

Table S1 —Adiposity measures by continuous sleep duration, efficiency, and variability per 1 SD: the Multi-Ethnic Study of Atherosclerosis 2010-2013						
	Sleep Duration		Sleep Efficiency		Sleep Duration Variability	
	Continuous per 1 SD	P for linear trend	Continuous per 1 SD	P for linear trend	Continuous per 1 SD	P for linear trend
BMI (kg/m²)						
Model 1	-0.58	<0.001	-0.45	<0.001	0.29	0.012
Model 2	-0.56	<0.001	-0.43	<0.001	0.34	0.005
Model 3	n/a		-0.33	0.008	0.23	0.062
Waist circumference (cm)						
Model 1	-1.30	<0.001	-1.27	<0.001	0.84	0.005
Model 2	-1.17	<0.001	-1.21	<0.001	0.94	0.003
Model 3	n/a		-1.00	0.002	0.73	0.025
Total body fat (kg)						
Model 1	-0.88	<0.001	-0.90	<0.001	0.64	0.004
Model 2	-0.81	0.001	-0.82	<0.001	0.73	0.002
Model 3	n/a		-0.68	0.004	0.58	0.014

Sleep duration variability is defined as the within-person standard deviation of sleep duration and is measured in minutes

Model 1 adjusted for age, sex, race, and field center

Model 2 adjusted for model 1, plus depressive symptoms, anti-depressants, alcohol use, sleep medication, smoking, income, marital status, and education

Model 3 adjusted for model 2, plus sleep duration

Table S2—Adjusted means of adiposity measures by categories of sleep duration, efficiency and variability restricted to those without sleep apnea (AHI<15): the Multi-Ethnic Study of Atherosclerosis 2011-2013

Sleep Duration	<5 hours	5-6 hours	6-7 hours	7-8 hours	>8 hours	P for trend
<i>N</i>	135	241	427	354 (Referent)	143	
BMI						
Model 1	28.4*	28.3 **	27.7	27.2	27.7	0.009
Model 2	28.3*	28.4**	27.8	27.2	27.8	0.028
Waist Circumference						
Model 1	98.2*	98.2*	96.9	95.4	97.2	0.058
Model 2	97.6	98.2*	97.1	95.5	97.8	0.214
Total Body Fat						
Model 1	24.5	24.7*	23.8	22.9	23.6	0.049
Model 2	24.3	24.8*	23.9	23.0	23.9	0.128
Sleep Efficiency						
<i>N</i>	<85%	85-87.9%	87.9-90.4%	90.4%-92.4%	>92.4%	
<i>N</i>	105	175	321	341	358 (Referent)	
BMI						
Model 1	27.5	29.0***	27.9	27.6	27.3	0.010
Model 2	27.4	29.1***	28.0	27.5	27.4	0.018
Model 3	27.2	29.1***	28.0	27.6	27.4	0.043
Waist Circumference						
Model 1	96.8	100.1***	97.3	96.6	95.3	0.003
Model 2	96.1	100.3***	97.5	96.6	95.5	0.015
Model 3	95.9	100.3***	97.5	96.6	95.6	0.021
Total Body Fat						
Model 1	23.8	25.9***	24.0	23.5	22.8	0.005
Model 2	23.4	26.1***	24.2	23.4	23.0	0.014
Model 3	23.2	26.1**	24.2	23.4	23.0	0.026
Sleep Duration Variability						
<i>N</i>	<=48	48-70	70-99	99-262		
<i>N</i>	335 (Referent)	348	301	316		
BMI						
Model 1	27.5	27.8	27.8	28.0		0.245
Model 2	27.6	27.8	27.8	28.1		0.272
Model 3	27.7	27.9	27.7	27.9		0.670
Waist Circumference						
Model 1	95.8	97.1	97.2	97.6		0.090
Model 2	96.0	97.1	97.0	97.9		0.110
Model 3	96.2	97.2	97.0	97.7		0.239
Total Body Fat						
Model 1	23.2	23.7	23.9	24.3		0.124
Model 2	23.3	23.8	23.8	24.5		0.139
Model 3	23.5	23.9	23.8	24.4		0.306

Sleep duration variability is defined as the within-person standard deviation of sleep duration and is measured in minutes.

*p<0.05, **p<0.01, ***p<0.001

Model 1 adjusted for age, sex, race, and field center

Model 2 adjusted for model 1, plus depressive symptoms, anti-depressants, alcohol use, sleep medication, smoking, income, marital status, and education

Model 3 adjusted for model 2, plus sleep duration

Table S3—Sleep efficiency and adiposity stratified by sex: the Multi-Ethnic Study of Atherosclerosis

BMI	<85%	85-87.9%	87.9-90.4%	90.4%-92.4%	>92.4% (Referent)	P for interaction
Model 1						0.0074
Men	28.7 (28.0, 29.5)	28.5 (27.9, 29.1)	28.2 (27.6, 28.7)	28.5 (28.0, 29.1)	28.2 (27.6, 28.7)	
Women	30.0 (28.7, 31.3)*	30.5 (29.6, 31.5)***	29.4 (28.7, 30.0)*	28.9 (28.3, 29.6)	28.3 (27.7, 28.9)	
Model 2						0.0050
Men	28.5 (27.7, 29.3)	28.6 (27.9, 29.2)	28.3 (27.7, 28.9)	28.6 (28.0, 29.2)	28.3 (27.7, 28.9)	
Women	30.0 (28.6, 31.3)*	30.6 (29.6, 31.5)***	29.6 (28.9, 30.2)*	28.8 (28.2, 29.5)	28.4 (27.8, 29.1)	
Waist Circumference						
Model 1						0.0069
Men	103.1 (101.1, 105.2)	101.8 (100.1, 103.6)	100.6 (99.1, 102.1)	102.4 (100.8, 104.0)	101.0 (99.4, 102.6)	
Women	100.0 (96.6, 103.4)*	101.5 (99.1, 103.9)***	98.6 (96.9, 100.3)**	97.8 (96.1, 99.5)*	95.4 (93.7, 97.0)	
Model 2						0.0058
Men	102.4 (100.2, 104.5)	102.0 (100.2, 103.9)	101.0 (99.4, 102.6)	102.4 (100.7, 104.1)	101.2 (99.5, 102.8)	
Women	100.1 (96.5, 103.6)*	101.6 (99.1, 104.2)***	98.8 (97.1, 100.5)*	97.7 (95.9, 99.4)	95.6 (93.9, 97.4)	
Total Body Fat						
Model 1						0.0490
Men	22.5 (21.0, 24.1)	22.0 (20.7, 23.3)	21.0 (19.8, 22.1)	21.9 (20.7, 23.1)	20.8 (19.6, 22.0)	
Women	29.3 (26.8, 31.7)	30.6 (28.9, 32.3)***	29.1 (27.9, 30.3)**	28.1 (26.9, 29.3)	26.5 (25.4, 27.7)	
Model 2						0.0467
Men	22.1 (20.4, 23.8)	22.0 (20.7, 23.4)	21.1 (19.9, 22.4)	22.0 (20.7, 23.3)	20.9 (19.6, 22.2)	
Women	29.2 (26.7, 31.8)	30.5 (28.7, 32.3)**	29.3 (28.1, 30.6)**	27.9 (26.7, 29.1)	26.9 (25.7, 28.1)	

p<0.05, **p<0.01, ***p<0.001

Model 1 adjusted for age, sex, race, and field center

Model 2 adjusted for model 1, plus depressive symptoms, anti-depressants, alcohol use, sleep medication, smoking, income, marital status, and education

Table S4—Sleep efficiency and waist circumference stratified by age: the Multi-Ethnic Study of Atherosclerosis

	<85%	85-87.9%	87.9-90.4%	90.4%-92.4%	>92.4% (Referent)	P for Interaction
Model 1						0.0349
Age ≤68	102.5 (99.7, 105.3)***	102.3 (100.3, 104.4)***	99.4 (97.8, 101.0)*	99.9 (98.2, 101.6)**	96.6 (94.9, 98.3)	
Age > 68	100.2 (97.7, 102.7)	100.2 (98.0, 102.4)	99.9 (98.2, 101.5)	99.7 (98.0, 101.3)	99.2 (97.6, 100.7)	
Model 2						0.1274
Age ≤68	102.2 (99.3, 105.1)**	102.5 (100.3, 104.6)***	99.7 (98.1, 101.4)*	99.7 (98.0, 101.4)*	96.9 (95.1, 98.7)	
Age > 68	99.7 (97.1, 102.3)	100.4 (98.0, 102.8)	99.9 (98.2, 101.6)	99.9 (98.2, 101.6)	99.3 (97.6, 100.9)	

*p<0.05, **p<0.01, ***p<0.001

Model 1 adjusted for age, sex, race, and field center

Model 2 adjusted for model 1, plus depressive symptoms, anti-depressants, alcohol use, sleep medication, smoking, income, marital status, and education

Table S5—Sleep duration and adiposity stratified by sex: the Multi-Ethnic Study of Atherosclerosis

BMI	<5 hours	5-6 hours	6-7 hours	7-8 hours (Referent)	>8 hours	P for interaction
Model 1						0.0612
Men	29.6 (29.0, 30.3)***	28.3 (27.7, 28.9)	28.4 (27.9, 28.9)	27.6 (27.1, 28.2)	27.9 (26.9, 28.8)	
Women	30.5 (29.4, 31.6)**	30.2 (29.4, 31.0)**	28.8 (28.2, 29.4)	28.7 (28.1, 29.3)	28.5 (27.6, 29.4)	
Model 2						0.0462
Men	29.6 (28.9, 30.3)***	28.5 (27.8, 29.1)	28.4 (27.9, 28.9)	27.7 (27.1, 28.3)	28.0 (27.0, 29.0)	
Women	30.7 (29.5, 31.9)**	30.4 (29.5, 31.2)**	29.0 (28.4, 29.6)	28.7 (28.0, 29.3)	28.4 (27.5, 29.4)	
Waist Circumference	<5 hours	5-6 hours	6-7 hours	7-8 hours (Referent)	>8 hours	P for interaction
Model 1						0.0885
Men	105.1 (103.4, 106.9)***	101.2 (99.5, 102.9)	101.4 (100.1, 102.6)	99.9 (98.2, 101.5)	100.7 (98.2, 103.3)	
Women	100.1 (97.1, 103.0)*	100.8 (98.7, 102.9)**	97.5 (95.9, 99.1)	96.5 (94.9, 98.1)	97.0 (94.6, 99.4)	
Model 2						0.0988
Men	104.8 (102.9, 106.7)***	101.5 (99.7, 103.3)	101.4 (100.1, 102.8)	100.0 (98.3, 101.7)	101.2 (98.4, 103.9)	
Women	100.1 (97.1, 103.2)*	101.0 (98.8, 103.2)**	98.0 (96.4, 99.7)	96.4 (94.7, 98.0)	96.9 (94.4, 99.4)	

p<0.05, **p<0.01, ***p<0.001

Model 1 adjusted for age, sex, race, and field center

Model 2 adjusted for model 1, plus depressive symptoms, anti-depressants, alcohol use, sleep medication, smoking, income, marital status, and education

Table S6—Prevalence of obesity by sleep exposure: the Multi-Ethnic Study of Atherosclerosis

Sleep Duration	<5 hours	5-6 hours	6-7 hours	7-8 hours (Referent)	>8 hours
<i>N</i>	288	388	679	559	241
Overweight					
Model 1	0.07	0.09*	0.00	Ref.	-0.04
Model 2	0.07	0.09*	0.01	Ref.	-0.02
Model 3	0.03	0.07	0.01	Ref.	-0.04
Obese					
Model 1	0.16***	0.12**	0.04	Ref.	-0.02
Model 2	0.16***	0.14***	0.05	Ref.	0.00
Model 3	0.08	0.11**	0.04	Ref.	0.00
Waist circumference					
Model 1	0.10**	0.05	0.01	Ref.	0.01
Model 2	0.09**	0.05	0.02	Ref.	0.01
Model 3	0.05	0.04	0.02	Ref.	0.01
Sleep Efficiency	<85%	85-87.9%	87.9-90.4%	90.4%-92.4%	>92.4% (Referent)
<i>N</i>	208	329	544	523	547
Overweight					
Model 1	0.06	0.07	0.02	-0.03	Ref.
Model 2	0.06	0.04	0.03	-0.04	Ref.
Model 3	0.05	0.03	0.02	-0.04	Ref.
Obese					
Model 1	0.10*	0.12**	0.09**	0.02	Ref.
Model 2	0.09	0.10*	0.09**	0.01	Ref.
Model 3	0.04	0.05	0.07*	0.02	Ref.
Waist Circumference					
Model 1	0.06	0.09**	0.07*	0.02	Ref.
Model 2	0.04	0.10**	0.07*	0.03	Ref.
Model 3	0.01	0.07*	0.06*	0.04	Ref.
Sleep Duration Variability	<=48 (Referent)	48-70	70-99	99-262	
<i>N</i>	535	554	523	539	
Overweight					
Model 1	Ref.	0.04	0.00	0.01	
Model 2	Ref.	0.02	-0.02	0.01	
Model 3	Ref.	0.04	0.00	0.02	
Obese					
Model 1	Ref.	-0.01	0.04	0.05	
Model 2	Ref.	-0.01	0.03	0.05	
Model 3	Ref.	-0.04	-0.01	0.00	
Waist circumference					
Model 1	Ref.	0.03	0.06	0.06*	
Model 2	Ref.	0.02	0.05	0.06*	
Model 3	Ref.	0.02	0.04	0.04	

Reference is normal weight (BMI<25).

*p<0.05, **p<0.01, ***p<0.001.

Sleep duration variability is defined as the within-person standard deviation of sleep duration and is measured in minutes.

Model 1 adjusted for age, sex, race, and field center.

Model 2 adjusted for model 1, plus depressive symptoms, anti-depressants, alcohol use, sleep medication, smoking, income, marital status, and education.

Model 3 adjusted for model 2, plus sleep apnea.

Table S7—Prevalence of obesity by sleep exposure among those with AHI<15: the Multi-Ethnic Study of Atherosclerosis						
Sleep Duration	<5 hours	5-6 hours	6-7 hours	7-8 hours	>8 hours	
<i>N</i>	135	241	427	354	143	
	(Referent)					
Overweight						
Model 1	0.02	0.08	0.03	Ref.	-0.04	
Model 2	0.00	0.07	0.03	Ref.	-0.04	
Obese						
Model 1	0.15*	0.14**	0.07	Ref.	0.06	
Model 2	0.15*	0.17**	0.08*	Ref.	0.09	
Waist circumference						
Model 1	0.06	0.07	0.03	Ref.	0.08	
Model 2	0.05	0.06	0.04	Ref.	0.08	
Sleep Efficiency						
<i>N</i>	<85%	85-87.9%	87.9-90.4%	90.4%-92.4%	>92.4%	
	105	175	321	341	358	
	(Referent)					
Overweight						
Model 1	0.05	0.07	0.09*	-0.04	Ref.	
Model 2	0.06	0.07	0.08	-0.05	Ref.	
Obese						
Model 1	0.04	0.13*	0.09*	0.00	Ref.	
Model 2	0.04	0.12*	0.09*	-0.01	Ref.	
Waist Circumference						
Model 1	-0.01	0.12**	0.08*	0.01	Ref.	
Model 2	-0.04	0.13**	0.08*	0.02	Ref.	
Sleep Duration Variability						
<i>N</i>	<=48	48-70	70-99	99-262		
	335	348	301	316		
	(Referent)					
Overweight						
Model 1	Ref.	0.08	0.01	0.01		
Model 2	Ref.	0.06	0.00	0.02		
Obese						
Model 1	Ref.	-0.01	0.00	0.02		
Model 2	Ref.	-0.02	-0.01	0.01		
Waist circumference						
Model 1	Ref.	0.05	0.06	0.08*		
Model 2	Ref.	0.04	0.05	0.08*		

Sleep duration variability is defined as the within-person standard deviation of sleep duration and is measured in minutes

Reference is normal weight (BMI<25)

*p<0.05, **p<0.01, ***p<0.001

Model 1 adjusted for age, sex, race, and field center

Model 2 adjusted for model 1, plus depressive symptoms, anti-depressants, alcohol use, sleep medication, smoking, income, marital status, and education