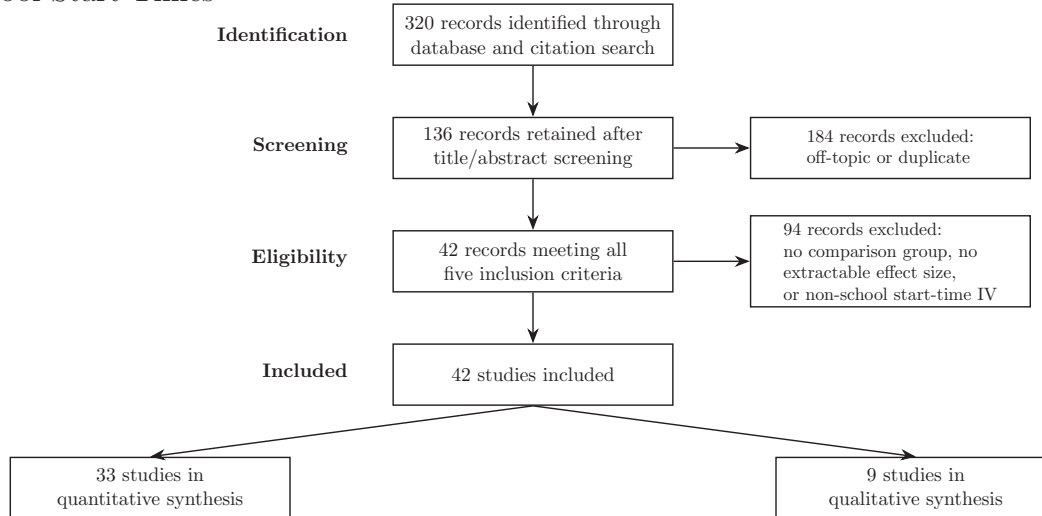


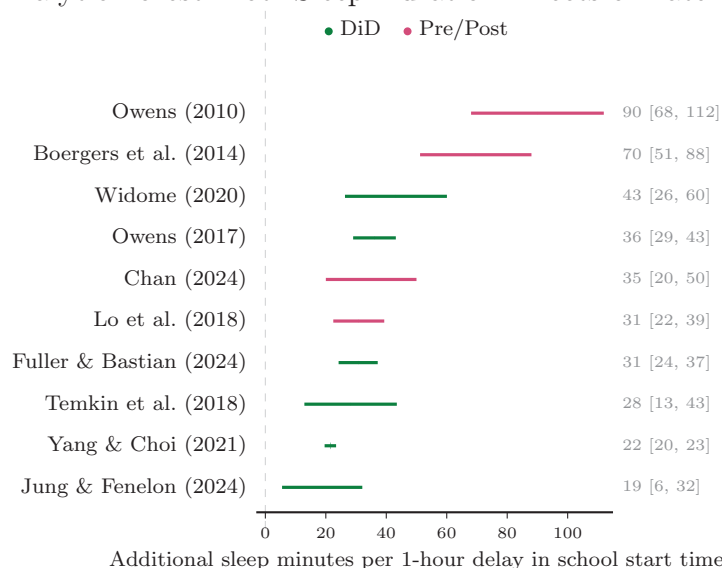
Appendix

Figure A.1: PRISMA Flow Diagram: Systematic Review of Quasi-Experimental Evidence on School Start Times



Notes: PRISMA-style flow diagram for the systematic review described in Section 2. Records were identified through backward and forward citation searches via OpenAlex, anchored on [Bowers and Moyer \(2017\)](#), [Yip et al. \(2022\)](#), [Carrell et al. \(2011\)](#), and [Heissel and Norris \(2018\)](#), and supplemented with keyword searches of the NBER and IZA working paper series. Inclusion criteria: (i) school start time as the independent variable; (ii) sleep, academic, or mental-health outcome; (iii) comparison-group design (pre/post with control, DiD, IV, or RCT); (iv) peer-reviewed publication in English; (v) extractable effect sizes. The 9 qualitative studies report effects without parametric standard errors and so do not enter the inverse-variance pooled estimates reported in the footnote of Section 2.

Figure A.2: Meta-Analytic Forest Plot: Sleep Duration Effects of Later School Start Times

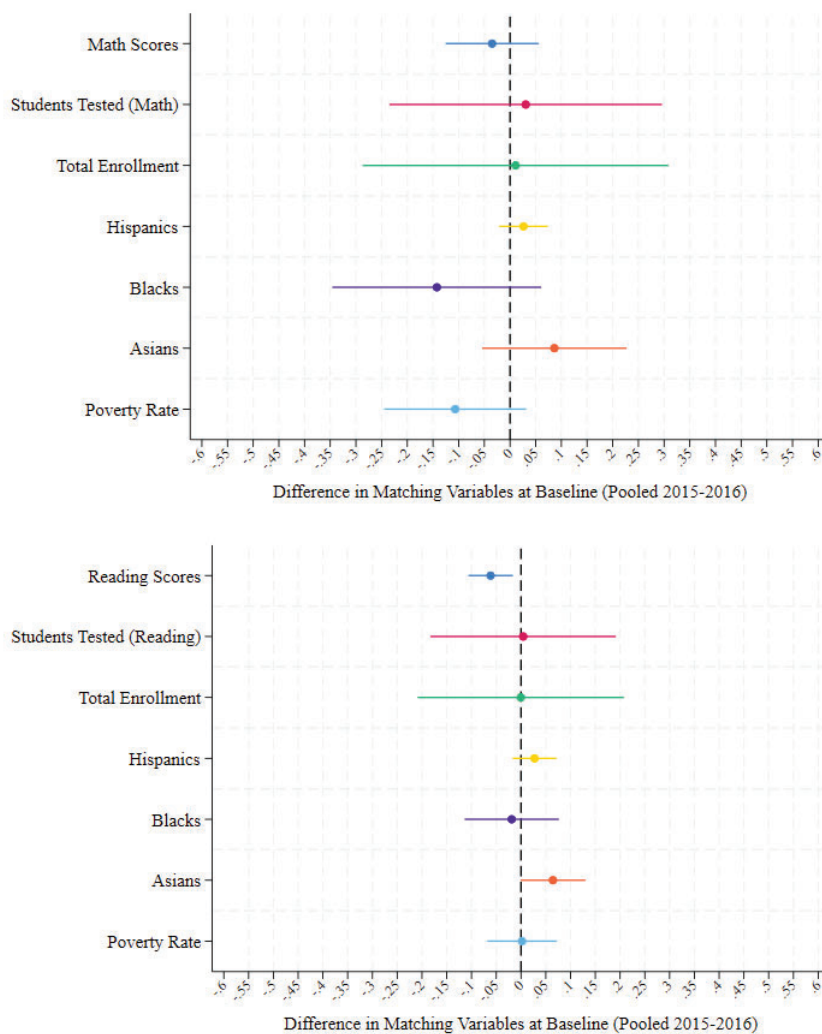


Notes: Each point represents a study-level estimate of additional sleep minutes per one-hour delay in school start time, with 95% confidence interval. Marker size is proportional to inverse-variance weight. Colors indicate identification strategy. The figure displays the full distribution of effects rather than an inverse-variance-pooled point estimate (see Footnote 3 in the text for a single rough-benchmark pooled value computed for comparability with prior meta-analyses). Chan et al. (2018) and Chan et al. (2024) report on the same Hong Kong residential boarding-school intervention (7:30 a.m. \rightarrow 8:30 a.m. SST change implemented September 2017) with overlapping Cohort 1 baseline samples; only the longer-term Chan (2024) follow-up is shown to avoid double-counting.

Study-specific disclosures. *Yang & Choi (2021):* the plotted point is the weekday-only sleep gain (raw +16.1 min, rescaled to +22 min/hr); the same source reports a partially offsetting weekend decline of -7.6 min/night, so the weekly-average effect is smaller ($\approx +9.3$ min/day before rescaling).

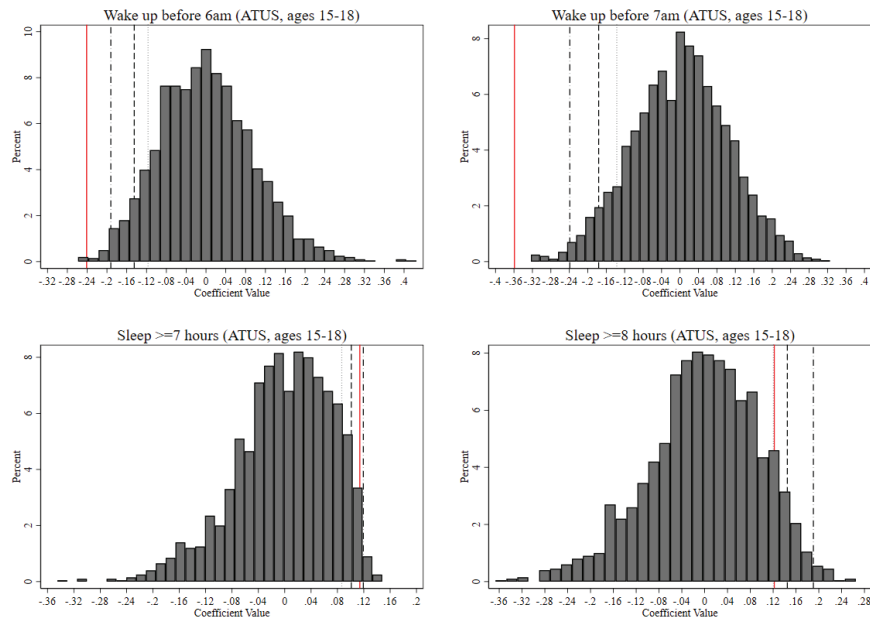
Widome et al. (2020): the plotted point is the school-night-only effect at follow-up 1 (raw +41 min); the same source reports concurrent weekend-night declines of -24 min (FU1) and -34 min (FU2). The per-hour rescale uses the midpoint of the two treated schools' delays (50 and 65 min). *Lo et al. (2018):* the plotted point is one-month time-in-bed (TIB); the same source reports a smaller +10 min total-sleep-time effect at nine-month follow-up. *Jung & Fenelon (2024):* the plotted point is the year-0 effect from the event-study specification; the same source documents that this gain fades to +7 min within one year as bedtimes shift later (see Table A.24 footnote h).

Figure A.3: Balance Check on Covariates and Outcomes at Baseline, SEDA



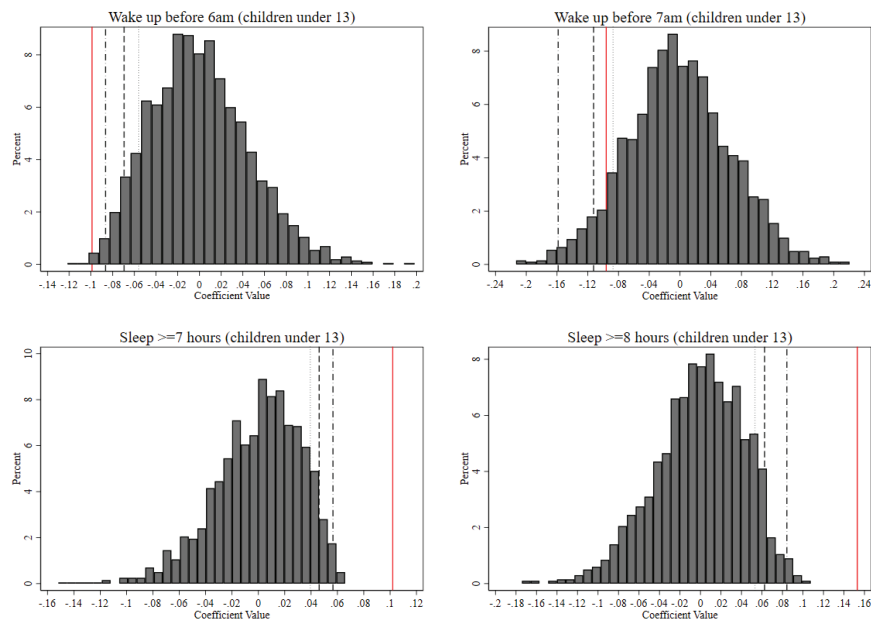
Notes: Data come from the Stanford Education Data Archive (SEDA-2024). The figure illustrates the differences in covariates and outcomes from the SEDA 2024 data at baseline (pooled 2015–2016) after matching as discussed in Section 3.2. Panel A shows the baseline analysis for the matched sample for math scores, and Panel B shows the baseline analysis for English scores. All variables are standardized.

Figure A.4: Permutation Tests, Adolescents Aged 15–18, ATUS



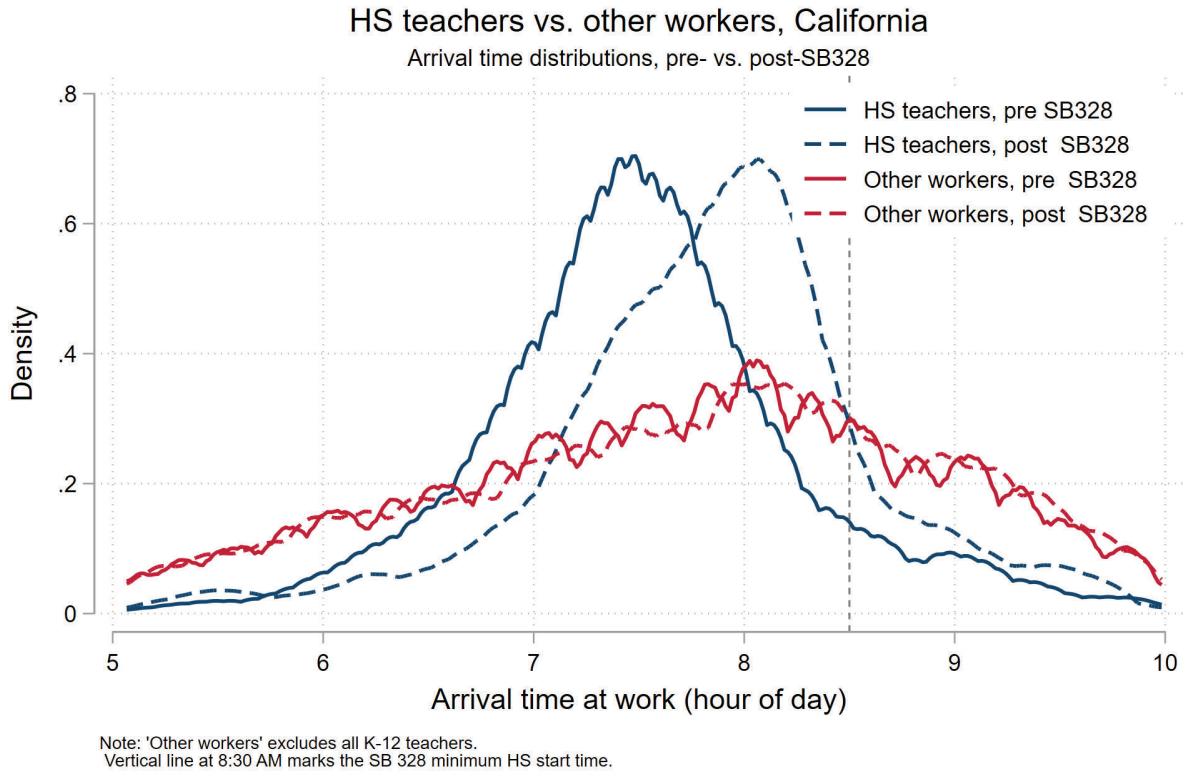
Notes: The figure illustrates the results of permutation tests for various outcomes from ATUS respondents aged 15-18, where the policy adoption year was randomly reassigned to other states to create placebo scenarios. The red vertical line represents the observed treatment effect, while the dashed lines indicate the 1%, 5%, and 10% significance thresholds derived from the placebo distribution. By comparing the observed effect to the distribution of placebo effects, the test evaluates whether the observed policy effect is statistically significant or could plausibly arise by random chance. Outcomes with observed effects beyond the dashed lines suggest a significant and likely causal policy impact. Standard errors are clustered at the state level.

Figure A.5: Permutation Tests, Children Under 13, ATUS



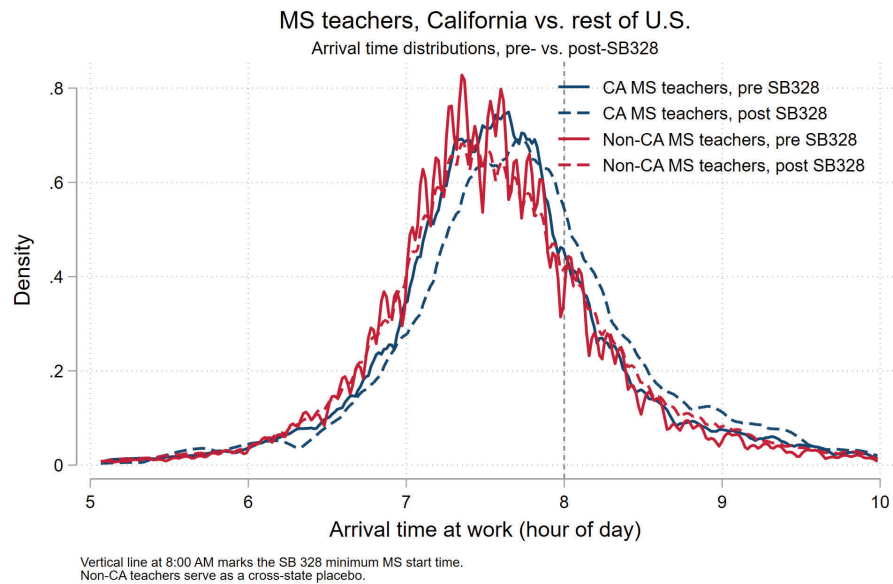
Notes: The figure illustrates the results of permutation tests for various outcomes from ATUS respondents under the age of 13, where the policy adoption year was randomly reassigned to other states to create placebo scenarios. The red vertical line represents the observed treatment effect, while the dashed lines indicate the 1%, 5%, and 10% significance thresholds derived from the placebo distribution. By comparing the observed effect to the distribution of placebo effects, the test evaluates whether the observed policy effect is statistically significant or could plausibly arise by random chance. Outcomes with observed effects beyond the dashed lines suggest a significant and likely causal policy impact. Standard errors are clustered at the state level.

Figure A.6: Validating the Teacher Arrival-Time Proxy: ACS Arrival Times, California High School Teachers vs. Other Workers, Pre- vs. Post-SB 328



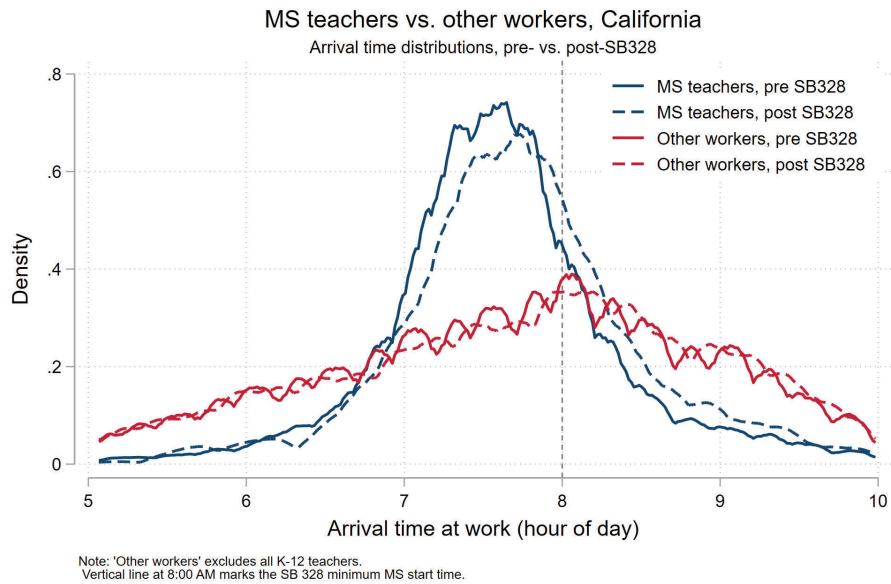
Notes: The figure presents kernel density estimates of self-reported arrival times at work among California workers, using data from the American Community Survey (ACS) for the years 2014–2019 and 2023. The pre-SB 328 period uses the 5-year ACS sample (2014–2019); the post-SB 328 period employs the 1-year 2023 ACS sample, the first full wave after the policy took effect on July 1, 2022. High school teachers are identified using IPUMS 2018 occupation code 2320. “Other workers” excludes all K–12 teachers (IPUMS codes 2310 and 2320). The sample is restricted to California residents with reported arrival times between 5:00 a.m. and 10:00 a.m.. Observations are weighted by ACS person weights. The vertical dashed line at 8:30 a.m. marks the minimum high school start time mandated by SB 328. The figure shows a marked rightward shift in the distribution of high school teacher arrival times following the policy, with the post-period mass concentrating immediately below the 8:30 a.m. threshold, while the distribution of arrival times for non-teacher workers is essentially unchanged between the pre- and post-periods. This pattern supports the use of pre-policy teacher arrival times as a proxy for pre-policy school start times in the within-state analysis.

Figure A.7: Teacher Arrival Time Proxy, Middle School Teachers: ACS Arrival Times, California vs. Other States, Pre- vs. Post-SB 328



Notes: The figure presents kernel density estimates of self-reported arrival times at work among middle school teachers, using data from the American Community Survey (ACS) for the years 2014–2019 and 2023. The pre-SB 328 period uses the 5-year ACS sample (2014–2019); the post-SB 328 period employs the 1-year 2023 ACS sample, the first full wave after the policy took effect on July 1, 2022. Note that the underlying ACS variable OCC2010 (value 2310) does not actually distinguish between elementary and middle school teachers. Hence, the graph captures the combined elementary school/middle school arrival time distributions. The sample is restricted to respondents with reported arrival times between 5:00 a.m. and 10:00 a.m.. Observations are weighted by ACS person weights. The vertical dashed line at 8:00 a.m. marks the minimum middle school start time mandated by SB 328. The figure shows a modest rightward shift in the distribution of arrival times for California elementary/middle school teachers following the policy, while the corresponding distribution for elementary/middle school teachers in other states remains largely unchanged. The smaller magnitude of the shift reflects both the fact that pre-policy arrival times for middle school teachers were already concentrated closer to the 8:00 a.m. threshold, as well as the contamination of the sample with elementary school teachers

Figure A.8: Teacher Arrival Time Proxy, Middle School Teachers: ACS Arrival Times, California Middle School Teachers vs. Other Workers, Pre- vs. Post-SB 328



Notes: The figure presents kernel density estimates of self-reported arrival times at work among California workers, using data from the American Community Survey (ACS) for the years 2014–2019 and 2023. The pre-SB 328 period uses the 5-year ACS sample (2014–2019); the post-SB 328 period employs the 1-year 2023 ACS sample, the first full wave after the policy took effect on July 1, 2022. Note that the underlying ACS variable OCC2010 (value 2310) does not actually distinguish between elementary and middle school teachers. Hence, the graph captures the combined elementary school/middle school arrival time distributions. “Other workers” excludes all K–12 teachers (IPUMS codes 2310 and 2320). The sample is restricted to California residents with reported arrival times between 5:00 a.m. and 10:00 a.m.. Observations are weighted by ACS person weights. The vertical dashed line at 8:00 a.m. marks the minimum middle school start time mandated by SB 328. The post-period shift is directionally consistent with the SB 328 mandate but smaller in magnitude than for high school teachers, reflecting both the fact that pre-policy MS teacher arrivals were already concentrated before 8:00 a.m. threshold, as well as the contamination of the sample with elementary school teachers.

Table A.1: Meta-Analytic Summary: Quasi-Experimental Evidence on School Start Times

Study	Design	Scope	Sleep (min./hr)	Academic (SD/hr)	MH
<i>Panel A: Sleep duration</i>					
Owens et al. (2017)	Pre/post QE	1 district	+36.1 (3.6)		
Widome et al. (2020)	DiD + actigraphy	1 metro	+43 (8.6)		
Lo et al. (2018)	Pre/post QE	1 school	+30.9 (4.3)		+
Jung & Fenelon (2024)	DiD (mandate)	Multi-state	+19 (6.8)		
<i>Panel B: Academic achievement</i>					
Hinrichs (2011)	Cross-district DiD	Multi-district		0.00 (0.02)	
Edwards (2012)	Transportation IV	1 district		+0.06 (0.01)	
Carrell et al. (2011)	Random assignment (within institution)	1 academy		+0.15 (0.07) ^a	
Heissel & Norris (2018)	Time-zone IV	1 state		+0.08 (0.02) ^b	
Groen & Pabilonia (2019)	OLS + Oster bounds	National		+0.16 (0.08) ^c	
Bastian & Fuller (2023)	Panel DiD	1 state		+0.08 (0.03) ^g	
James et al. (2023)	DiD + actigraphy	1 metro		+0.17 GPA pts (0.03) ^d	
<i>Panel C: Mental health</i>					
Chan et al. (2024)	Pre/post boarding	1 school	+35 (7.7)		+ ^e
Sadikova et al. (2024)	IV (SST→sleep)	1 metro			+ ^f

Notes: Sleep effects in additional minutes per one-hour delay in school start time (Panel A entries normalized uniformly to per-hour scale; raw source treatments: Owens 2017 50 min, Widome 2020 57 min, Lo 2018 45 min). Academic effects in SD units per one-hour delay. Standard errors in parentheses. MH = + indicates improvement in mental health outcomes. Panels A–C display representative studies; a single rough-benchmark random-effects pooled estimate is reported in Footnote 3 of the text for comparability with prior meta-analyses. See Appendix Table A.25 for the principal studies discussed in the text and the PRISMA flow.

^aPer-hour-equivalent of the 7:00 vs. 7:50 a.m. first-period contrast at USAFA, rescaled from the source paper’s 50-min contrast. ^bAdolescent (pubescent) subsample; near zero for younger children. ^cFemale subsample; OLS with Oster (2019) bounds (0.16–0.28 SD); males null. ^dEffect reported in GPA points (not SD units); excluded from the pooled academic estimate. GPA at two-year follow-up; attendance improves immediately. ^eSignificant reductions in depression, anxiety, and insomnia ($d = 0.29$ – 0.67); the $d = 0.72$ figure in Chan et al. (2024) refers to total sleep time, not mental health. ^fIV-estimated: a policy-induced 30-min sleep gain yields -0.78 depression points (SE 0.27) and -1.36 fatigue points (SE 0.38). ^gSchool-fixed-effect specification shown; the student-fixed-effect alternative reports math $+0.039$ (SE 0.012) and reading $+0.026$ (SE 0.009), both reported by the authors as robust.

Table A.2: Summary Statistics - YRBS (2007–2023)

	Mean	Std. Dev.	N
<i>Covariates</i>			
Age categories	5.00	1.25	139,021
Female	0.50	0.50	139,703
Asian	0.04	0.20	139,703
Black	0.16	0.36	139,703
Hispanic	0.25	0.44	139,703
White	0.45	0.50	139,703
<i>Outcomes</i>			
Sleep \geq 6 hours	0.79	0.41	120,919
Sleep \geq 7 hours	0.56	0.50	120,919
Sleep \geq 8 hours	0.27	0.44	120,919
Concentration difficulties	0.39	0.49	49,362
Sadness/hopelessness feelings	0.32	0.47	137,950
Suicidal intentions	0.18	0.39	122,451

Notes: Summary statistics reported for the full YRBS sample (2007–2023), including main covariates and mental health outcomes. Age categories are coded from 1 (≤ 12 years) to 7 (≥ 18 years). Outcomes are based on self-reported responses.

Table A.3: Summary Statistics - ATUS (2003–2024)

<i>Panel A: Children aged 15–18</i>	Mean	Std. Dev.	N
Wake up before 6am	0.280	0.449	5,926
Wake before 7am	0.586	0.493	5,926
Wake up before 8am	0.710	0.454	5,926
Bedtime after 9pm	0.695	0.460	5,926
Bedtime after 10pm	0.356	0.479	5,926
Bedtime after 11pm	0.228	0.420	5,926
Sleep hours	9.130	2.342	5,926
Sleep more than 6 hours	0.942	0.234	5,926
Sleep more than 7 hours	0.864	0.343	5,926
Sleep more than 8 hours	0.706	0.456	5,926
<i>Panel B: Children under 13</i>	Mean	Std. Dev.	N
Wake up before 6am	0.128	0.334	12,173
Wake before 7am	0.431	0.495	12,173
Wake up before 8am	0.757	0.429	12,173
Bedtime after 9pm	0.322	0.467	12,173
Bedtime after 10pm	0.135	0.342	12,173
Bedtime after 11pm	0.066	0.249	12,173
Sleep hours	9.662	1.999	12,173
Sleep more than 6 hours	0.965	0.185	12,173
Sleep more than 7 hours	0.938	0.241	12,173
Sleep more than 8 hours	0.877	0.329	12,173

Notes: Summary statistics reported for the full ATUS sample (2003–2024) for key sleep-related outcomes. Panel A shows results for children aged 15–18. Panel B presents summary statistics for children under 13, based on parental reports and linked child-level sleep data.

Table A.4: SB 328 and Teacher Arrival Time in California (ACS Evidence)

	(1) High School Teachers		(3) Middle School Teachers	
	Arrival time	Ln (arrival time)	Arrival time	Ln (arrival time)
Policy (SB 328)	13.027*** (3.050)	0.027*** (0.007)	4.512** (1.843)	0.010** (0.004)
Observations	5,577	5,577	12,485	12,485
R-squared	0.064	0.061	0.028	0.027

Notes: The table reports difference-in-differences estimates of the effect of SB 328 on teacher arrival-at-work time, using individual-level data from the American Community Survey (ACS) for the years 2019-2024 (2020 wave is dropped due to COVID-19). Columns (1)–(2) restrict to high school teachers (IPUMS 2018 occupation code 2320), with arrival times trimmed to 4:00–9:30 AM; columns (3)–(4) restrict to elementary/middle school teachers (IPUMS 2018 occupation code 2310), with arrival times trimmed to 4:00–9:00 AM. Note that the occupation code 2310 does not actually distinguish between elementary and middle school teachers. Hence, cols. (3)–(4) capture a combined effect on elementary school and middle school teachers. The dependent variable is the arrival time at work (in minutes from midnight) in columns (1) and (3), and its natural logarithm in columns (2) and (4). Regressions in cols. (1)–(2) use teacher-arrival treatment intensity defined for high school teachers (IPUMS occupation 2320; bottom three quartiles vs. top quartile plus rural counties). Regressions in cols. (3)–(4) use teacher-arrival treatment intensity defined for elementary/middle school teachers (IPUMS occupation 2310; bottom two quartiles vs. top two quartiles plus rural counties). All specifications include county-of-work and year fixed effects, individual-level controls (sex, marital status, number of children, race/ethnicity, education), and ACS person weights. Standard errors in parentheses, clustered at the county-of-work level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.5: CA SB 328 and High School Senior SAT Scores

	(1)	(2)	(3)
	SAT	Math	Evidence-based reading and writing score
CA SB 328	24.987*** (4.793)	10.673*** (2.288)	13.313*** (2.535)
Observations	204	204	204
Mean of dep. var.	1,112	549.7	562.3
Std. dev. of dep. var.	95.05	49.49	45.87

Notes: Data on SAT scores were published by the College Board. Data include 50 US states and Washington, D.C., for the years 2018, 2021, 2022, and 2023. All estimates include state and year fixed effects. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level.

Table A.6: ACS Placebo Test on ACS Arrival Time – Vision and Hearing Difficulties

	(1)	(2)	(3)	(4)	(5)	(6)
	State Level		CA (High School)		CA (Middle School)	
	Vision	Hearing	Vision	Hearing	Vision	Hearing
Policy (SB 328)	-0.0000 (0.0010)	0.0003 (0.0000)	-0.0026 (0.0020)	-0.0012 (0.0010)	0.0016 (0.0020)	0.0016 (0.0010)
Observations	1,598,031	1,598,031	99,831	99,831	89,936	89,936
R-squared	0.002	0.000	0.003	0.002	0.002	0.001
Mean of dep. var.	0.011	0.006	0.012	0.007	0.009	0.005
Std. dev. of dep. var.	0.106	0.078	0.110	0.081	0.094	0.073

Notes: This table reports placebo estimates of the effect of the ACS-based teacher arrival-time treatment on outcomes that should be unaffected by the schedule mandate, namely DIFFEYE (whether respondent is blind or has a serious vision difficulty) and DIFFHEAR (whether respondent is deaf or has a serious hearing difficulty). Data comes from the 2019-2024 American Community Survey (ACS). 2020 is dropped due to COVID-19. Columns 1-2 use the full U.S. sample of teens aged 11-18; columns 3-4 use within-California variation with a sample of high-school-age teens (aged 15-18); columns 5-6 restrict to California middle-school-age teens (aged 11-14). Regressions in cols. (1)-(2) use the California x post-SB 328 interaction term. Regressions in cols. (3)-(4) use teacher-arrival treatment intensity defined for high school teachers (IPUMS occupation 2320; bottom three quartiles vs. top quartile plus rural counties). Regressions in cols. (5)-(6) use teacher-arrival treatment intensity defined for elementary/middle school teachers (IPUMS occupation 2310; bottom two quartiles vs. top two quartiles plus rural counties). All specifications include state/county and year fixed effects, individual-level controls (age, sex, race/ethnicity), and ACS person weights. Analyses in cols. (1)-(2) further employ state-level time-varying socioeconomic covariates. Standard errors in parentheses, clustered at the state level (cols. 1-2) or county level (cols. 3-6). *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.7: CDE Placebo Test on School Characteristics

	(1)	(2)	(3)	(4)	(5)
	Total Enrollment	White Share	Hispanic Share	Female Share	Socioecon. Disadvantaged Share
Policy (SB 328)	-13.92 (14.46)	0.283 (0.516)	-0.383 (0.748)	0.079 (0.083)	0.693 (1.189)
Observations	63,450	64,024	76,551	63,450	63,450
R-squared	0.024	0.345	0.192	0.002	0.216
Mean of dep. var.	803.2	25.78	56.02	48.21	61.31
Std. dev. of dep. var.	703.7	21.21	27.58	4.514	26.05

Notes: This table reports placebo regressions using school-level characteristics from CDE data for the academic years 2014-15 through 2024-25. The dependent variables include total enrollment and demographic shares (race/ethnicity, sex, and socioeconomically disadvantaged students). All regressions use a combined HS+ES/MS teacher-arrival treatment intensity (IPUMS occupations 2320 and 2310; bottom three quartiles vs. top quartile plus rural counties). All specifications include school and year fixed effects, as well as time-varying demographic covariates unrelated to the outcome tested. Standard errors in parentheses, clustered at the county level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.8: Wake-up Times and Sleep, Children Under 13, ATUS with All Households

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Wake-up time			Bedtime			Sleep			
	6am	7am	8am	after 9pm	after 10pm	after 11pm	sleep hours	sleep \geq 6	sleep \geq 7	sleep \geq 8
CA SB 328	-0.037*** (0.011)	-0.022 (0.022)	0.006 (0.025)	0.027 (0.019)	0.007 (0.014)	-0.002 (0.008)	0.247*** (0.055)	0.034*** (0.006)	0.022 (0.014)	0.038*** (0.011)
Observations	41,496	41,496	41,496	41,496	41,496	41,496	41,496	41,496	41,496	41,496
R-squared	0.014	0.047	0.078	0.065	0.040	0.024	0.036	0.013	0.014	0.021
Mean of dep. var.	0.144	0.509	0.812	0.372	0.154	0.071	9.295	0.960	0.923	0.840
Std. dev. of dep. var.	0.352	0.500	0.391	0.483	0.361	0.256	1.975	0.196	0.267	0.366

Notes: Data comes from the 2003–2024 American Time Use Survey (ATUS). Observations are weighted by population weights obtained from the National Cancer Institute’s SEER Program and assigned according to individual’s state of residence, survey year, age, sex, and race. Estimation sample comprises children under 13 (including those from households with more than one child). All specifications control for state/year/month fixed effects, individual-level covariates (race/ethnicity of the parent) and state-level characteristics (population, % households with children, marital status & education-related variables, unemployment rate, median household income, and child poverty rate). The analysis is restricted to weekdays. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level.

Table A.9: Robustness Check for SB 328, Wake-up Times and Sleep, ATUS Without Outliers

	Wake-up time			Bedtime			Sleep			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	6am	7am	8am	after 9pm	after 10pm	after 11pm	sleep hours	sleep \geq 6	sleep \geq 7	sleep \geq 8
<i>Panel A: Children aged 15–18</i>										
CA SB 328	-0.227*** (0.052)	-0.346*** (0.027)	-0.163*** (0.040)	0.052 (0.049)	0.113** (0.049)	0.088* (0.045)	0.537** (0.203)	0.020 (0.021)	0.099*** (0.019)	0.110* (0.056)
Observations	5,820	5,820	5,820	5,820	5,820	5,820	5,820	5,820	5,820	5,820
R-squared	0.072	0.159	0.152	0.055	0.057	0.051	0.066	0.018	0.027	0.044
Mean of dep. var.	0.282	0.593	0.719	0.702	0.358	0.228	9.034	0.944	0.864	0.703
Std. dev. of dep. var.	0.450	0.491	0.450	0.457	0.479	0.419	2.118	0.231	0.343	0.457
<i>Panel B: Children under 13 (Single-Child Households)</i>										
CA SB 328	-0.093** (0.035)	-0.089** (0.037)	-0.032 (0.034)	0.030 (0.049)	-0.029 (0.024)	-0.011 (0.017)	0.455** (0.190)	0.059*** (0.016)	0.094*** (0.019)	0.146*** (0.030)
Observations	12,016	12,016	12,016	12,016	12,016	12,016	12,016	12,016	12,016	12,016
R-squared	0.014	0.026	0.038	0.040	0.032	0.020	0.027	0.013	0.017	0.022
Mean of dep. var.	0.121	0.428	0.757	0.318	0.129	0.060	9.693	0.972	0.945	0.883
Std. dev. of dep. var.	0.327	0.495	0.429	0.466	0.336	0.237	1.698	0.164	0.228	0.321

Notes: Data comes from the 2003–2024 American Time Use Survey (ATUS). Observations with sleep hours below 2 and above 15 are dropped as outliers. Observations are weighted by population weights obtained from the National Cancer Institute’s SEER Program and assigned according to individual’s state of residence, survey year, age, sex, and race. Panel A restricts the analysis sample to children aged 15–18. Panel B restricts the sample to children under the age of 13. All specifications control for state, year, and month fixed effects. Panel A regressions further control for individual-level covariates (age, sex, race/ethnicity) and state-level characteristics (% households with children, marital status & education-related variables, unemployment rate, and child poverty rate). Panel B regressions further control for individual-level covariates (race/ethnicity of the parent) and state-level characteristics (population, % households with children, marital status & education-related variables, unemployment rate, median household income, and child poverty rate). The analysis is restricted to weekdays. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level.

Table A.10: SB 328, Wake-up Times and Sleep Triple-Difference Estimates (ATUS)

	Wake-up time			Bedtime			Sleep			
	(1) before 6am	(2) before 7am	(3) before 8am	(4) after 9pm	(5) after 10pm	(6) after 11pm	(7) sleep hours	(8) sleep \geq 6	(9) sleep \geq 7	(10) sleep \geq 8
Triple Interaction	-0.281*** (0.062)	-0.352*** (0.036)	-0.179*** (0.034)	0.067 (0.048)	0.106* (0.060)	0.076 (0.061)	0.737** (0.275)	0.037 (0.038)	0.125*** (0.034)	0.145* (0.072)
Observations	5,871	5,871	5,871	5,871	5,871	5,871	5,871	5,871	5,871	5,871
R-squared	0.073	0.160	0.153	0.055	0.057	0.050	0.061	0.019	0.027	0.044
Mean of dep. var.	9.334	0.585	0.709	0.696	0.356	0.228	9.129	0.942	0.864	0.705
Std. dev. of dep. var.	2.190	0.493	0.454	0.460	0.479	0.420	2.342	0.233	0.343	0.456

Panel A: Children aged 15–18

Panel B: Children under 13 (Single-Child Households)

Triple Interaction	-0.104*** (0.038)	-0.101*** (0.035)	-0.029 (0.038)	0.015 (0.046)	-0.039* (0.022)	-0.018 (0.017)	0.797*** (0.186)	0.068*** (0.014)	0.104*** (0.021)	0.159*** (0.031)
Observations	12,078	12,078	12,078	12,078	12,078	12,078	12,078	12,078	12,078	12,078
R-squared	0.016	0.026	0.037	0.041	0.035	0.024	0.029	0.016	0.020	0.026
Mean of dep. var.	0.128	0.431	0.757	0.322	0.135	0.066	9.661	0.965	0.938	0.876
Std. dev. of dep. var.	0.334	0.495	0.429	0.467	0.342	0.249	1.998	0.185	0.241	0.329

Notes: Data come from the 2003–2024 American Time Use Survey (ATUS), restricted to weekdays. The triple interaction is California \times post-SB 328 \times non-rural (IPUMS metro codes 1–3 vs. rural metro code 4). All regressions control for the 3 underlying indicator variables (California, post-SB 328, non-rural), as well as all pairwise interactions of these variables. Panel A restricts the analysis sample to children aged 15–18, weighted by SEER population weights based on state of residence, survey year, age, sex, and race; specifications include fixed effects for state, year, sex, age, month, SEER race, and Hispanic origin and state-level controls (% households with children, marital status and education-related variables, the share of 16–19 year-olds out of school, the unemployment rate, and the child poverty rate). Panel B restricts to households with exactly one child under 13, weighted by SEER state-year population aged 0–12; specifications include fixed effects for state, year, month, SEER race, and Hispanic origin and state-level controls (total population, % households with children, share divorced, share with at least a high school degree, the unemployment rate, median household income, and the child poverty rate). Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.11: SB 328, Wake-up Times and Sleep, Evidence from ATUS (2003–2024), Excluding Summer and Holidays

	Wake-up time			Bedtime			Sleep			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	6am	7am	8am	after 9pm	after 10pm	after 11pm	sleep hours	sleep \geq 6	sleep \geq 7	sleep \geq 8
<i>Panel A: Children aged 15–18</i>										
CA SB 328	-0.251*** (0.058)	-0.388*** (0.029)	-0.206*** (0.038)	0.039 (0.046)	0.098* (0.053)	0.078 (0.057)	0.827*** (0.294)	0.041 (0.036)	0.120*** (0.029)	0.132*** (0.061)
Observations	5,348	5,348	5,348	5,348	5,348	5,348	5,348	5,348	5,348	5,348
R-squared	0.077	0.157	0.149	0.053	0.056	0.052	0.063	0.019	0.028	0.044
Mean of dep. var.	9.278	0.624	0.748	0.683	0.341	0.216	9.022	0.941	0.859	0.694
Std. dev. of dep. var.	2.113	0.484	0.434	0.465	0.474	0.411	2.291	0.235	0.348	0.461
<i>Panel B: Children under 13 (Single-Child Households)</i>										
CA SB 328	-0.100*** (0.036)	-0.089*** (0.039)	-0.026 (0.033)	0.006 (0.054)	-0.041** (0.018)	-0.034* (0.017)	0.681*** (0.179)	0.074*** (0.016)	0.111*** (0.022)	0.157*** (0.031)
Observations	10,987	10,987	10,987	10,987	10,987	10,987	10,987	10,987	10,987	10,987
R-squared	0.017	0.027	0.033	0.036	0.033	0.025	0.027	0.018	0.020	0.024
Mean of dep. var.	0.130	0.444	0.775	0.312	0.130	0.064	9.646	0.965	0.940	0.878
Std. dev. of dep. var.	0.336	0.497	0.418	0.463	0.336	0.246	1.981	0.185	0.238	0.327

Notes: Data come from the 2003–2024 American Time Use Survey (ATUS). Observations are weighted by population weights obtained from the National Cancer Institute’s SEER Program and assigned according to individual’s state of residence, survey year, age, sex, and race. Panel A restricts the analysis sample to children aged 15–18. Panel B restricts the sample to households with exactly one child under the age of 13. Panel A specifications include fixed effects for state, year, sex, age, month, SEER race, and Hispanic origin and control for state-level characteristics (% households with children, marital status and education-related variables, the share of 16–19 year-olds out of school, the unemployment rate, and the child poverty rate). Panel B specifications include fixed effects for state, year, month, SEER race, and Hispanic origin and control for state-level characteristics (total population, % households with children, share divorced, share with at least a high school degree, the unemployment rate, median household income, and the child poverty rate). The analysis is restricted to weekdays. Both panels further exclude observations from the summer and all the other holidays. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.12: SB 328 and School Performance: Triple-Difference Estimates (SEDA)

	(1)	(2)	(3)	(4)
	Full	Full	Matched	Matched
	Sample	Sample	Sample	Sample
	<i>Math</i>	<i>English</i>	<i>Math</i>	<i>English</i>
Triple Interaction	0.075*** (0.011)	0.050*** (0.010)	0.087** (0.035)	0.141*** (0.031)
Observations	44,928	65,101	9,950	11,206
District FE	YES	YES	—	—
District Pair FE	—	—	YES	YES
Year FE	YES	YES	YES	YES

Notes: Data come from the Stanford Education Data Archive (SEDA-2024); the estimation sample covers 2015–2024, excluding 2020 and 2021. Estimates are based on triple-difference specifications interacting California \times post-SB 328 \times non-rural status (rural districts in California being exempted from the policy). All specifications include the same controls and fixed effects as in Table 5 and are weighted by baseline (2015) total district enrollment. All regressions further control for the 3 underlying indicator variables (California, post-SB 328, non-rural), as well as all pairwise interactions of these variables. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.13: Above and Below Mean – Effect of SB 328 on Academic and School Outcomes (CDE)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Log Math Score	Math Std. Met Share	Log English Score	English Std. Met Share	Log Science Score	Science Std. Met Share	Dropout Rate	Suspension Rate	No. Suspensions per 1,000
Policy (SB 328)	0.0023*** (0.001)	2.126*** (0.496)	0.0017*** (0.001)	1.690*** (0.507)	0.0017*** (0.000)	1.747*** (0.501)	-0.868* (0.443)	-0.174 (0.160)	-3.439 (3.878)
Observations	13,653	13,660	13,668	13,676	8,014	8,014	14,507	75,541	75,541
R-squared	0.165	0.095	0.077	0.065	0.246	0.144	0.023	0.168	0.104
Mean of dep. var.		24.81		50.93		26.32	8.700	3.624	60.56
Std. dev. of dep. var.		20.47		23.46		18.27	12.28	5.279	117.8
<i>Panel B: Middle School</i>									
Policy (SB 328)	0.0014* (0.001)	1.898*** (0.478)	0.0013** (0.001)	1.862*** (0.539)	0.0011** (0.000)	0.838** (0.396)			
Observations	17,236	17,243	17,246	17,252	10,116	10,116			
R-squared	0.893	0.875	0.867	0.852	0.034	0.041			
Mean of dep. var.		33.95		48.09		30.17			
Std. dev. of dep. var.		20.79		19.37		18.33			

Notes: Results of a robustness check where teacher-arrival treatment intensity is defined as above vs. below mean (and not based on quartiles). Regressions in Panel A (cols. 1-7), use teacher-arrival treatment intensity defined for high school teachers (IPUMS occupation 2320); regressions in Panel B (cols. 1-6) use teacher-arrival treatment intensity defined for elementary/middle school teachers (IPUMS occupation 2310); regressions in Panel A (cols. 8-9) use a combined HS+ES/MS teacher-arrival treatment intensity (IPUMS occupations 2320 and 2310). Data come from the California Department of Education for the academic years 2014-15 through 2024-25 (Panels A and B, cols. 1-4); academic years 2018-19 through 2024-25 (Panels A and B, cols. 5-6); academic years 2016-17 through 2024-25 (Panel A, col. 7); and academic years 2011-12 through 2024-25 (Panel A, cols. 8-9). In Panels A and B (cols. 1-6), academic years 2019-2020 and 2020-2021 are excluded due to COVID-19 disruptions. Panel A (cols. 7-9) contain school-wide outcomes, with high school-only sample in col. (7), and a combined high school/middle school sample in cols. (8)-(9). All specifications include school fixed effects, year fixed effects, baseline-enrollment-quartile-by-year linear trends, and control for total enrollment, the shares of White, Hispanic, and female students, and the share of socioeconomically disadvantaged students. Standard errors in parentheses, clustered at the county level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.14: Top and Bottom Quartile – Effect of SB 328 on Academic and School Outcomes (CDE)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Log Math Score	Math Std. Met Share	Log English Score	English Std. Met Share	Log Science Score	Science Std. Met Share	Dropout Rate	Suspension Rate	No. Suspensions per 1,000
<i>Panel A: High School</i>									
Policy (SB 328)	0.0017 (0.001)	1.903** (0.864)	0.0014* (0.001)	1.865** (0.775)	0.0011* (0.001)	0.997 (0.625)	-1.311* (0.670)	-0.307 (0.198)	-7.437 (4.553)
Observations	5,558	5,560	5,558	5,560	3,277	3,277	5,974	38,119	38,119
R-squared	0.190	0.100	0.092	0.069	0.196	0.098	0.028	0.179	0.119
Mean of dep. var.		24.04		49.91		25.66	8.526	4.152	69.14
Std. dev. of dep. var.		20.33		23.47		18.21	11.95	5.398	115.4
<i>Panel B: Middle School</i>									
Policy (SB 328)	0.0007 (0.001)	1.515** (0.679)	0.0002 (0.001)	0.878 (0.696)	0.0009 (0.001)	0.560 (0.445)			
Observations	8,470	8,474	8,476	8,480	5,055	5,055			
R-squared	0.894	0.876	0.860	0.846	0.038	0.045			
Mean of dep. var.		32.91		47.10		29.29			
Std. dev. of dep. var.		21.03		19.56		18.36			

Notes: Results of a robustness check where teacher-arrival treatment intensity is defined as top vs. bottom quartile plus rural counties. Regressions in Panel A (cols. 1-7), use teacher-arrival treatment intensity defined for high school teachers (IPUMS occupation 2320); regressions in Panel B (cols. 1-6) use teacher-arrival treatment intensity defined for elementary/middle school teachers (IPUMS occupation 2310); regressions in Panel A (cols. 8-9) use a combined HS+ES/MS teacher-arrival treatment intensity (IPUMS occupations 2320 and 2310). Data come from the California Department of Education for the academic years 2014–15 through 2024–25 (Panels A and B, cols. 1-4); academic years 2018–19 through 2024–25 (Panels A and B, cols. 5-6); academic years 2016–17 through 2024–25 (Panel A, col. 7); and academic years 2011–12 through 2024–25 (Panel A, cols. 8-9). In Panels A and B (cols. 1-6), academic years 2019-2020 and 2020-2021 are excluded due to COVID-19 disruptions. Panel A (cols. 7-9) contain school-wide outcomes, with high school-only sample in col. (7), and a combined high school/middle school sample in cols. (8)-(9). All specifications include school fixed effects, year fixed effects, baseline-enrollment-quartile-by-year linear trends, and control for total enrollment, the shares of White, Hispanic, and female students, and the share of socioeconomically disadvantaged students. Standard errors in parentheses, clustered at the county level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.15: Survey Responses – Effect of SB 328 on Academic and School Outcomes (CDE)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Log Math Score	Math Std. Met Share	Log English Score	English Std. Met Share	Log Science Score	Science Std. Met Share	Dropout Rate
<i>Panel A: High School</i>							
Policy (SB 328)	0.0019*** (0.001)	1.305** (0.544)	0.0015** (0.001)	1.520** (0.621)	0.0017*** (0.001)	1.755*** (0.584)	-1.024* (0.609)
Observations	13,653	13,660	13,668	13,676	8,014	8,014	14,507
R-squared	0.163	0.091	0.076	0.064	0.246	0.143	0.023
Mean of dep. var.		24.81		50.93		26.32	8.700
Std. dev. of dep. var.		20.47		23.46		18.27	12.28
<i>Panel B: Middle School</i>							
Policy (SB 328)	0.0013** (0.001)	1.350*** (0.418)	0.0013** (0.001)	1.645*** (0.552)	0.0009* (0.001)	0.433 (0.382)	
Observations	17,236	17,243	17,246	17,252	10,116	10,116	
R-squared	0.893	0.875	0.867	0.852	0.034	0.041	
Number of schools					2,230	2,230	
Mean of dep. var.		33.95		48.09		30.17	
Std. dev. of dep. var.		20.79		19.37		18.33	

Notes: Results of a robustness check where the ACS-based teacher-arrival treatment intensity (as defined in Table 6) is replaced with compliance information from the direct survey of California districts (for those districts which responded to the survey). Data come from the California Department of Education for the academic years 2014–15 through 2024–25 (Panels A and B, cols. 1–4); academic years 2018–19 through 2024–25 (Panels A and B, cols. 5–6); academic years 2016–17 through 2024–25 (Panel A, col. 7); and academic years 2011–12 through 2024–25 (Panel A, cols. 8–9). In Panels A and B (cols. 1–6), academic years 2019–2020 and 2020–2021 are excluded due to COVID-19 disruptions. Panel A (cols. 7–9) contain school-wide outcomes, with high school-only sample in col. (7), and a combined high school/middle school sample in cols. (8)–(9). All specifications include school fixed effects, year fixed effects, baseline-enrollment-quartile-by-year linear trends, and control for total enrollment, the shares of White, Hispanic, and female students, and the share of socioeconomically disadvantaged students. Standard errors in parentheses, clustered at the county level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.16: SB 328, Wake-up Times and Sleep by Gender (YRBS)

	(1)	(2)	(3)	(4)	(5)	(6)
	Sleep ≥ 6	Sleep ≥ 7	Sleep ≥ 8	Difficulty concentrating	Felt sad/hopeless	Suicidal intentions
<i>Girls</i>						
CA SB 328	0.069*** (0.018)	0.052*** (0.022)	0.032 (0.020)	-0.055* (0.031)	-0.034 (0.034)	0.011 (0.021)
Observations	59,288	59,288	59,288	24,144	67,424	59,782
R-squared	0.020	0.028	0.025	0.047	0.045	0.016
Mean of dep. var.	0.778	0.532	0.253	0.478	0.411	0.239
Std. dev. of dep. var.	0.416	0.499	0.435	0.500	0.492	0.426
<i>Boys</i>						
CA SB 328	0.068*** (0.019)	0.086*** (0.021)	0.041** (0.019)	-0.056* (0.029)	-0.023** (0.011)	-0.038*** (0.009)
Observations	58,747	58,747	58,747	24,055	66,972	59,501
R-squared	0.028	0.043	0.046	0.014	0.019	0.008
Mean of dep. var.	0.806	0.584	0.290	0.300	0.225	0.124
Std. dev. of dep. var.	0.395	0.493	0.454	0.458	0.418	0.329

Notes: Data comes from the 2007-2023 national Youth Risk Behavior Survey (YRBS). Observations are weighted by population weights obtained from National Cancer Institute's SEER Program and assigned according to individual's state of residence, survey year, age, sex, and race. All specifications control for individual-level covariates (grade, race/ethnicity) and state-level characteristics (population, population density, % households with children, marital status & education-related variables, unemployment rate, median household income, and child poverty rate). All regressions further include state and year fixed effects. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level.

Table A.17: Wake up times and Sleep by Gender, Children Aged 15–18 (ATUS)

	Wake-up time			Bedtime			Sleep			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	6am	7am	8am	after 9pm	after 10pm	after 11pm	sleep hours	sleep \geq 6	sleep \geq 7	sleep \geq 8
<i>Girls</i>										
CA SB 328	-0.303*** (0.086)	-0.197** (0.075)	-0.145*** (0.047)	-0.162** (0.071)	-0.095 (0.068)	-0.161*** (0.057)	0.901*** (0.296)	0.052* (0.028)	0.050 (0.037)	0.383*** (0.080)
Observations	2,933	2,933	2,933	2,933	2,933	2,933	2,933	2,933	2,933	2,933
R-squared	0.123	0.186	0.168	0.077	0.075	0.068	0.069	0.032	0.043	0.063
Mean of dep. var.	0.286	0.567	0.690	0.713	0.369	0.236	9.105	0.942	0.854	0.691
Std. dev. of dep. var.	0.452	0.496	0.462	0.453	0.483	0.425	2.356	0.234	0.353	0.462
<i>Boys</i>										
CA SB 328	-0.220*** (0.058)	-0.503*** (0.056)	-0.234*** (0.065)	0.179** (0.069)	0.213*** (0.074)	0.234** (0.093)	0.773** (0.314)	0.028 (0.044)	0.172*** (0.042)	-0.039 (0.062)
Observations	2,992	2,992	2,992	2,992	2,992	2,992	2,992	2,992	2,992	2,992
R-squared	0.064	0.172	0.167	0.065	0.068	0.066	0.081	0.031	0.036	0.051
Mean of dep. var.	0.274	0.604	0.729	0.678	0.343	0.220	9.155	0.942	0.873	0.720
Std. dev. of dep. var.	0.446	0.489	0.445	0.467	0.475	0.414	2.329	0.233	0.333	0.449

Notes: Data comes from the 2003-2024 American Time Use Survey (ATUS). Panel A restricts to girls, and Panel B restricts to boys. Observations are weighted by population weights obtained from the National Cancer Institute's SEER Program and assigned according to the individual's state of residence, survey year, age, sex, and race. The estimation sample comprises children aged 15–18. All specifications control for state/year/month fixed effects, individual-level covariates (age, race/ethnicity) and state-level characteristics (% households with children, marital status & education-related variables, unemployment rate, and child poverty rate). The analysis is restricted to weekdays. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level.

Table A.18: Within-State Analysis by Gender – Effect of SB 328 on High School Academic and School Outcomes (CDE)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Log Math Score	Math Std. Met Share	Log English Score	English Std. Met Share	Log Science Score	Science Std. Met Share	Dropout Rate	Suspension Rate	No. Suspensions per 1,000
Policy (SB 328)	0.0020** (0.001)	2.061*** (0.644)	0.0017** (0.001)	1.770** (0.670)	0.0014*** (0.001)	1.563** (0.595)	-1.133* (0.634)	-0.198 (0.123)	-3.492* (2.015)
Observations	12,398	12,403	12,434	12,439	7,205	7,205	13,711	75,541	75,541
R-squared	0.219	0.131	0.059	0.052	0.228	0.136	0.015	0.089	0.057
Mean of dep. var.		25.58		57.43		26.28	6.977	2.172	32.89
Std. dev. of dep. var.		20.50		23.36		18.67	11.14	4.178	83.71
<i>Boys</i>									
Policy (SB 328)	0.0018** (0.001)	1.699*** (0.540)	0.0011* (0.001)	1.084* (0.583)	0.0015*** (0.001)	1.481** (0.588)	-1.069* (0.573)	-0.432* (0.239)	-9.559* (5.617)
Observations	12,507	12,515	12,514	12,521	7,264	7,264	13,773	75,531	75,531
R-squared	0.109	0.062	0.071	0.051	0.191	0.100	0.026	0.185	0.116
Mean of dep. var.		26.24		46.86		27.68	9.586	4.936	85.23
Std. dev. of dep. var.		21.07		22.98		18.75	12.91	6.483	151.0

Notes: Top panel contains regression estimates with outcomes measured for girls, while bottom panel contains regression estimates with outcomes measured for boys. Data come from the California Department of Education for the academic years 2014–15 through 2024–25 (cols. 1–4); academic years 2018–19 through 2024–25 (cols. 5–6); academic years 2016–17 through 2024–25 (col. 7); and academic years 2011–12 through 2024–25 (cols. 8–9). In cols. (1)–(6), academic years 2019–2020 and 2020–2021 are excluded due to COVID-19 disruptions. Cols. (7)–(9) show school-wide outcomes, with high school-only sample in col. (7), and a combined high school/middle school sample in cols. (8)–(9). Regressions in cols. (1)–(7) use teacher-arrival treatment intensity defined for high school teachers (IPUMS occupation 2320; bottom three quartiles vs. top quartile plus rural counties). Regressions in cols. (8)–(9) use a combined HS+ES/MS teacher-arrival treatment intensity (IPUMS occupations 2320 and 2310; bottom three quartiles vs. top quartile plus rural counties). All specifications include school fixed effects, year fixed effects, baseline-enrollment-quartile-by-year linear trends, and control for total enrollment, the shares of White, Hispanic, female students, and the share of socioeconomically disadvantaged students. Standard errors in parentheses, clustered at the county level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.19: Within-State Analysis by Gender – Effect of SB 328 on Middle School Academic and School Outcomes (CDE)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Math Score	Math Std. Met Share	Log English Score	English Std. Met Share	Log Science Score	Science Std. Met Share
<i>Girls</i>						
Policy (SB 328)	0.0006 (0.001)	1.551*** (0.534)	0.0009 (0.001)	1.677*** (0.551)	0.0010 (0.001)	0.810* (0.471)
Observations	15,568	15,570	15,569	15,571	9,159	9,159
R-squared	0.881	0.857	0.854	0.828	0.033	0.047
Mean of dep. var.		34.54		54.14		29.19
Std. dev. of dep. var.		21.31		19.71		18.84
<i>Boys</i>						
Policy (SB 328)	0.0009 (0.001)	1.137** (0.546)	0.0006 (0.001)	1.042 (0.677)	0.0005 (0.001)	0.530 (0.405)
Observations	15,538	15,541	15,549	15,552	9,125	9,125
R-squared	0.886	0.865	0.853	0.836	0.042	0.037
Mean of dep. var.		33.84		42.48		31.43
Std. dev. of dep. var.		20.87		19.59		18.70

Notes: Top panel contains regression estimates with outcomes measured for girls, while bottom panel contains regression estimates with outcomes measured for boys. Data come from the California Department of Education for the academic years 2014–15 through 2024–25 (cols. 1–4); academic years 2018–19 through 2024–25 (cols. 5–6). In all regressions, academic years 2019–2020 and 2020–2021 are excluded due to COVID-19 disruptions. All specifications employ elementary/middle school teacher-arrival treatment intensity (IPUMS occupation 2310; bottom two quartiles vs. top two quartiles plus rural counties). All regressions further include school fixed effects, year fixed effects, baseline-enrollment-quartile-by-year linear trends, and control for total enrollment, the shares of White, Hispanic, female students, and the share of socioeconomically disadvantaged students. Standard errors in parentheses, clustered at the county level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.20: SB 328, Sleep and Mental Health by Race (YRBS)

	(1) Sleep ≥ 6	(2) Sleep ≥ 7	(3) Sleep ≥ 8	(4) Difficulty concentrating	(5) Felt sad/hopeless	(6) Suicidal intentions
<i>Hispanics</i>						
CA SB 328	0.057* (0.030)	0.040*** (0.014)	0.012 (0.009)	-0.099*** (0.027)	-0.010 (0.021)	-0.025 (0.018)
Observations	30,043	30,043	30,043	12,745	34,745	30,144
R-squared	0.021	0.037	0.030	0.057	0.065	0.030
Mean of dep. var.	0.799	0.569	0.286	0.404	0.343	0.179
Std. dev. of dep. var.	0.401	0.495	0.452	0.491	0.475	0.383
<i>Whites</i>						
CA SB 328	0.080*** (0.023)	0.093*** (0.026)	0.056** (0.026)	-0.033 (0.034)	-0.031* (0.018)	-0.016 (0.012)
Observations	55,808	55,808	55,808	22,566	61,574	55,325
R-squared	0.020	0.034	0.038	0.053	0.068	0.030
Mean of dep. var.	0.818	0.590	0.281	0.379	0.307	0.183
Std. dev. of dep. var.	0.386	0.492	0.449	0.485	0.461	0.387
<i>Others</i>						
CA SB 328	0.017 (0.021)	-0.007 (0.019)	-0.009 (0.016)	-0.007 (0.019)	-0.016 (0.028)	0.020 (0.017)
Observations	32,184	32,184	32,184	12,888	38,077	33,814
R-squared	0.023	0.032	0.033	0.062	0.064	0.037
Mean of dep. var.	0.740	0.491	0.241	0.391	0.316	0.181
Std. dev. of dep. var.	0.439	0.500	0.428	0.488	0.465	0.385

Notes: Data comes from the 2007-2023 national Youth Risk Behavior Survey (YRBS). Observations are weighted by population weights obtained from National Cancer Institute's SEER Program and assigned according to individual's state of residence, survey year, age, sex, and race. All specifications control for individual-level covariates (grade, sex) and state-level characteristics (population, population density, % households with children, marital status & education-related variables, unemployment rate, median household income, and child poverty rate). All regressions further include state and year fixed effects. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level.

Table A.21: SB 328, Wake up times and Sleep by Race, Children Aged 15–18 (ATUS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Wake-up time			Bedtime			Sleep			
	6am	7am	8am	after 9pm	after 10pm	after 11pm	sleep hours	sleep \geq 6	sleep \geq 7	sleep \geq 8
<i>Hispanics</i>										
CA SB 328	-0.339*** (0.042)	-0.712*** (0.105)	-0.046 (0.051)	-0.056 (0.050)	-0.071 (0.072)	0.021 (0.123)	1.763*** (0.373)	0.083 (0.075)	0.211*** (0.051)	0.427*** (0.098)
Observations	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071	1,071
R-squared	0.111	0.190	0.222	0.098	0.103	0.081	0.104	0.065	0.058	0.077
Mean of dep. var.	0.306	0.587	0.712	0.625	0.322	0.208	9.302	0.941	0.870	0.737
Std. dev. of dep. var.	0.461	0.493	0.453	0.484	0.468	0.406	2.421	0.235	0.336	0.441
<i>Whites</i>										
CA SB 328	-0.264*** (0.056)	-0.421*** (0.030)	-0.230*** (0.039)	0.010 (0.048)	0.107* (0.053)	0.128** (0.057)	0.742*** (0.251)	0.040 (0.034)	0.117*** (0.030)	0.087 (0.061)
Observations	4,706	4,706	4,706	4,706	4,706	4,706	4,706	4,706	4,706	4,706
R-squared	0.070	0.156	0.150	0.055	0.055	0.050	0.061	0.020	0.028	0.043
Mean of dep. var.	0.278	0.595	0.720	0.693	0.350	0.218	9.062	0.943	0.866	0.704
Std. dev. of dep. var.	0.448	0.491	0.449	0.461	0.477	0.413	2.244	0.231	0.341	0.456

Notes: Data comes from the 2003–2024 American Time Use Survey (ATUS). Observations are weighted by population weights obtained from the National Cancer Institute’s SEER Program and assigned according to individual’s state of residence, survey year, age, sex, and race. Estimation sample comprises children aged 15–18. All specifications control for state/year/month fixed effects, individual-level covariates (age, sex), and state-level characteristics (% households with children, marital status & education-related variables, unemployment rate, and child poverty rate). The analysis is restricted to weekdays. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level.

Table A.22: Within-State Analysis by Race – Effect of SB 328 on High School Academic and School Outcomes (CDE)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Log Math Score	Math Std. Met Share	Log English Score	English Std. Met Share	Log Science Score	Science Std. Met Share	Dropout Rate	Suspension Rate	No. Suspensions per 1,000
<i>Panel A: Hispanics</i>									
Policy (SB 328)	0.0034*** (0.0001)	1.921*** (0.473)	0.0025*** (0.0001)	1.928*** (0.584)	0.0020*** (0.0001)	2.254*** (0.655)	-1.272* (0.680)	-0.357** (0.171)	-5.995 (3.785)
Observations	11,725	11,728	11,792	11,796	6,982	6,982	13,062	75,541	75,541
R-squared	0.186	0.083	0.067	0.045	0.243	0.136	0.026	0.144	0.096
Mean of dep. var.		18.24		45.88		19.96	8.721	3.585	57.99
Std. dev. of dep. var.		14.77		21.13		14.23	12.22	5.303	113.0
<i>Panel B: Whites</i>									
Policy (SB 328)	0.0006 (0.0001)	1.437** (0.661)	0.0002 (0.0001)	0.379 (0.679)	0.0009 (0.0001)	1.150 (0.773)	-0.298 (0.442)	-0.207 (0.167)	-5.860 (3.716)
Observations	9,338	9,344	9,375	9,380	5,324	5,324	10,981	75,425	75,425
R-squared	0.084	0.058	0.040	0.041	0.120	0.070	0.012	0.104	0.069
Mean of dep. var.		35.11		62.99		37.97	7.842	3.632	61.65
Std. dev. of dep. var.		21.14		20.96		18.55	12.21	5.669	126.7
<i>Panel C: Socioeconomically Disadvantaged</i>									
Policy (SB 328)	0.0026*** (0.0001)	1.502** (0.627)	0.0015** (0.0001)	1.451** (0.675)	0.0019*** (0.0001)	1.861*** (0.506)	-1.234** (0.612)	-0.352* (0.202)	-7.071 (4.482)
Observations	12,408	12,413	12,426	12,431	7,399	7,399	14,153	75,445	75,445
R-squared	0.150	0.071	0.048	0.036	0.234	0.135	0.029	0.167	0.106
Mean of dep. var.		19.07		45.12		21.15	9.210	4.162	70.13
Std. dev. of dep. var.		15.94		21.06		15.01	12.40	5.637	126.7

Notes: Panel A contains regression estimates with outcomes measured for Hispanic students; Panel B contains regression estimates with outcomes measured for White students; Panel C contains regression estimates with outcomes measured for socioeconomically disadvantaged students. Data come from the California Department of Education for the academic years 2014–15 through 2024–25 (cols. 1–4); academic years 2018–19 through 2024–25 (cols. 5–6); academic years 2016–17 through 2024–25 (col. 7); and academic years 2011–12 through 2024–25 (cols. 8–9). In cols. (1)–(6), academic years 2019–2020 and 2020–2021 are excluded due to COVID-19 disruptions. Cols. (7)–(9) show school-wide outcomes, with high school-only sample in col. (7), and a combined high school/middle school sample in cols. (8)–(9). Regressions in cols. (1)–(7) use teacher-arrival treatment intensity defined for high school teachers (IPUMS occupation 2320; bottom three quartiles vs. top quartile plus rural counties). Regressions in cols. (8)–(9) use a combined HS+ES/MS teacher-arrival treatment intensity (IPUMS occupations 2320 and 2310; bottom three quartiles vs. top quartile plus rural counties). All specifications include school fixed effects, year fixed effects, baseline-enrollment-quartile-by-year linear trends, and control for total enrollment, the shares of White, Hispanic, female students, and the share of socioeconomically disadvantaged students. Standard errors in parentheses, clustered at the county level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.23: Within-State Analysis by Race – Effect of SB 328 on Middle School Academic Outcomes (CDE)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Math Score	Math Std. Met Share	Log English Score	English Std. Met Share	Log Science Score	Science Std. Met Share
<i>Panel A: Hispanics</i>						
Policy (SB 328)	0.0025*** (0.001)	1.924*** (0.542)	0.0019** (0.001)	1.816*** (0.606)	0.0015*** (0.001)	0.881* (0.451)
Observations	14,166	14,168	14,162	14,164	8,418	8,418
R-squared	0.813	0.774	0.784	0.756	0.033	0.044
Mean of dep. var.		24.70		40.01		21.67
Std. dev. of dep. var.		15.62		16.31		13.47
<i>Panel B: Whites</i>						
Policy (SB 328)	0.0004 (0.001)	0.864 (0.777)	-0.0001 (0.001)	0.720 (0.737)	-0.0008 (0.001)	-0.473 (0.658)
Observations	11,744	11,746	11,769	11,771	6,617	6,617
R-squared	0.823	0.790	0.791	0.753	0.030	0.024
Mean of dep. var.		44.23		58.67		42.12
Std. dev. of dep. var.		20.52		18.53		18.22
<i>Panel C: Socioeconomically Disadvantaged</i>						
Policy (SB 328)	0.0014 (0.001)	1.260** (0.620)	0.0010* (0.001)	0.806 (0.575)	0.0008 (0.000)	0.543 (0.337)
Observations	15,096	15,101	15,092	15,096	8,969	8,969
R-squared	0.804	0.763	0.762	0.727	0.034	0.037
Mean of dep. var.		24.47		38.54		21.73
Std. dev. of dep. var.		15.51		15.62		13.38

Notes: Panel A contains regression estimates with outcomes measured for Hispanic students; Panel B contains regression estimates with outcomes measured for White students; Panel C contains regression estimates with outcomes measured for socioeconomically disadvantaged students. Data come from the California Department of Education for the academic years 2014–15 through 2024–25 (cols. 1–4); academic years 2018–19 through 2024–25 (cols. 5–6). In all regressions, academic years 2019–2020 and 2020–2021 are excluded due to COVID-19 disruptions. All specifications employ elementary/middle school teacher-arrival treatment intensity (IPUMS occupation 2310; bottom two quartiles vs. top two quartiles plus rural counties). All specifications further include school fixed effects, year fixed effects, baseline-enrollment-quartile-by-year linear trends, and control for total enrollment, the shares of White, Hispanic, female students, and the share of socioeconomically disadvantaged students. Standard errors in parentheses, clustered at the county level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Table A.24: CA SB 328 and School Performance, Heterogeneity By Sex/Race (SEDA)

	(1) All Students	(2) Girls	(3) Boys	(4) Hispanics	(5) Whites	(6) ECD Students
<i>Panel A: Math Scores</i>						
CA SB 328	0.096*** (0.015)	0.063*** (0.016)	0.118*** (0.020)	0.122*** (0.017)	0.076*** (0.016)	0.109*** (0.016)
Observations	9,950	7,860	7,984	7,164	6,880	7,937
<i>Panel B: English (ELA) Scores</i>						
CA SB 328	0.077*** (0.013)	0.050** (0.021)	0.100*** (0.016)	0.105*** (0.014)	0.036** (0.017)	0.109*** (0.011)
Observations	11,206	9,024	9,085	8,042	7,731	8,999
District Pair FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Notes: Data come from the Stanford Education Data Archive (SEDA-2024); the estimation sample covers 2015-2024, excluding 2020 and 2021. All specifications include year and matched-district-pair fixed effects, controls for the shares of White, Hispanic, Black, and Asian students and total enrollment, and baseline-enrollment-quartile-by-year linear trends. Observations are weighted by baseline (2015) total district enrollment. Standard errors in parentheses, clustered at the state level. *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

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Evidence Taxonomy

Table A.25 summarizes principal studies discussed in the text, organized by evidence type. The pool used to construct Figure 1 and Figure A.2 includes additional within-paper rows from Bastian & Fuller (2018) and Fuller & Bastian (2024), and several Panel A sleep studies (Owens 2010; Boergers; Temkin; Yang & Choi) not separately listed here.

Table A.25: Evidence Taxonomy: School Start Times, Sleep, and Student Outcomes

Study	Evidence	Design	Sleep	Academic / Other	Verdict
<i>Panel A: Correlational and descriptive</i>					
Wahlstrom et al. (2001, 2014)	Descriptive	Pre/post; control	no +	Slight GPA gains; ↓ tardiness	Mixed
Dewald et al. (2010)	Correlational	Meta-analysis; 26 studies	—	$r = 0.07-0.13$	Suggestive
Dunster et al. (2018)	Pre/post	Actigraphy; HS; no control	2 +34 min	+4.5% grades	Mixed
Bowers & Moyer (2017)	Meta-analysis	20 studies	+	No academic pooling	Sleep: +
Yip et al. (2022)	Meta-analysis	28 studies; $N \approx 1.8M$	+	No significant pooled effect ^a	Sleep: +
<i>Panel B: Quasi-experimental — United States</i>					

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Table A.25 continued

Study	Evidence	Design	Sleep	Academic / Other	Verdict
Hinrichs (2011)	QE	Cross-district DiD	—	0.00 (ACT) ^b	Null
Carrell et al. (2011)	QE	Randomized; USAFA	—	+0.15 SD ^k	Positive
Edwards (2012)	QE	Transportation IV; NC	—	+0.03–0.05 SD ^c	Positive
Lusher & Yasenov (2016)	QE	Double-shift; Eastern Europe	—	0.00 (aggregate) ^d	Null (ag- gregate)
Lusher & Yasenov (2018)	QE	Same; gender- disaggregated	—	+ boys; 0.00 girls	Positive (boys)
Lusher et al. (2019)	Experimental	Random as- signment; Vietnam	+	+ (smaller than obs.)	Positive
Groen & Pabilonia (2019)	Observational	DLS + Oster bounds; PSID- CDS	+(F)	+0.16–0.28 SD (F; suggestive) ^e	Suggestive
Heissel & Norris (2018)	QE	Time-zone IV; FL	—	+0.06–0.08 SD ^f	Positive
Owens et al. (2017)	QE	Pre/post; Fair- fax County VA	+30 min	—	Sleep: +
Widome et al. (2020)	QE	DiD + actigra- phy; MN	+41–43 min	—	Sleep: +
Lenard et al. (2020)	QE	DiD (advance); Wake County	—	+0.04 SD [–0.19, 0.28] [†]	Null (test)

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Table A.25 continued

Study	Evidence	Design	Sleep	Academic / Other	Verdict
James et al. (2023)	QE	DiD; MN (START co- hort)	— ^g	+0.17 GPA pts; ↓ tardi- ness	Mixed ^g
<i>Panel C: Quasi-experimental — international and time-of-day</i>					
Cortes et al. (2012)	QE	Admin data; first-period; Chicago	—	↓ grades, first period	Positive
Pope (2016)	QE	Admin data; LAUSD	—	Mixed (teacher learning)	Mixed
Jung & Fenelon (2024)	QE	DiD; South Ko- rea mandate	+19–7 min ^h	↓ substance use	Sleep: + (fades)
Lo et al. (2018)	QE	Pre/post; Sin- gapore	+23 min (TIB)	—	Sleep: +
Chan et al. (2018)	QE	Pre/post boarding; HK (1-mo follow- up)	+48 min ^l	—	Excluded from pool ^l
Chan et al. (2024)	QE	Pre/post boarding; HK (7-mo follow- up)	+35 min	↑ life satis- faction	Positive ⁱ

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Table A.25 continued

Study	Evidence	Design	Sleep	Academic / Other	Verdict
Sadikova et al. (2024)	QE	IV (SST→sleep); MN	—	↓ depression	Positive ^j
Bastian & Fuller (2023)	QE	Panel DiD; NC middle	—	+0.08 SD math; +0.04 reading	Positive
<i>Panel D: Experimental evidence on sleep</i>					
Giuntella et al. (forthcoming)	RCT	Field exper- iment; university	+19 US min	+0.10–0.11 SD	Positive

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Table A.25 continued

Study	Evidence	Design	Sleep	Academic / Other	Verdict
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Notes: QE = quasi-experimental; RCT = randomized controlled trial; DiD = difference-in-differences; F = female students only; HS = high school; MN = Minnesota. Sleep effects in minutes of additional school-night sleep; academic effects in SD units where available. Dashes indicate outcome not primary focus. ^a Null pooled academic effect reflects aggregation across designs of varying quality rather than evidence of a true zero. ^b The ACT captures cumulative knowledge and is likely to respond slowly to short-run schedule changes. This caveat applies to every ACT-outcome row in the meta-analysis, including Hinrichs (2011), Lenard et al. (2020), Bastian & Fuller (2018, ACT), and Fuller & Bastian (2024, ACT), and is not a Hinrichs-specific dismissal. ^c Standardized-test (Z-score) coefficients from Edwards (2012), Table 7, student-school FE specification (math +0.057, SE 0.010; reading +0.035, SE 0.013). ^d Aggregate null reflects offsetting gender-specific effects. ^e OLS with Oster (2019) bounds; not causally identified. ^f Effects concentrated among pubescent students; near zero for pre-pubescent children. James’s GPA effect is reported in grade-point units (not SD), so the study contributes to the qualitative discussion only and is excluded from the pooled academic estimate. [†] Studies a start time advance rather than a delay; the per-hour-delay equivalent is computed by dividing the raw ACT-points coefficient by the in-sample ACT SD (5.727) and flipping sign to express on a delay scale. ^h Initial gain of 19 min. fades to 7 min. within one year as bedtimes shift later. ⁱ Seven-month follow-up; significant reductions in depression, anxiety, and insomnia ($d = 0.29\text{--}0.67$). A separate $d = 0.72$ effect-size in the same paper refers to total sleep time (paired-sample), not mental health. ^j IV-estimated: 30-min sleep gain $\rightarrow -0.78$ depression points (SE 0.27); -1.36 fatigue points (SE 0.38). ^k Per-hour-equivalent of the 7:00 vs. 7:50 a.m. first-period contrast at USAFA, rescaled from the source paper’s 50-min contrast (raw 0.13 SD over 50 min \rightarrow 0.15 SD per hour). ^l Same Hong Kong residential boarding-school intervention as Chan et al. (2024), reported at 1-month follow-up rather than 7-month. Excluded from the sleep pool to avoid double-counting the shared Cohort 1 baseline sample.