Obesity in the United States and economic intervention options: A study linking ecological epidemiology and system dynamics modeling

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Table S1. The flow rates of transition across body weight and socioeconomic status (SES) among the US adults: Medical Expenditure Panel Survey (MEPS) 2001-2010^

Transition*:	Year										Average rate**
	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	
Normal weight became overweight	15.4%	15.2%	14.4%	15.1%	15.6%	14.2%	15.1%	14.6%	15.6%	14.8%	15.0%
Normal weight became obese	1.5%	0.9%	0.9%	0.8%	1.0%	1.2%	1.5%	1.4%	1.0%	1.3%	1.2%
Overweight became normal weight	12.9%	12.8%	13.2%	13.1%	12.6%	13.1%	12.0%	12.7%	13.1%	13.4%	12.9%
Overweight became obese	12.9%	13.0%	13.1%	12.3%	13.3%	12.9%	14.9%	12.7%	13.5%	13.8%	13.2%
Obese became normal weight	1.6%	1.3%	1.2%	2.2%	1.5%	0.9%	0.8%	1.3%	1.8%	1.0%	1.4%
Obese became overweight	15.0%	16.2%	14.0%	13.4%	12.8%	12.9%	16.0%	13.6%	15.3%	12.3%	14.2%
Family income from low to middle	24.4%	22.0%	22.0%	24.5%	25.2%	24.9%	23.7%	21.2%	22.3%	19.5%	23.0%
Family income from low to high	7.8%	5.3%	4.8%	5.9%	5.4%	5.6%	7.0%	6.0%	6.2%	6.1%	6.0%
Family income from middle to low	18.5%	17.1%	16.2%	16.6%	15.5%	16.3%	19.6%	18.2%	18.7%	16.7%	17.3%
Family income from middle to high	22.0%	24.8%	24.3%	23.8%	27.3%	24.2%	27.2%	24.4%	24.6%	22.8%	24.5%
Family income from high to low	4.2%	3.8%	3.4%	2.7%	3.3%	3.6%	3.9%	4.7%	4.1%	3.1%	3.7%
Family income from high to middle	14.6%	14.7%	16.3%	13.5%	14.8%	13.8%	16.2%	15.1%	15.9%	14.7%	14.9%
Employed to unemployed	1.0%	1.0%	1.3%	0.9%	1.0%	1.1%	1.1%	1.7%	1.4%	1.4%	1.2%
Employed to not in labor force	0.3%	0.3%	0.4%	0.2%	0.3%	0.2%	0.3%	0.4%	0.3%	0.3%	0.3%
Unemployed to employed	8.5%	8.6%	9.4%	7.8%	8.9%	8.8%	7.5%	8.3%	10.8%	8.8%	8.8%
Unemployed to not in labor force	0.3%	0.7%	0.1%	0.4%	0.2%	0.2%	0.1%	0.0%	0.2%	0.2%	0.2%
Not in labor force to employed	11.0%	16.4%	9.5%	9.3%	11.6%	9.3%	9.0%	6.4%	9.5%	9.1%	10.1%
Not in labor force to unemployed	0.1%	0.0%	0.3%	0.5%	1.1%	0.5%	0.1%	0.5%	0.0%	0.0%	0.3%

^State transitions were based on comparison of the states at the ends of the two consecutive years. For example, from the end of 2001 to the end of 2002, 15.1% of normal weight adults became overweight.

**Arithmetic average

Table S2. The baseline distributions of body weight status and SES in the US by year of cohort: Medical Expenditure Panel Survey (MEPS) 2001-2010^

	Baseline year of cohorts									
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Normal weight	39.0%	38.1%	37.6%	38.2%	36.7%	36.5%	34.8%	34.8%	33.0%	33.6%
Overweight	35.9%	36.2%	35.5%	34.8%	35.1%	34.9%	35.1%	35.1%	35.7%	35.1%
Obese	25.0%	25.7%	26.9%	27.0%	28.1%	28.6%	30.1%	30.1%	31.2%	31.3%
Low income	25.3%	24.3%	26.0%	28.2%	27.3%	27.3%	27.1%	27.9%	30.1%	30.5%
Middle income	31.5%	32.3%	31.5%	31.4%	31.4%	30.9%	33.4%	31.5%	30.8%	31.7%
High income	43.2%	43.4%	42.5%	40.4%	41.3%	41.8%	39.5%	40.6%	39.2%	37.8%
Employed	82.1%	82.2%	81.7%	80.6%	81.1%	81.6%	82.1%	80.8%	78.3%	78.8%
Not in labor force	4.7%	4.6%	4.9%	5.4%	5.2%	5.2%	5.8%	5.0%	6.1%	6.9%
Unemployed	13.2%	13.2%	13.4%	13.9%	13.8%	13.1%	12.0%	14.2%	15.7%	14.2%

^For each year, the results are based on survey measurements at the end of the years

Normal weight, BMI<25; overweight, BMI≥25 and <30; obese, BMI≥30.

Low income, family income <200% federal poverty line (FPL); middle income, family income ≥200% and <400% FPL; high income, family income ≥400% FPL.

Table S3. The equations and parameters used for system dynamics model setup

Logit (Flow rate)	Parameter/equation	Number of predictors in the equation
1. Normal to overweight	=-1.7347	0
2. Normal to obese	=-4.4545	0
3. Overweight to normal weight	=-0.8076 - 3.4816 * Middle income	1
4. Overweight to obese	=-2.8617 + 4.8315 * Middle income - 1.5165 * Normal weight	2
5. Obese to normal weight	=-12.4697 + 31.5337 * Unemployed + 10.6137 * Normal weight	2
6. Obese to overweight	=-9.1421 + 8.7471 * Middle income + 12.9377 * Overweight	2
7. Employed to unemployed	=-1.6476 - 7.7052 * Normal weight	1
8. Employed to not in labor force	=-5.8527	0
9. Unemployed to employed	=-3.4508 + 8.0671 * Unemployed	1
10. Unemployed to not in labor force	=-6.1359	0
11. Not in labor force to employed	=-15.5877 + 37.8222 * Overweight	1
12. Not in labor force to unemployed	=90.3792 -117.9005 * Employed	1
13. Family income low to middle	=-1.2215	0
14. Family income low to high	=-2.7626	0
15. Family income middle to low	=-1.5634	0
16. Family income middle to high	=-1.1192	0
17. Family income high to middle	=-1.7401	0
18. Family income high to low	=-3.2773	0

*All the equations were the result of stepwise model selection based on the MEPS data. Flow rates are at logit scale, which were then converted into probability scale in system dynamics model. All the predictors are the prevalence of the SES/weight status in the previous year.

Figure S1. The system dynamics between population body weight status and SES (income and employment status): based on the Medical Expenditure Panel Survey (MEPS) 2001-2010 data
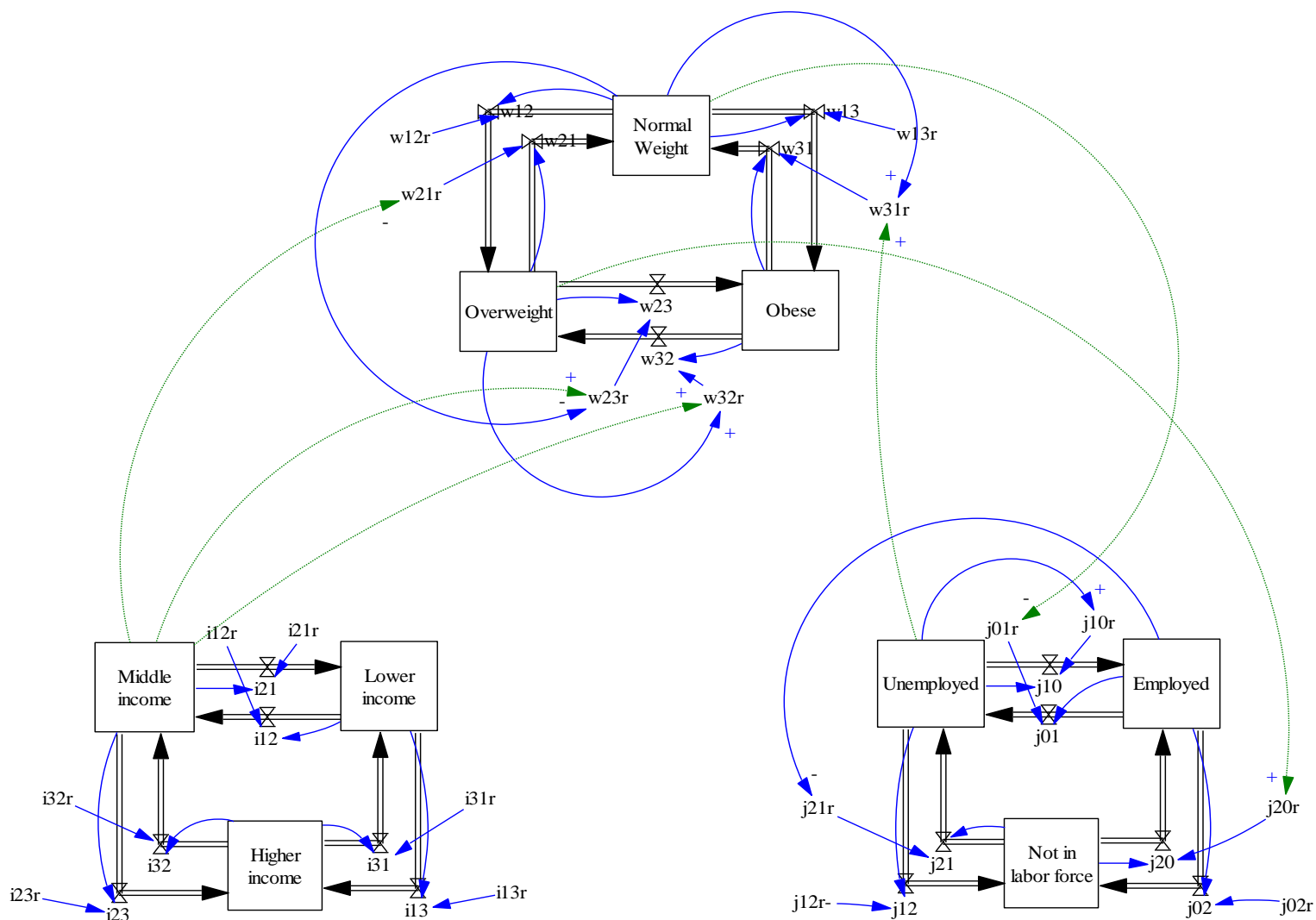
Green dashed arrows: the crosstalk pathways between subsystems, the significant predictors in Table S3 that predict flows in another subsystem. Predictors in Table S3 that predict flows within the same subsystem are shown as blue arrows with a +/- sign.

+: up regulate; -: down regulate

Denotations: prefix i for $i$ncome change, j for employment/$j$ob status change, w for $w$eight status change; suffix r for flow $r$ate; the numbers denoting the statuses. For example, $w21$ denotes the flow overweight (*2*) returning normal weight (*1*) state, which is the product of $w21r$ and the prevalence of overweight in previous year.

Figure S2. Simulated flow of job dynamics: status quo and experiment 2*
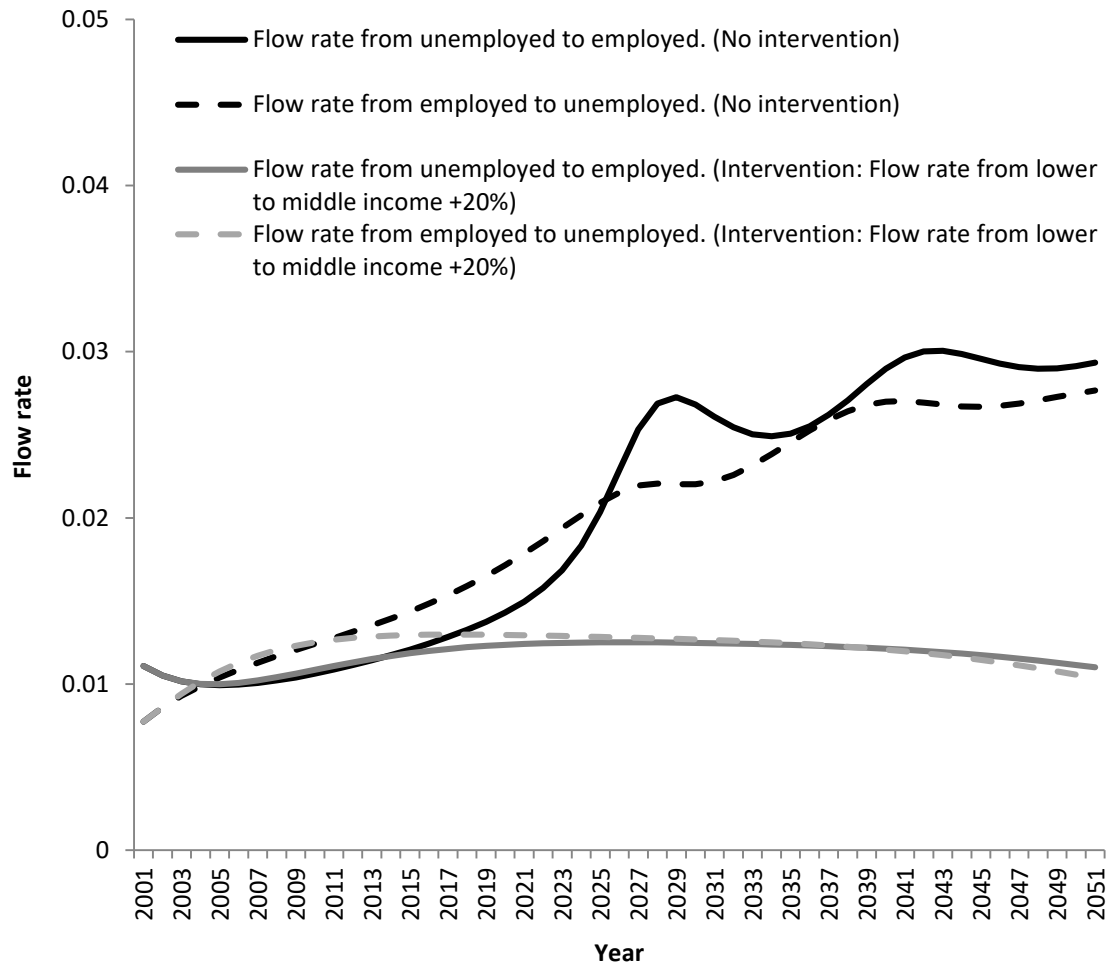
*Experiment 2: Improving the flow rate from lower to middle income

Figure S3. Comparing simulated and empirical* prevalence of overweight and obesity

$y = 0.998x - 3.222$
$R^2 = 0.9499$

Prevalence of overweight and obesity, BRFSS 2001-2013 (%)

Simulated prevalence of overweight and obesity (%)
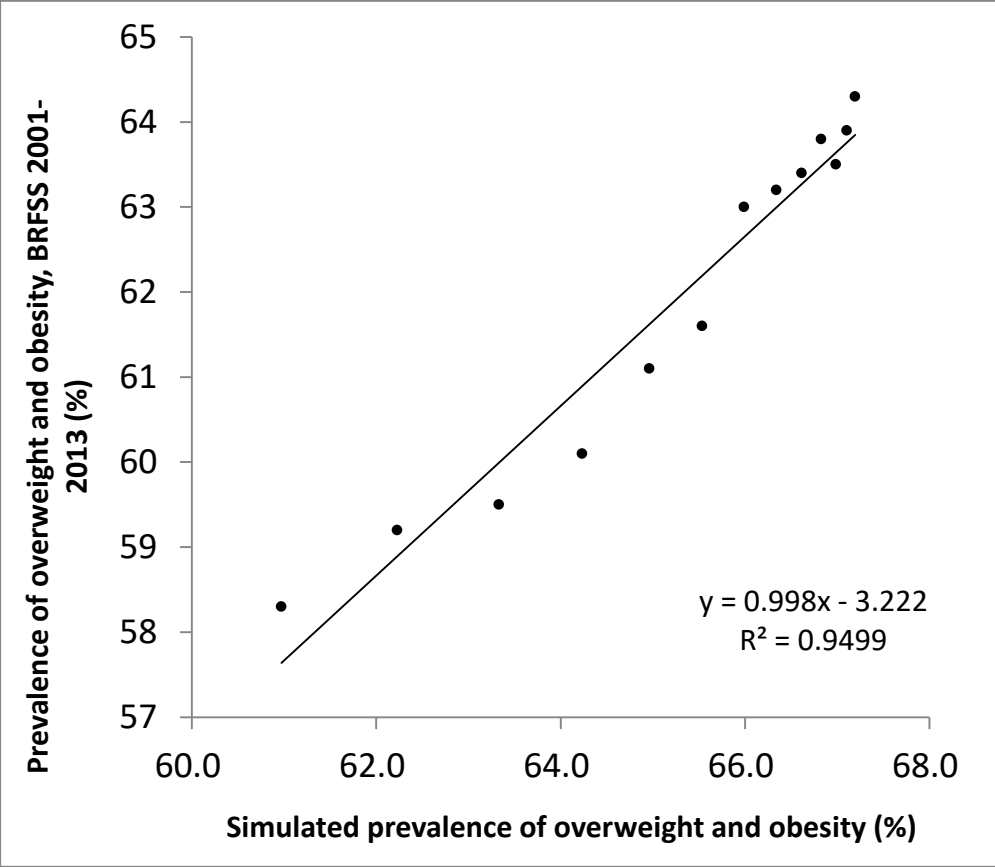
* Empirical data from the U.S. Behavioral Risk Factor Surveillance Systems, 2001-2013.

Figure S4 Sensitivity simulations of predicted prevalence of overweight and obesity.