Socioeconomic Status and Use of Obesogenic and Anti-obesity Medications in the United States—A Population-based Study

Beini Lyu[1], MD, PhD, Alex R. Chang[2], MD, Lesley A. Inker[3], MD, Elizabeth Selvin[1,4], PhD, Morgan E. Grams[1,4,5,6], MD, PhD, Jung-Im Shin[1,5,6], MD, PhD

1. Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD
2. Kidney Health Research Institute, Geisinger Health System, Danville, PA
3. Division of Nephrology, Tufts Medical Center, Boston, MA
4. Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, MD
5. Center for Drug Safety and Effectiveness, Johns Hopkins University, Baltimore, MD
6. Welch Center for Prevention, Epidemiology and Clinical Research, Johns Hopkins University, Baltimore, MD

Correspondence

Dr. Jung-Im Shin

2024 E. Monument Street

Suite 2-600 (room 2-204)

Baltimore, Maryland 21205

Email: jshin19@jhmi.edu

Phone: 443-287-7262

Tables of contents

Supplemental Table 1. List of obesogenic medications and potential alternatives[##]

Medication class	Obesogenic medication*	Examples of weight-neutral or leptogenic alternatives*
Anticonvulsants	Carbamazepine, Gabapentin, Pregabalin, Valproic acid, vigabatrin, Carbamazepine	Felbamate, Topiramate, Zonisamide, Lamotrigine, Levetiracetam, Phenytoin.
Antidepressants/ antianxiety	Amitriptyline, Mirtazapine, Nortriptyline, Paroxetine, Doxepin, Escitalopram	Fluoxetine, Imipramine, Sertraline, Citalopram or Escitalopram, Bupropion
Antipsychotics	Olanzapine, Quetiapine, Risperidone, Clozapine, perphenazine	Ziprasidone[#]
Beta-blockers	Atenolol, Metoprolol, Propanolol	Carvedilol. ACE inhibitors, ARBs, and calcium channel blockers for hypertension.
Corticosteroids	Prednisone, Hydrocortisone, Methylprednisolone, Prednisolone	Nonsteroidal anti-inflammatory drugs and disease-modifying antirheumatic drugs when possible, in patients with chronic inflammatory disease.
Antidiabetic medications	Insulin, Sulfonylureas, Thiazolidinediones, Meglitinides	Metformin, dipeptidyl peptidase-4 inhibitors, GLP-1 receptor agonists, SGLT-2 inhibitors
anti-obesity medications	Naltrexone-bupropion, Phentermine-topiramate, Lorcaserin**, Benzphetamine, Diethylpropion, Phendimetrazine, Orlistat, Phentermine, Liraglutide 3mg, Sibutramine**	

* List obesogenic medications and potential alternatives was identified in reference to the Pharmacological management of obesity: an Endocrine Society clinical practice guideline. 2015.

** Lorcaserin was withdrawn from the market in 2020 and sibutamine was withdrawn from the market in 2010.

[#]Some evidence suggested that Ziprasidone may also be associated with weight gain but the weight gain effect of Ziprasidone was the least compared with other antipsychotics.

[##]It is worth noting that for many of these alternatives, there is limited high quality evidence on the long-term weight change effects.

Supplemental Table 2. Sensitivity analysis without adjusting for race/ethnicity

	Odds ratio (95% confidence interval) for use of obesogenic medications		
	Crude model	**Model 1**	**Model 2**
Composite SES			
Low	1.7 (1.5, 1.9)	1.5 (1.4, 1.8)	1.3 (1.2, 1.5)
Intermediate	1.8 (1.6, 2.0)	1.2 (1.03,1.4)	1.1 (0.96, 1.3)
High	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Education			
<High school	2.0 (1.7, 2.3)	1.4 (1.2, 1.7)	1.2 (1.02, 1.4)
High school graduate	1.7 (1.4, 2.0)	1.4 (1.2, 1.7)	1.2 (0.99, 1.4)
Some college	1.5 (1.3, 1.7)	1.3 (1.1, 1.6)	1.2 (1.01, 1.5)
College graduate or above	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Household income			
Below poverty level	1.5 (1.3, 1.7)	1.3 (1.1, 1.5)	1.2 (1.04, 1.4)
Equal or above poverty level	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Insurance type			
No insurance	1.0 (0.9, 1.2)	1.6 (1.4, 1.9)	1.4 (1.2, 1.7)
Public insurance only	2.0 (1.7, 2.2)	1.3 (1.1, 1.4)	1.2 (1.02, 1.3)
Private insurance	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)

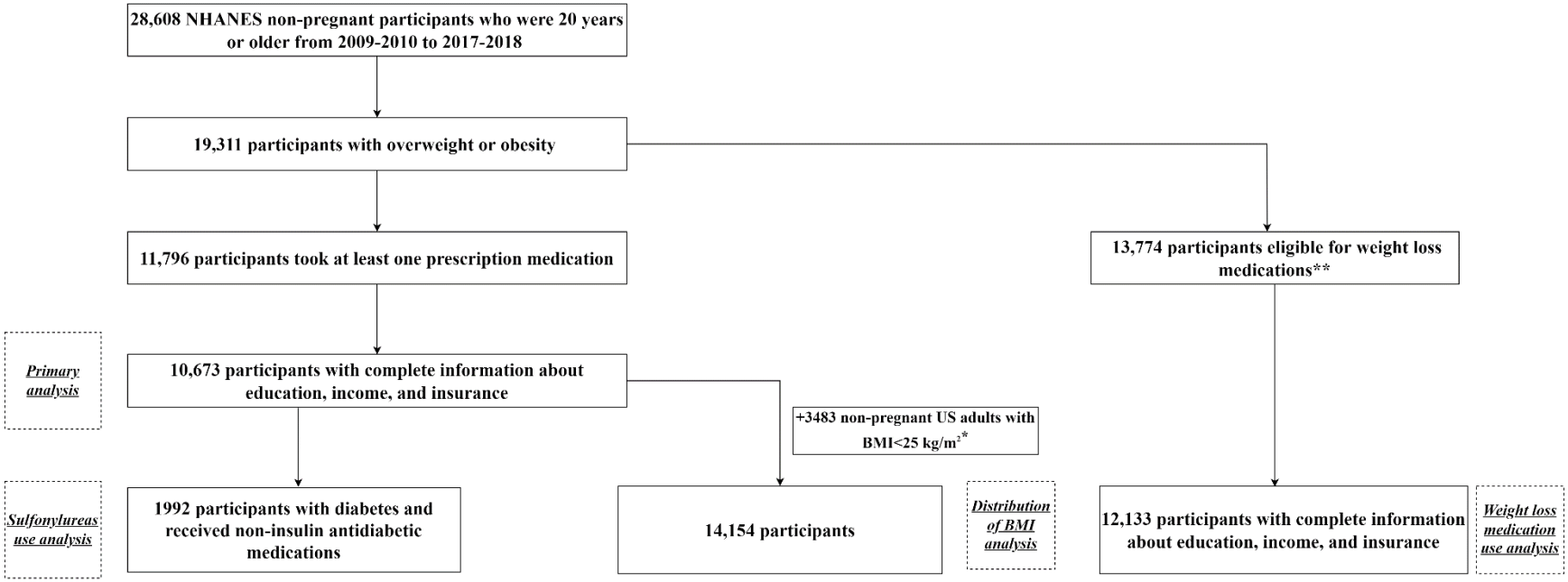
Model 1 adjusted for age, sex, and number of prescription medications.

Model 2 further adjusted for diabetes, depression, hypertension, cardiovascular disease, and arthritis.

Supplemental Table 3. Sensitivity analysis with stratification by race/ethnicity

	Odds ratio (95% confidence interval) for the use of obesogenic medications				
	Total population	**Race/ethnicity**			
		Non-Hispanic white	**Non-Hispanic black**	**Mexican American**	**Others**
Composite SES					
Low	1.3 (1.2, 1.5)	1.6 (1.3, 2.0)	1.2 (0.8, 1.6)	1.4 (1.0, 1.9)	1.9 (1.1, 3.0)
Intermediate	1.1 (0.96, 1.3)	1.1 (0.9, 1.3)	1.2 (0.8, 1.5)	1.2 (0.9, 1.6)	1.1 (0.6, 1.9)
High	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)

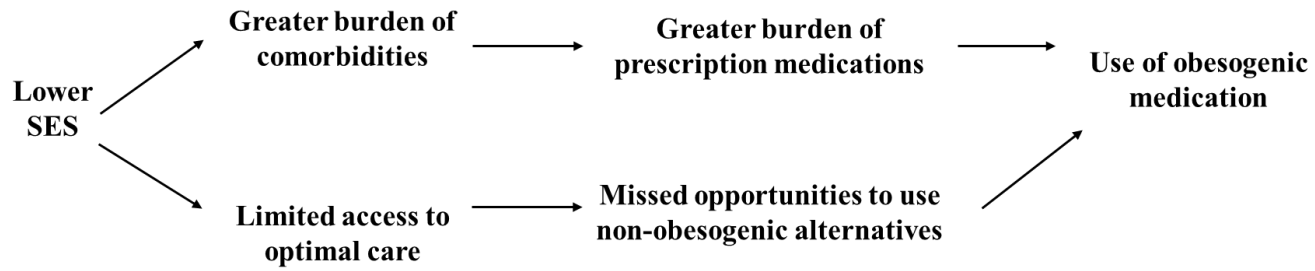
Adjusted for age, sex, number of prescription medications, diabetes, depression, hypertension, cardiovascular disease, and arthritis.



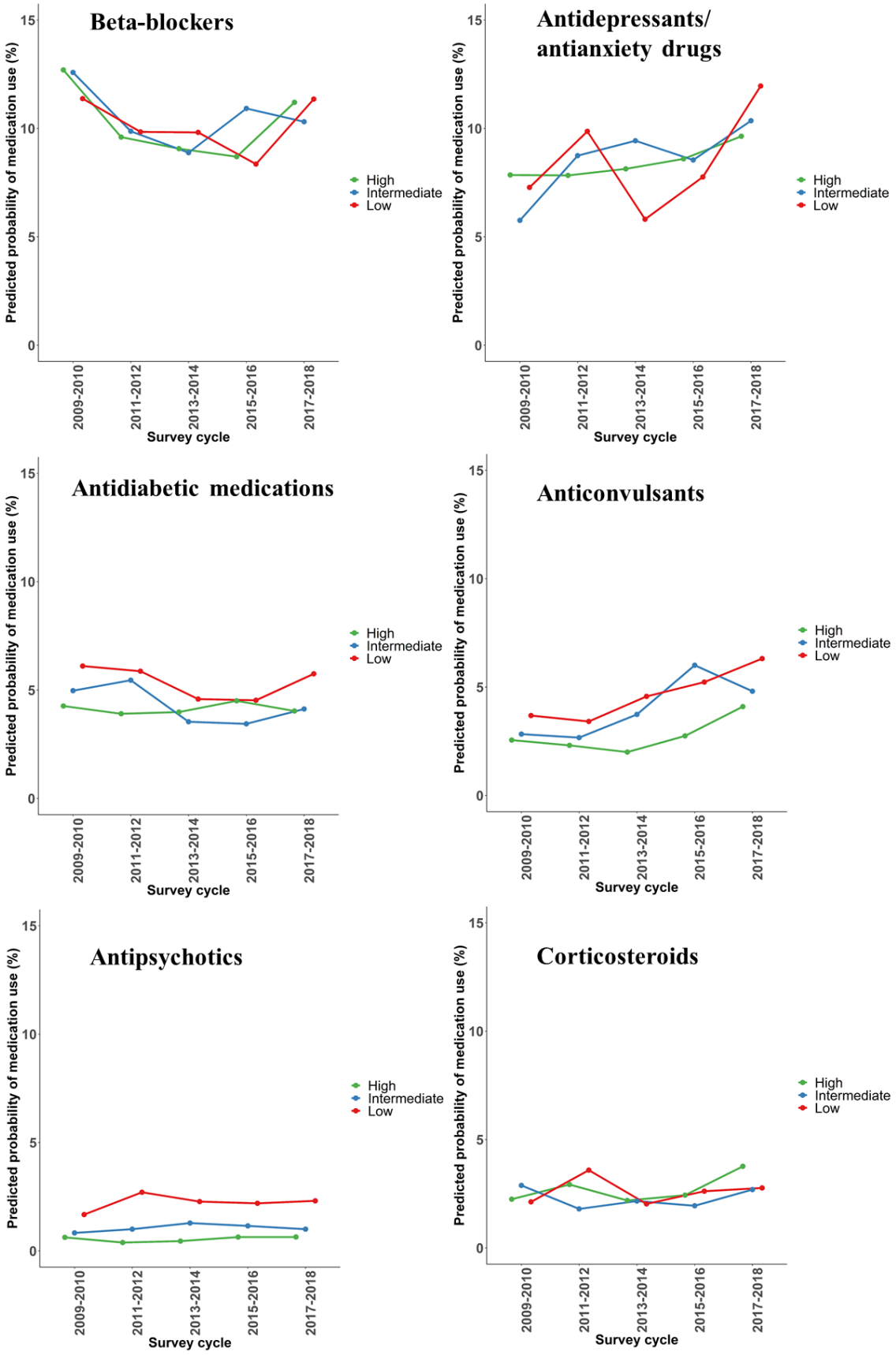
Supplemental Figure 1. Participants flow chart.

*3483 participants with BMI <25kg/m^2 with health insurance, took at least one prescription medication, and had complete information about education, income, and insurance.

**Defined as participants with a BMI ≥30kg/m^2 or with a BMI 27-29.9 kg/m^2 and at least 1 obesity-related comorbidity (hypertension, diabetes, dyslipidemia, or cardiovascular disease).

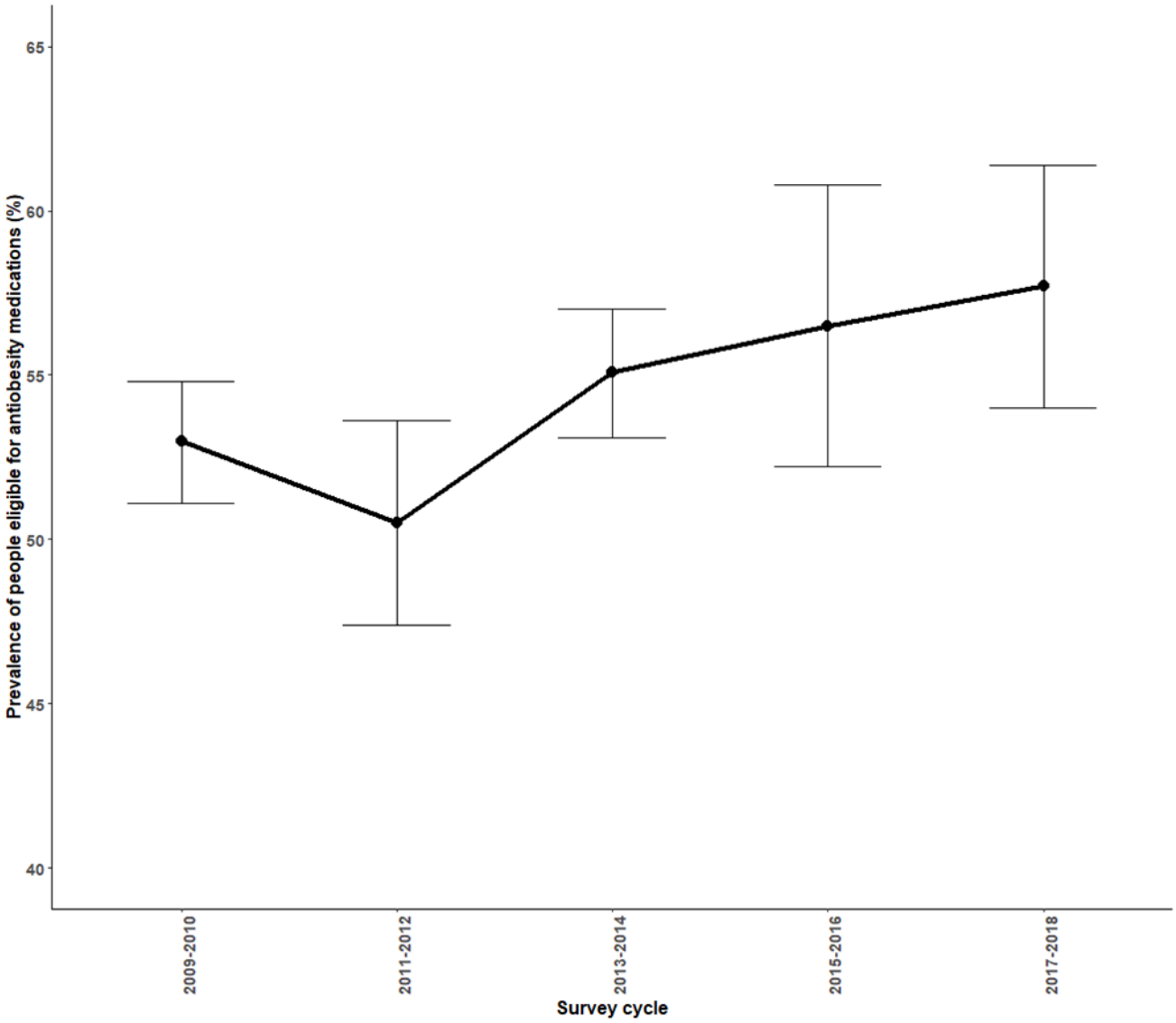


Supplemental Figure 2. Potential pathways between lower SES and use of obesogenic medication.


Beta-blockers
Antidepressants/ antianxiety drugs
Antidiabetic medications
Anticonvulsants
Antipsychotics
Corticosteroids
Predicted probability of medication use (%)
Survey cycle
2009-2010
2011-2012
2013-2014
2015-2016
2017-2018
High
Intermediate
Low

Supplemental Figure 3. Adjusted* predicted probability of use of obesogenic medications by medication class among US adults who had overweight or obesity and took at least one prescription medication by (a) composite SES, (b) education, (c) household income, and (d) type of health insurance, NHANES 2009-2018.

*Adjusted for age, sex, race/ethnicity, number of prescription medications and comorbidities.



Supplemental Figure 4. Prevalence (95% confidence interval) of US adults who were eligible for anti-obesity medications*, NHANES 2009-2018