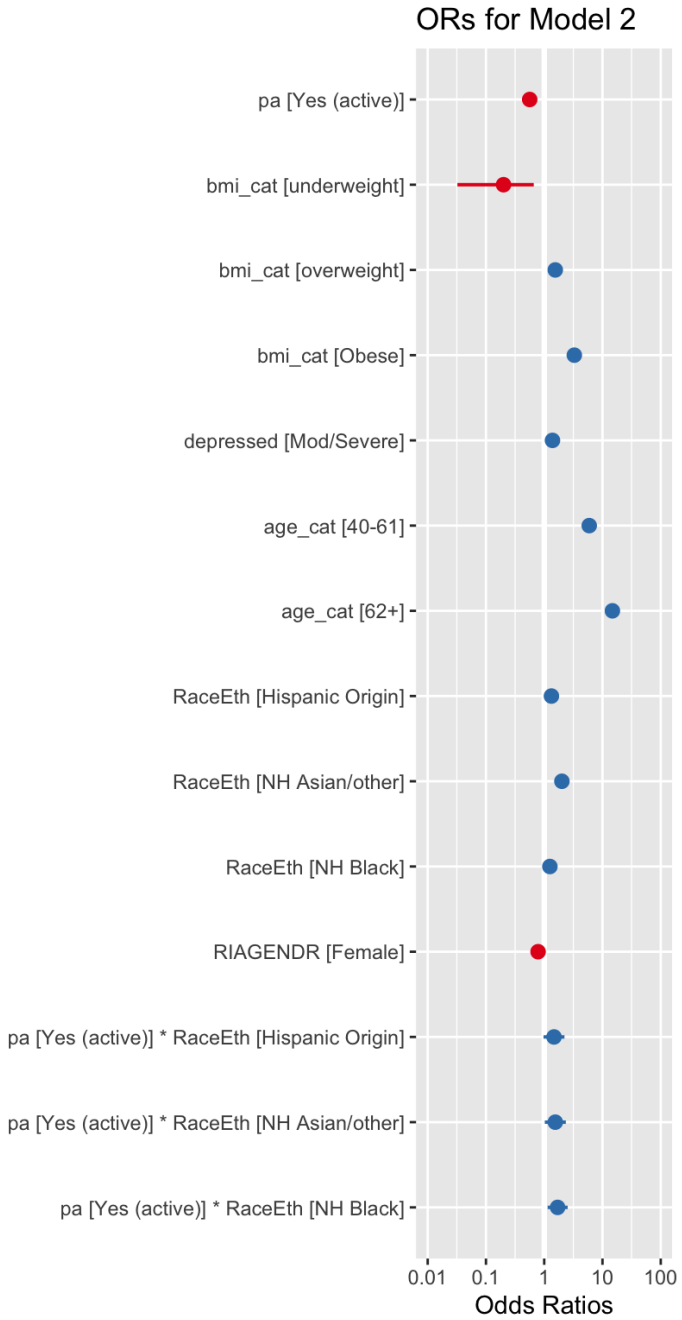
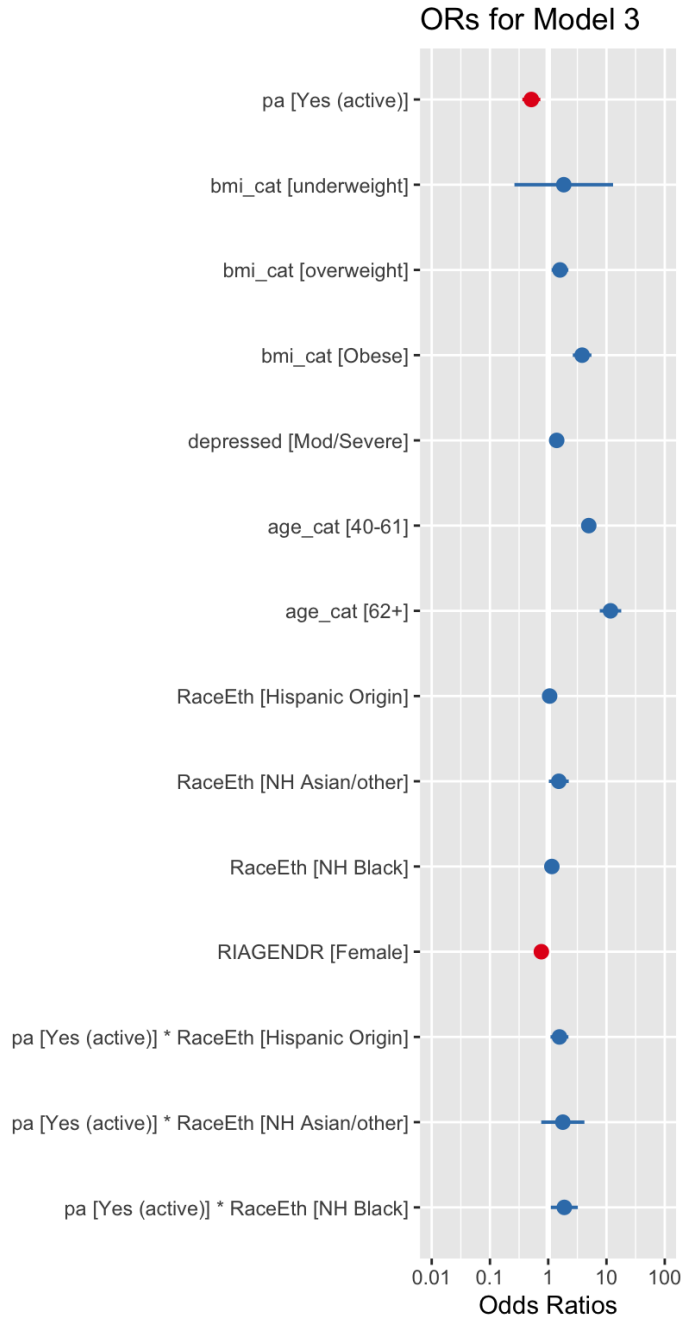
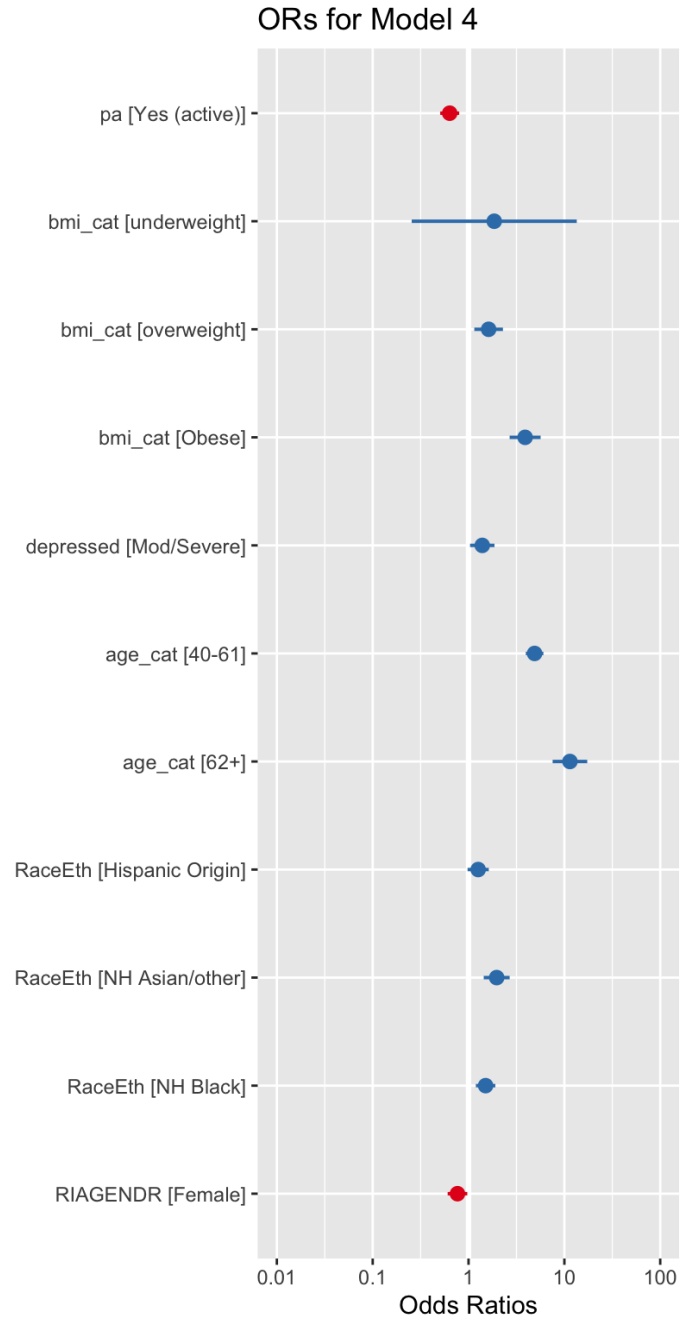
FIRUTE 3. Forest Plot : Risk Ratios for Diabetes vs. Non-Diabetes [Model 2 – Model 4]







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Results and Conclusions

- The ***Physical Recreational Activity*** by ***Race/Ethnicity*** interaction was present in the unweighted model, suggesting the PRA protective effect on diabetes is significantly less pronounced in non-Hispanic Blacks or non-Hispanic Asian/Other groups as compared to non-Hispanic Whites (reference).
- However, the modifying effect of race/ethnicity was not observed in the survey-weighted analysis.

- The survey-weighted final model (see Model 4 in TABLE 3) revealed that ***Physical Recreation Activity***, ***Obesity*** , ***Age*** *and* ***Race/Ethnicity*** were the strongest predictors for probability of developing diabetes, adjusting for other variables in the model.
- Compared with those of sedentary lifestyle, individuals undergoing moderate or vigorous recreational activity had lower risk of diabetes (OR and 95% CI 0.64 [0.51, 0.80], P-value=0.018).
- Obesity, aging, being non-Hispanic Blacks or non-Hispanic Asian/Other ethnic origin were associated with significantly higher risk of diabetes.

Limitations and Further Topics

- Not able to include important variable ***Family history*** due to considerable missing.
- Since 2017-2018 ***Energy/Carbohydrate intake*** data are not available yet, more subjective self-reported diet data were used in the analysis.
- Automatic stepwise variable selection was not applicable to survey-weighted data possibly due to relatively large regression model, therefore only a complete training set of unweighted sample with total 4581 observations was used instead.
- The inconsistency between some of the adjusted P-values and CI generated from **svyglm()** is worth further investigation.

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