Supplementary Online Content

Paksarian D, Rudolph K, Stapp EK, et al. Association of outdoor artificial light at night with mental disorders and sleep patterns among US adolescents. *JAMA Psychiatry*. Published online July 8, 2020. doi:10.1001/jamapsychiatry.2020.1935

This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1. Associations between quartiles of outdoor artificial light at night and sleep patterns among adolescents

	Model 1			Model 2			Model 3		
Quartile of ALAN	**Estimate**	**95% CI**	**P-value**	**Estimate**	**95% CI**	**P-value**	**Estimate**	**95% CI**	**P-value**
Weeknight bedtime in minutes (n=9,871):									
Lowest	(Ref.)	---	<.001	(Ref.)	---	0.001	(Ref.)	---	.002
2nd	14.47	(8.07, 20.87)		13.44	(6.08, 20.80)		12.65	(5.28, 20.01)	
3rd	23.16	(15.33, 31.00)		23.01	(12.26, 33.76)		22.08	(10.92, 33.24)	
Highest	28.56	(18.82, 38.30)		29.56	(14.65, 44.46)		29.35	(15.22, 43.47)	
Weekend bedtime delay in minutes (n=9,404):									
Lowest	(Ref.)	---	.240	(Ref.)	---	0.195	(Ref.)	---	.326
2nd	-0.24	(-9.46, 8.98)		-1.01	(-13.63, 11.61)		-0.11	(-12.64, 12.42)	
3rd	-5.87	(-14.64, 2.90)		-6.46	(-18.32, 5.40)		-5.05	(-16.92, 6.83)	
Highest	-3.43	(-11.75, 4.90)		-3.41	(-15.69, 8.87)		-2.26	(-14.51, 9.99)	
Weeknight sleep duration in minutes (n=10,018):									
Lowest	(Ref.)	---	<.001	(Ref.)	---	<.001	(Ref.)	---	<.001
2nd	-17.24	(-23.04, -11.44)		-13.65	(-19.78, -7.51)		-13.89	(-19.74, -8.04)	
3rd	-12.71	(-19.29, -6.13)		-9.05	(-15.58, -2.52)		-10.32	(-16.56, -4.07)	
Highest	-8.77	(-15.29, -2.24)		-5.34	(-13.60, 2.93)		-10.58	(-19.18, -1.97)	
Weekend oversleep in minutes (n=9,890):									
Lowest	(Ref.)	---	.001	(Ref.)	---	0.175	(Ref.)	---	.155
2nd	22.87	(10.73, 35.00)		12.41	(-2.02, 26.85)		11.15	(-3.02, 25.32)	
3rd	23.31	(12.24, 34.38)		12.87	(-3.33, 29.06)		10.32	(-6.29, 26.94)	
Highest	14.50	(1.66, 27.35)		4.90	(-12.11, 21.91)		1.57	(-17.42, 20.55)	

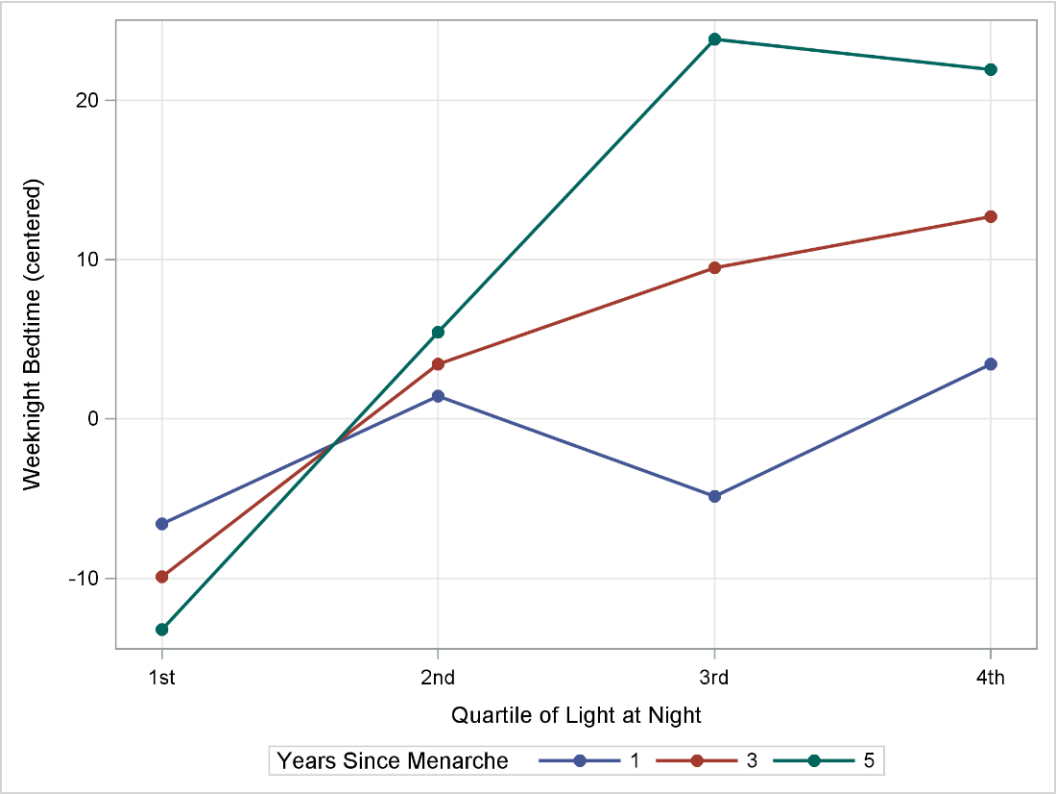
Note: Positive values indicate later bedtimes and greater amounts of bedtime delay, sleep duration, and oversleep. Model 1 is adjusted for age and sex. Model 2 is additionally adjusted for race/ethnicity, family income, parental education, family structure, nativity, region, and urbanicity. Model 3 is additionally adjusted for area-level population density and socioeconomic status. 48 adolescents missing values for area-level SES were not included in Model 3. P-values are from Wald F tests.

eTable 2. Results of interaction tests between outdoor artificial light at night and sex, age among boys, and years since menarche among girls.

Interaction	Outcome	F Statistic	df	P-value
Sex	Weeknight Bedtime	0.61	3	.6144
	Weeknight Sleep Duration	0.40	3	.7515
	Weekend Bedtime Delay	0.73	3	.5373
	Weekend Oversleep	0.46	3	.7149
	Mood Disorder	3.26	1	.0781
	Anxiety Disorder	0.79	1	.3797
	Substance Use Disorder	0.01	1	.9219
	Behavior Disorder	0.00	1	.9774
Age (boys Only)	Weeknight Bedtime	1.27	3	.2975
	Weeknight Sleep Duration	0.36	3	.7853
	Weekend Bedtime Delay	0.98	3	.4091
	Weekend Oversleep	0.59	3	.6236
	Mood Disorder	0.06	1	.8044
	Anxiety Disorder	0.05	1	.8298
	Substance Use Disorder	2.62	1	.1132
	Behavior Disorder	2.30	1	.1365
Years since Menarche (girls only)	Weeknight Bedtime	8.15	3	.0002
	Weeknight Sleep Duration	0.77	3	.5189
	Weekend Bedtime Delay	1.66	3	.1903
	Weekend Oversleep	1.13	3	.3463
	Mood Disorder	0.17	1	.6859
	Anxiety Disorder	1.29	1	.2622
	Substance Use Disorder	2.43	1	.1269
	Behavior Disorder	0.05	1	.8165

Note: P-values do not correct for multiple comparisons.

eFigure. Predicted mean weeknight bedtimes for adolescent girls by quartile of outdoor artificial light at night, for those who are 1, 3, and 5 years post menarche.



Note: predictions generated for the mean sample age (15.2 years) and not adjusted for other covariates.

eTable 3. Associations between quartiles of outdoor artificial light at night and sleep patterns among adolescents; sensitivity analysis in which extreme reports (outside 3 standard deviations) are not excluded

	Model 1			Model 2			Model 3		
Quartile of ALAN	**Estimate**	**95% CI**	**P-value**	**Estimate**	**95% CI**	**P-value**	**Estimate**	**95% CI**	**P-value**
Weeknight bedtime in minutes (n=10,094):									
Lowest	(Ref.)	---	<.001	(Ref.)	---	.001	(Ref.)	---	.005
2nd	19.63	(9.55, 29.71)		20.95	(9.08, 32.83)		20.11	(8.21, 32.01)	
3rd	28.88	(15.66, 42.11)		30.90	(15.11, 46.69)		29.22	(13.23, 45.21)	
Highest	31.15	(18.19, 44.12)		34.95	(18.46, 51.44)		30.81	(13.74, 47.89)	
Weeknight bedtime delay in minutes (n=9,989):									
Lowest	(Ref.)	---	.469	(Ref.)	---	.199	(Ref.)	---	.845
2nd	-8.53	(-24.26, 7.20)		-11.38	(-28.57, 5.80)		-7.42	(-24.50, 9.67)	
3rd	-8.08	(-21.45, 5.29)		-11.90	(-28.26, 4.45)		-3.69	(-21.72, 14.35)	
Highest	-11.25	(-28.53, 6.03)		-17.87	(-35.26, -0.49)		-1.90	(-20.49, 16.70)	
Weekend sleep duration in minutes (n=10,080):									
Lowest	(Ref.)	---	<.001	(Ref.)	---	<.001	(Ref.)	---	<.001
2nd	-18.34	(-23.55, -13.14)		-14.80	(-20.10, -9.49)		-14.94	(-19.99, -9.89)	
3rd	-14.40	(-21.16, -7.63)		-11.06	(-18.10, -4.02)		-12.23	(-19.11, -5.35)	
Highest	-8.68	(-15.65, -1.71)		-5.86	(-15.07, 3.35)		-11.30	(-20.73, -1.87)	
Weekend oversleep in minutes (n=10,004):									
Lowest	(Ref.)	---	<.001	(Ref.)	---	.135	(Ref.)	---	.124
2nd	23.35	(10.93, 35.77)		12.73	(-1.94, 27.41)		11.31	(-3.17, 25.80)	
3rd	23.58	(12.40, 34.77)		13.41	(-2.97, 29.78)		10.71	(-6.05, 27.47)	
Highest	13.84	(1.20, 26.48)		4.63	(-11.95, 21.20)		1.65	(-16.29, 19.58)	

Note: Positive values indicate later bedtimes and greater amounts of bedtime delay, sleep duration, and oversleep. Model 1 is adjusted for age and sex. Model 2 is additionally adjusted for race/ethnicity, family income, parental education, family structure, nativity, region, and urbanicity. Model 3 is additionally adjusted for area-level population density and socioeconomic status. 48 adolescents missing values for area-level SES were not included in Model 3. P-values are from Wald F tests.

eTable 4. Associations between quartiles of outdoor artificial light at night and sleep patterns among adolescents; sensitivity analysis in which bedtimes reported as 12:00 Noon are recoded as Midnight

	Model 1			Model 2			Model 3		
Quartile of ALAN	**Estimate**	**95% CI**	**P-value**	**Estimate**	**95% CI**	**P-value**	**Estimate**	**95% CI**	**P-value**
Weeknight bedtime in minutes (n=9,948):									
Lowest	(Ref.)	---	<.001	(Ref.)	---	<.001	(Ref.)	---	<.001
2nd	13.71	(7.73, 19.69)		12.28	(5.79, 18.76)		11.49	(5.11, 17.88)	
3rd	22.59	(15.02, 30.16)		22.16	(12.06, 32.27)		21.28	(10.79, 31.76)	
Highest	28.54	(19.24, 37.84)		29.50	(15.52, 43.49)		29.46	(16.46, 42.46)	
Weeknight bedtime delay in minutes (n=9,687):									
Lowest	(Ref.)	---	.082	(Ref.)	---	.183	(Ref.)	---	.238
2nd	0.06	(-7.47, 7.59)		0.21	(-9.15, 9.57)		1.10	(-8.04, 10.24)	
3rd	-6.10	(-14.43, 2.24)		-5.75	(-16.34, 4.85)		-4.51	(-14.97, 5.95)	
Highest	-4.17	(-12.00, 3.67)		-3.69	(-14.22, 6.85)		-3.36	(-14.01, 7.28)	

Note: Positive values indicate later bedtimes and greater amounts of bedtime delay. Model 1 is adjusted for age and sex. Model 2 is additionally adjusted for race/ethnicity, family income, parental education, family structure, nativity, region, and urbanicity. Model 3 is additionally adjusted for area-level population density and socioeconomic status. 48 adolescents missing values for area-level SES were not included in Model 3. P-values are from Wald F tests.

eTable 5. Sensitivity analysis including categorical season variable in Model 3 of eTable 1

	Model 3 of eTable 1			Adding season		
Quartile of ALAN	**Estimate**	**95% CI**	**P-value**	**Estimate**	**95% CI**	**P-value**
Weeknight bedtime in minutes (n=9,871):						
Lowest	(Ref.)	---	.002	(Ref.)	---	.002
2nd	12.65	(5.28, 20.01)		13.64	(6.02, 21.26)	
3rd	22.08	(10.92, 33.24)		22.92	(11.63, 34.21)	
Highest	29.35	(15.22, 43.47)		29.81	(14.99, 44.63)	
Weekend bedtime delay in minutes (n=9,404):						
Lowest	(Ref.)	---	.326	(Ref.)	---	.398
2nd	-0.11	(-12.64, 12.42)		-1.15	(-13.97, 11.67)	
3rd	-5.05	(-16.92, 6.83)		-5.63	(-17.99, 6.73)	
Highest	-2.26	(-14.51, 9.99)		-3.02	(-15.56, 9.53)	
Weeknight sleep duration in minutes (n=10,018):						
Lowest	(Ref.)	---	<.001	(Ref.)	---	<.001
2nd	-13.89	(-19.74, -8.04)		-13.09	(-18.99, -7.19)	
3rd	-10.32	(-16.56, -4.07)		-9.74	(-16.09, -3.39)	
Highest	-10.58	(-19.18, -1.97)		-10.13	(-18.55, -1.70)	
Weekend oversleep in minutes (n=9,890):						
Lowest	(Ref.)	---	.155	(Ref.)	---	.208
2nd	11.15	(-3.02, 25.32)		10.35	(-3.68, 24.38)	
3rd	10.32	(-6.29, 26.94)		9.99	(-6.78, 26.77)	
Highest	1.57	(-17.42, 20.55)		0.77	(-18.23, 19.77)	

Note: Season was measured according to the month in which the interview started and entered as a 4-level categorical variable. A season*region interaction is included because it was present for bedtime delay.

eTable 6. Sensitivity analysis including categorical season variable in Model 3 of Table 2

	Model 3 of Table 2			Adding Season		
Disorder Class	**OR**	**95% CI**	**P-value**	**OR**	**95% CI**	**P-value**
Mood	1.07	(1.00, 1.14)	.038	1.07	(1.00, 1.14)	.046
Anxiety	1.10	(1.05, 1.16)	<.001	1.10	(1.05, 1.16)	<.001
Substance	1.00	(0.90, 1.11)	.964	1.00	(0.90, 1.11)	.980
Behavior	1.04	(0.93, 1.17)	.457	1.05	(0.93, 1.17)	.452

Note: Season was measured according to the month in which the interview started and entered as a 4-level categorical variable. No season*region interactions were present.