Delaying School Start Time on Adolescents' Time Use in South Korea

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Evaluating Educational Policies in South Korea

Causal Effects of Single-Sex Schools on College Entrance Exams and College Attendance: Random Assignment in Seoul High Schools

Hyunjoon Park · Jere R. Behrman · Jaesung Choi

Separating boys and girls and increasing weight? Assessing the impacts of single-sex schools through random assignment in Seoul

Jaesung Choi [a,*], Hyunjoon Park [b], Jere R. Behrman [c]

Evaluating the effects of governmental regulations on South Korean private cram schools

Jaesung Choi[a] and Rosa Minhyo Cho[b*]

THE EFFECT OF SCHOOL CHOICE ON STUDENT'S ACADEMIC PERFORMANCE[*]

JAESUNG CHOI   JISOO HWANG

- **Human rights ordinance** on student behavior (학생인권조례)
- The impact of **universal school lunch** on student misbehavior (무상급식)

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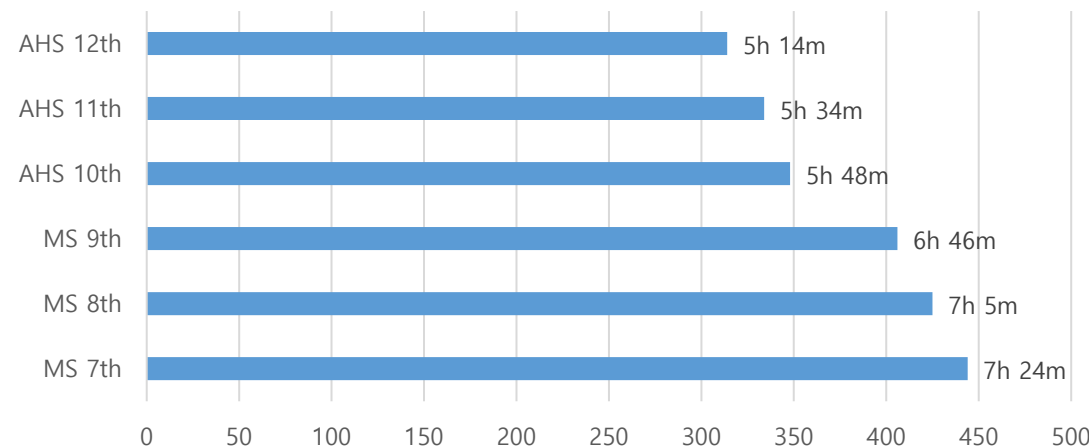University of Colorado, Boulder

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Motivation

- Recommended sleep time for ages 14-17 is 8-10 hours (National Sleep Foundation, 2006)

- Severe **sleep deprivation** among **Korean students**

Average Sleep Duration by Grade

(2015, Korea CDC)

Grade	Duration
AHS 12th	5h 14m
AHS 11th	5h 34m
AHS 10th	5h 48m
MS 9th	6h 46m
MS 8th	7h 5m
MS 7th	7h 24m

0 50 100 150 200 250 300 350 400 450 500

- Sleep duration of academic high school students on weekdays is **2.5 hours less** than their counterparts in **US** (BLS, 2018)

Motivation

- Previous studies reported associations between **sleep time (sleep deprivation)** and
  - **Health:** Obesity, mental health (suicidal ideation), daytime functioning, mortality risk
    (e.g., Chen et al. 2006; Dahl et al. 2002)
  - **Academic outcomes** (e.g., Carrell et al. 2011)

- Efforts were made to introduce a **delay in the school start time** into a **policy**
  - To help **students to sleep more**
  - (consequently) to have **positive impacts on health and academic outcomes**

Motivation
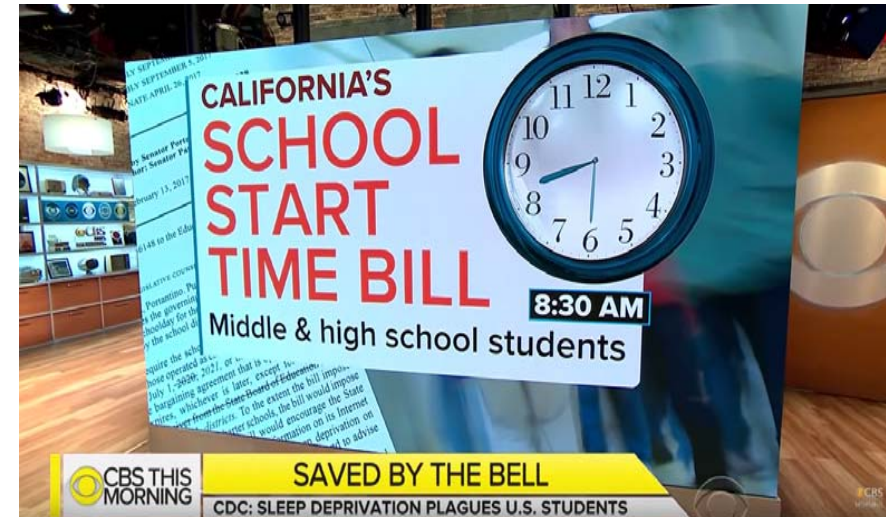
- "Later Start Times For **California** Middle, High Students Signed Into Law" (CBS, Oct., 2019)

  - A new law pushed back start times at most public middle and high schools, no earlier than 8:30 a.m (NY Times, 2019)

- "**Seattle** high schools find later start time improves academic performance" (Dec., 2018)

Motivation

["California Tells Schools to Start Later, Giving Teenagers More Sleep"](#) (NY Times, Oct, 2019)

About 90 percent of high schools and 80 percent of middle schools in the nation start before 8:30 a.m., the Centers for Disease Control and Prevention said in 2014.

American students are not the only ones used to getting up early. In South Korea, students often start the day before 8 a.m. and take extra classes after school late into the night. But the country has a high suicide rate among adolescents, and experts there, like their counterparts in the United States, have expressed worries about the effects of sleep deprivation on youth mental health.

Some schools in Australia and New Zealand have even tried out start times of 10 a.m. or later, which school officials say has helped with alertness in class.

School Starting Time before the policy (Gyeonggi)

|	Middle School (7th, 8th, 9th)		General High School (10th & 11th)		General High School (12th)	
Before Policy Introduction	Before 8:00	3%	Before 7:40	8%	Before 7:40	14%
	8:00~8:30	96%	7:40~8:00	55%	7:40~8:00	50%
	After 8:30	1%	After 8:00	37%	After 8:00	36%

Introduction of a Policy

Gyeonggi 9 o'clock attendance policy

- The newly elected superintendent put a strong drive on the policy after regional election on June 2014

- Immediately delayed the school start time to 9 am from **2014 fall semester**
  - Average **delay of 45 minutes**
  - 99.1% middle schools, 88.9% high schools adopted the policy as of 2015

- In contrast, **Seoul** did not prioritize the changes, and less than 4% of schools delayed school starting time in 2015
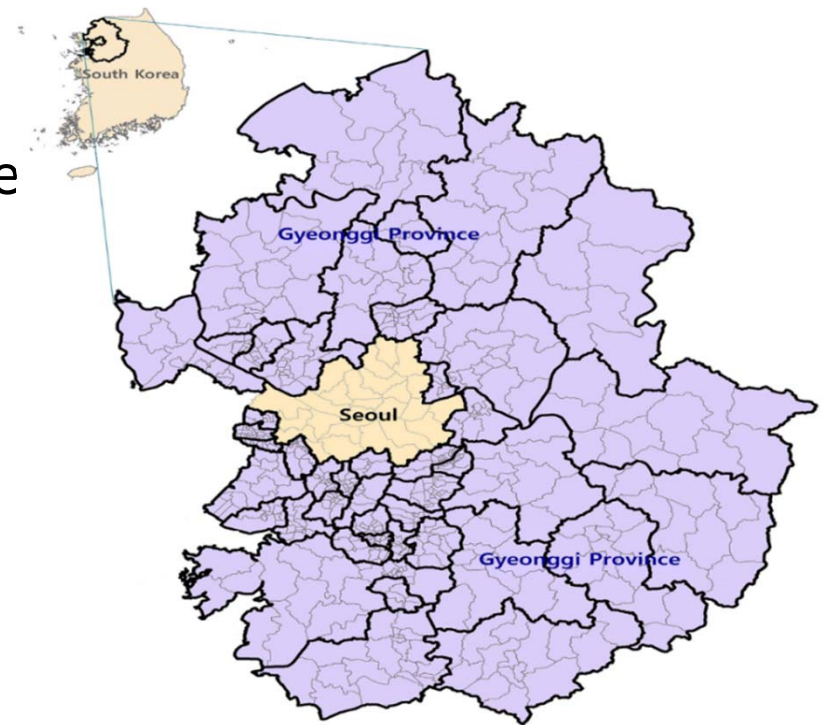
Time Schedule, Before and After

Figure 1: Changes in School Schedule by School Level before and after Policy Change
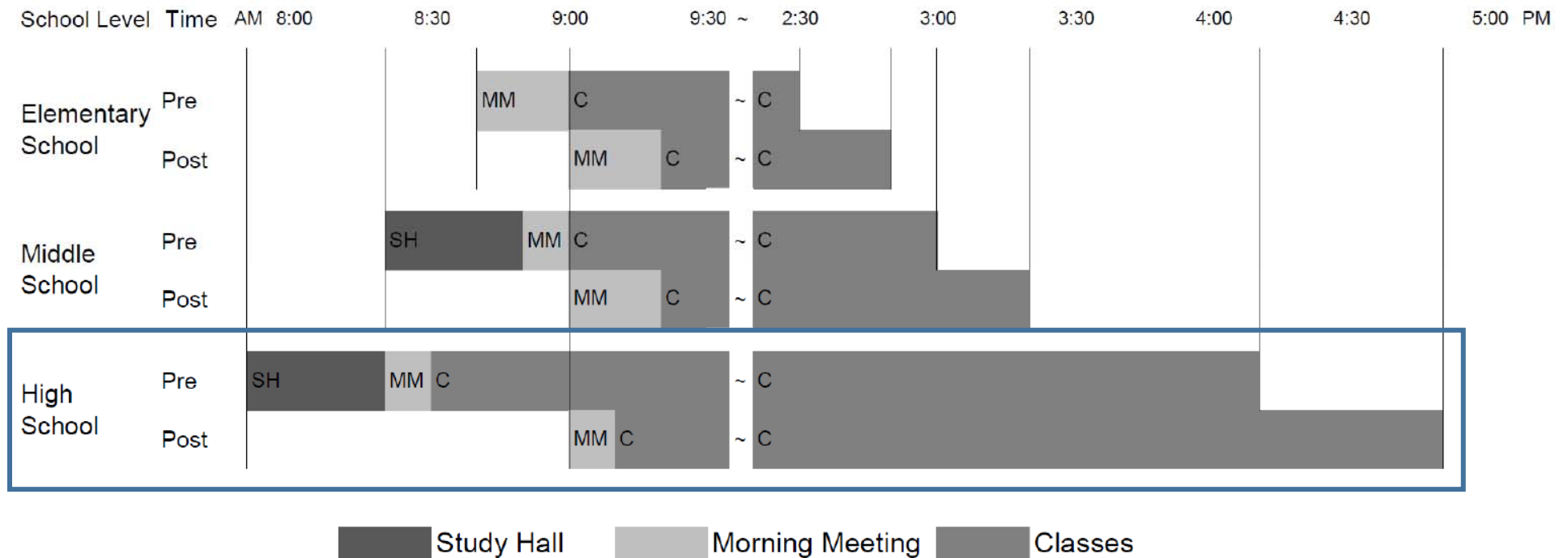
Notes: An example of changes in school schedule by school level. Source: a telephone survey of representative schools.

Source: Shin (2018)

Introduction of a policy

Sharply divided opinions on the policy
(Controversy over '9am School Start' in Arirang TV, Sep 2, 2014)

- **Proponents**:
  - Students will **sleep more** and have a leisurely breakfast
  - This will **improve their health and concentration**

- **Opponents**:
  - Lead to **poorer academic performance** due to the shortening of time spent in school for self-study or extra classes
  - More time spent on **private supplementary education** and **other non-academic activities** at night (e.g., more games and smartphone use)
  - Concerns for **dual-income families** for leaving young students unattended

Research Question

Previous studies (Kim 2018; Shin 2018) on the policy focus on
- The **mean** effects on **sleep time (+)**:
  Any **heterogeneous effects** or which components would drive the change?

- Academic outcomes **(+)**:
  How about other activities and health outcomes?

1. Does delaying school starting time affect students'
   - **sleep behavior?**
   - **time use on other activities?**
   - (health outcomes?)
     : sleep satisfaction, subjective health, stress level, height

2. Are there any **differential** impacts by **socioeconomic backgrounds**?

3. What could be a **potential mechanism**?

Data_KYRBS

Korea Youth Risk Behavior Web-based Survey (KYRBS, 2011~2017)

- Cross-sectional, web-based survey to understand health behavior of Korean teenagers (similar to YRBSS in the U.S.)

- Conducted between **May** and **July**
  (The policy was introduced in **Sep**. **2014**)
    ⇒ **2011~2014 (pre-treatment) vs.**
                       2015~2017 (post-treatment)

- Sample: 146,248 secondary school students living in Seoul and Gyeonggi

- Used to estimate the **policy impact** on **sleep behavior** and **health outcomes**

- Question on **sleep behavior** (answers in minutes):

    "For the past **weekdays** (**weekends**),
    when did you **go to sleep** and when did you **wake up**?"

Descriptive Analysis_KYRBS
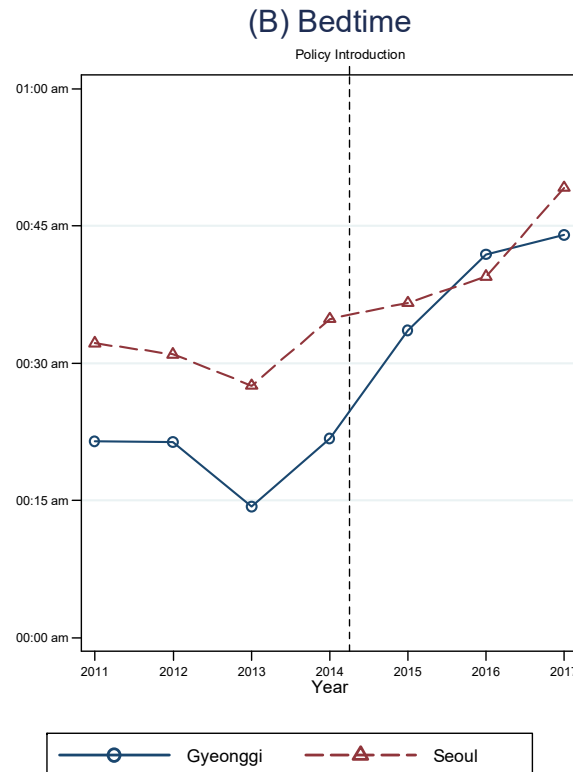
Changes in Sleep Patterns of Adolescents

(A) Proportion of Students Sleeping
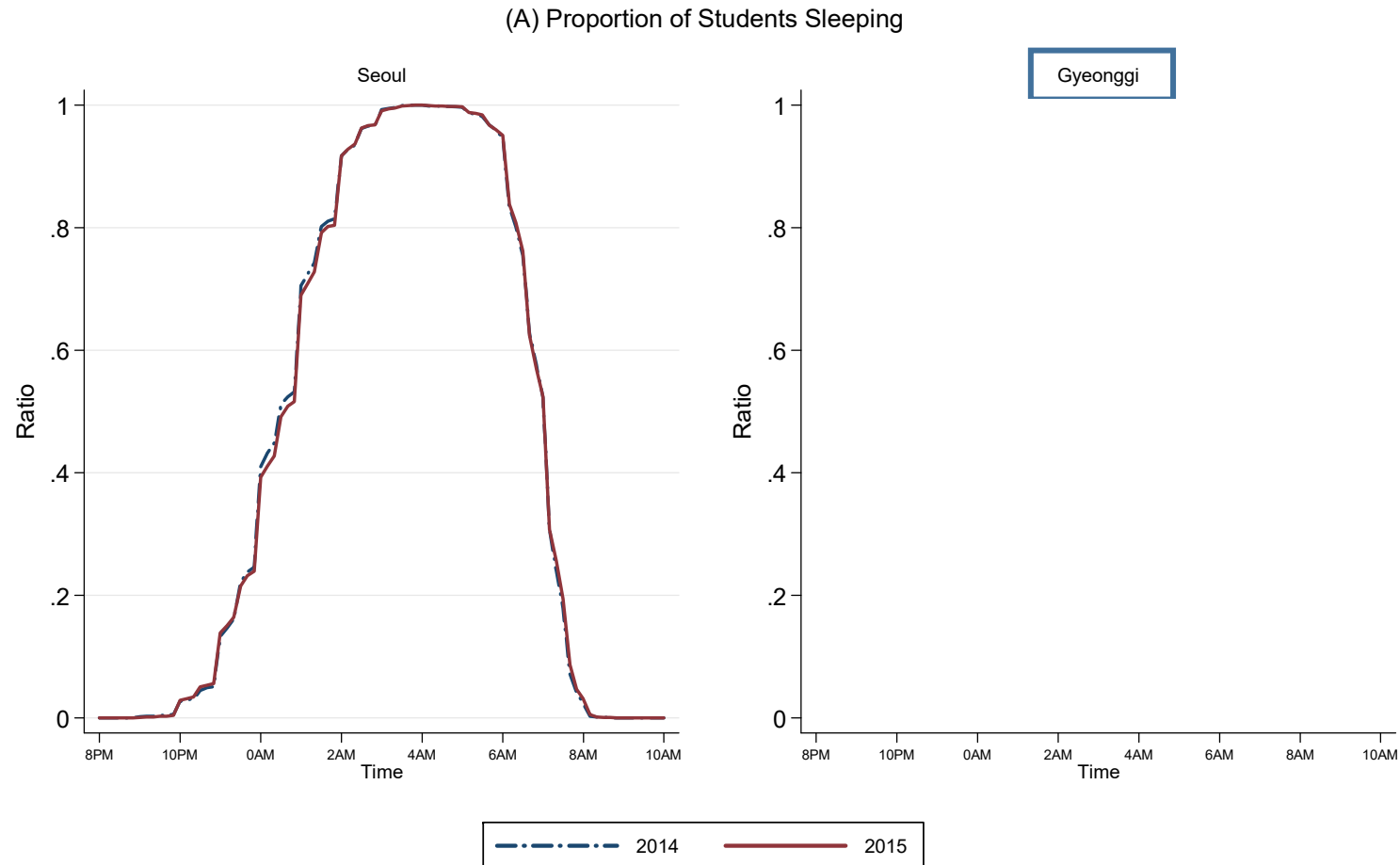
- The curve for Gyeonggi **shifts to the right** after the policy
- Students in Gyeonggi **slept later** and **woke up later** in 2015 compared to 2014

Descriptive Analysis_KYRBS

Change in Sleep Patterns of Adolescents

(B) Bedtime

- Show a similar trend before the policy implementation (2011–2014)
- However, sleep schedule diverges after the policy introduction
- Wake-up time among students in Gyeonggi was even more delayed, outweighing the difference in bedtime

Data_Korea Media Panel

Korea Media Panel (KMP, 2011~2017)

- Examine **media usage** in detail

- **Media diary**: record of media consumption every 15 minutes for three days
  ⇒ Time spent on **electronic devices (computer, smartphone, TV)** at **home** from **8 pm to bedtime**

- Conducted between **May** and **July**
  ⇒ **2011~2014 (pre-treatment)** vs. **2015~2017 (post-treatment)**

- Sample: 4,643 person-year observations, living in Seoul and Gyeonggi

Time	Media Usage			
	Media Device	**Action**	**Connection**	**Location**
00:00 - 00:15				
00:15 - 00:30				
00:30 - 00:45				
00:45 - 01:00				
01:00 - 01:15				
01:15 - 01:30				
01:30 - 01:45				
01:45 - 02:00				

Descriptive Analysis_Korea Media Panel

- **Change in Electronic Device Usage of Adolescents**

(B) Proportion of Students using Electronic Devices
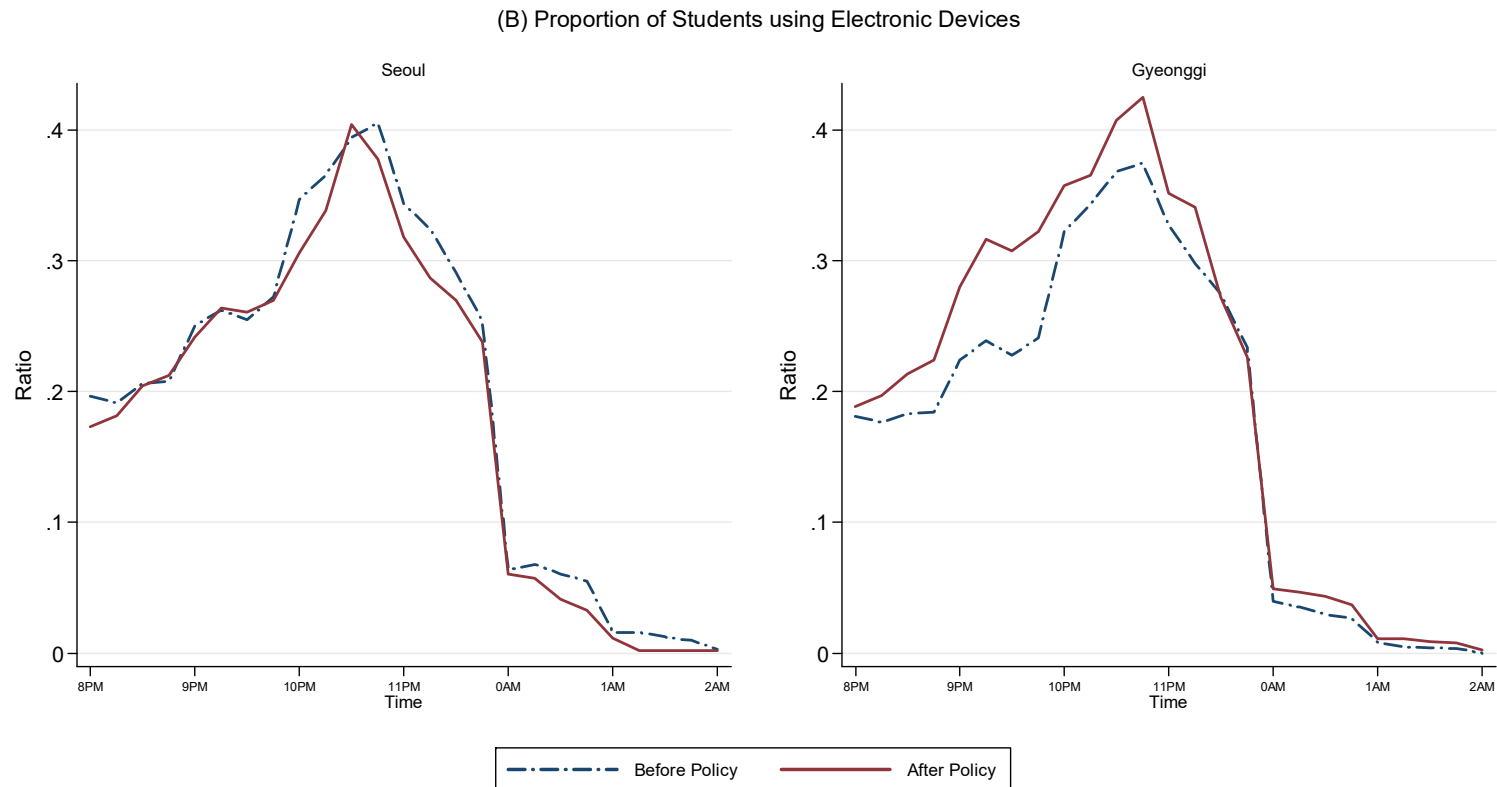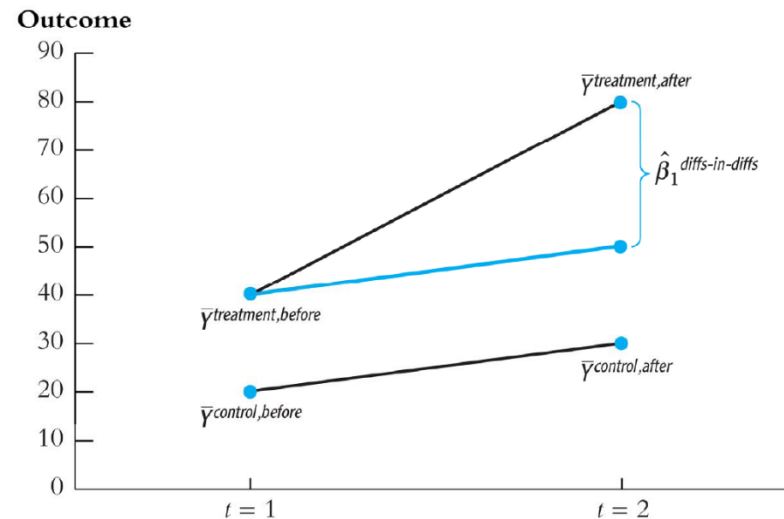

- Students in Gyeonggi increased the use of electronic devices after the policy introduction (10:45pm: 37.5% -> 42.5%)

Difference in Differences (DID) Estimation

$$\hat{\beta}_1^{diffs-in-diffs} = (\overline{Y}^{treat,after} - \overline{Y}^{treat,before}) - (\overline{Y}^{control,after} - \overline{Y}^{control,before})$$

	Before	**After**	Difference
Treatment	a	a+c+**X**	c+**X**
Control	b	b+c	c
Difference	a-b	a+**X**-b	**X**

$$\text{Outcome}_{it} = \beta_1 + \beta_2 \, \text{Treat}_i + \beta_3 \, \text{Post}_t + \boxed{\beta_4} (\text{Treat} * \text{Post})_{it} + \varepsilon$$

Treatment = a dummy if the observation is in the treatment group
Post = post treatment dummy

Estimation Strategy

Differenece-in-Differences (DID)

$$y_{ist} = \alpha + \beta X_{ist} + \delta d_{st} + \lambda_s + \lambda_t + \varepsilon_{ist}$$

- d_{st} : indicator equals 1 <u>if region s at time t is subjected to the policy</u>
  (=Gyeonggi X Post)
- X_{ist} : set of individual, household, and school characteristics
- λ_s : region fixed effects
- λ_t : year fixed effects

| Control Variable	
Individual Characteristics	**age, gender**
Household Characteristics	**socioeconomic status (SES), parental education number of parents living together**
School Characteristics	**general high schools, vocational high schools**

Result 1_Change in Sleep Behavior

	Sleep Time			Bedtime	Wake Time
	(1)	(2)	(3)	(4)	(5)
Gyeonggi	9.61***	6.48***	6.52***	-8.95***	-2.43***
(Treatment Group)	(0.556)	(0.459)	(0.459)	(0.457)	(0.217)
Post	-9.04***	-7.46***	-1.68***	1.89**	0.21
(After Policy)	(0.672)	(0.556)	(0.788)	(0.781)	(0.385)
Gyeonggi X Post	15.61***	16.18***	16.15***	8.77***	24.92***
	(0.884)	(0.736)	(0.736)	(0.734)	(0.364)
Female		-30.16***	-30.14***	18.83***	-11.30***
		(0.357)	(0.357)	(0.356)	(0.176)
Age		-12.57***	-12.58***	12.53	-0.05
		(0.187)	(0.187)	(0.187)	(0.093)
Vocational High School		-23.22***	-23.06***	-9.45***	-32.52***
		(0.890)	(0.889)	(0.890)	(0.447)
General High School		-45.44***	-45.36***	16.81***	-28.55***
		(0.668)	(0.670)	(0.669)	(0.327)
Household Characteristics		O	O	O	O
Year FE			O	O	O
Constant	375.53***	445.28***	443.44***	1,424.31***	427.76***
Sample	142,861	142,387	142,387	142,387	142,387
R-squared	0.012	0.318	0.319	0.189	0.253

Note: Robust standard errors are presented in parentheses. * p , 0.1; ** p , 0.05; *** p , 0.01.

- **Increase** sleep hours **16.2** minutes on **weekdays**
- **Decrease** sleep hours **12.7** minutes during the **weekend**
  → More **balanced sleep** schedule throughout a week

Result 2_Heterogeneity in Sleep Time

**Any differential impacts by socioeconomic backgrounds?**
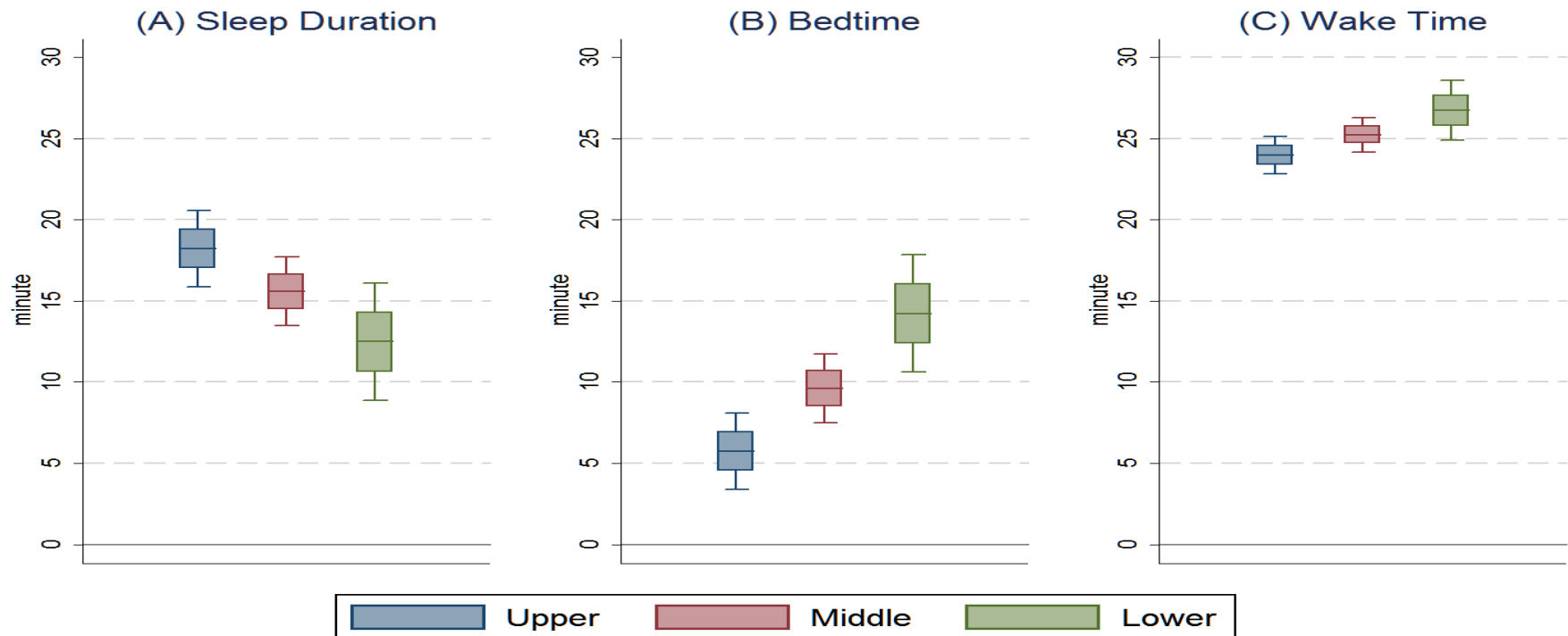
The better students' backgrounds are, the more positive effects they enjoy due to the policy change

- Students with higher SES increased sleep time more
- The differences in sleep duration by SES is mainly driven by bedtime
- Students with higher SES slept more even before the policy

Result 3_Heterogeneity for Other Activities

How about other activities?

(D) Weekday Study Time

(E) Weekday Electronic Device Usage
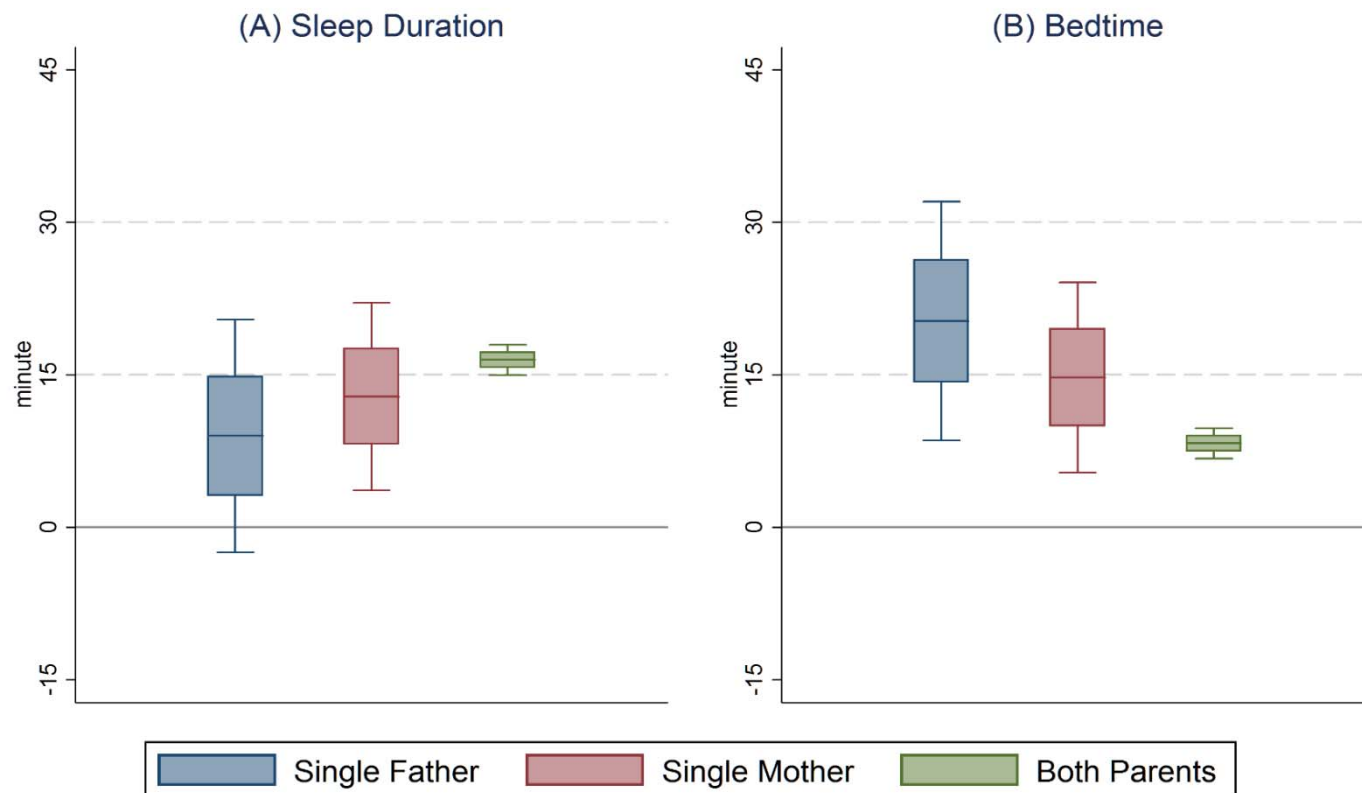
Legend: Upper — Middle — Lower
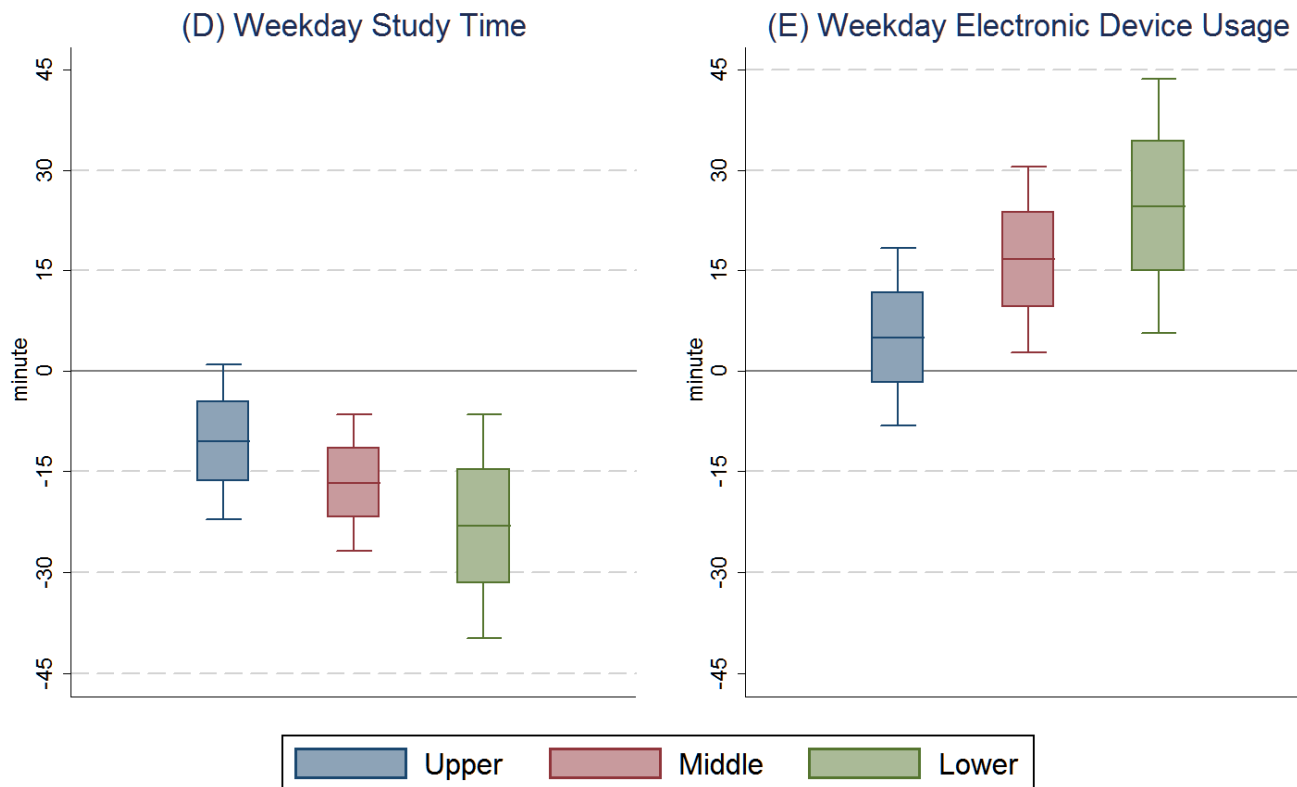
- Students with **lower** SES **decreased** study time **more**
- Students with **lower** SES **increased** time for electronic device usage more

Potential Mechanism 1_Parental Monitoring

Would the disparities by SES reflect any differences in the degree of parental guidance and involvement?

→ Examine differentials by the **Composition of Household**

- Increase in **sleep duration**: **Single Fa** < SMa < **Both P** (9 min vs 16.5 min)
- Delay in **time to bed**: **Single Fa** > SMa > **Both P**

Potential Mechanism 2_Private Education

Any differentials in **time use** of **Private Supplementary Education**?
- **Korea Time Use Survey 2014** (Sample: 682 students)
- Conducted three times: July (29.3%) vs. Sept. (45.6%), Nov. (25.1%)

	Time Spent on Private Lectures		
	Upper	Middle	Lower
	(1)	(2)	(3)
Gyeonggi (Treatment Group)	-19.77	-23.71	-10.58
	(25.104)	(16.514)	(31.140)
Post (After Policy)	-7.53	-3.17	-17.26
	(22.721)	(15.676)	(25.649)
Gyeonggi X Post	21.56	24.82	3.83
	(29.151)	(19.608)	(34.135)
Constant	135.00***	99.21***	67.31***
Sample	190	318	174
R-squared	0.004	0.014	0.009

Note: Robust standard errors are presented in parentheses. * p , 0.1; ** p , 0.05; *** p , 0.01.

- (Although insignificant due to the small samples,) **differential impacts by SES** on the **time spent on private supplementary education** was observed

Discussion

- **Main findings:**
  - **Delaying school start time about 45 minutes**
    - students sleep 16.2 minutes more
    - increased time spent on electronic devices at night
    - (improved physical and mental health outcomes)
  - **Differential impacts in favor of those from higher SES**
    - Lower SES: sleep less, study less, electronic devices more

- **Potential mechanisms:**
  - **Parental monitoring:** household composition
  - **Spending on education**: differential use of private supplementary education

Discussion

- **Implication:**

  Any **unintended consequences**?

  - The policy change further **widened the preexisting gap in study and sleeping time by SES**
  - **Despite the reported positive mean effect in Kim (2008) and Shin (2008),**

    there can be a **growing gap** in **academic outcomes by SES** & possibly **negative impacts** for those with **lower SES**

- **Robustness Checks:**

  - **6 other metro** areas as a control group
  - Leads and lags (**event study** framework)

Appendix

By Grade and Gender for Sleep Hours

Sleep hours on weekdays

Grade	Boys			Girls		
	1st	2nd	3rd	1st	2nd	3rd
MS	19.1	15.1	18.4	13.4	17.3	14.5
GHS	22.7	19.8	22.6	11.3	13.2	11.4
VHS	15.7	4.4	13.7	14.3	12.1	22.0

For MS

	1st	2nd	3rd	1st	2nd	3rd
Bed time	0.7	5.8	4.9	6.4	6.5	9.2
Wake-up time	19.9	20.9	23.3	19.7	23.9	23.8

For GHS

	1st	2nd	3rd	1st	2nd	3rd
Bed time	6.5	14.5	4.4	16.2	14.0	9.7
Wake-up time	29.2	34.3	26.9	27.5	27.2	21.1

Data_KYRBS

- **Change in Within School Average Wake-up and Sleep Time**
  - Average wake-up time for **middle and high schools** in Gyeonggi have been delayed
  - Average sleep time for schools in Gyeonggi have been increased

With-in School Average Wake Time and Sleep Time

(A) 2014   (B) 2015

Legend: ● Gyeonggi - High School   ▲ Gyeonggi - Middle School   ◇ Seoul - High School   □ Seoul - Middle School
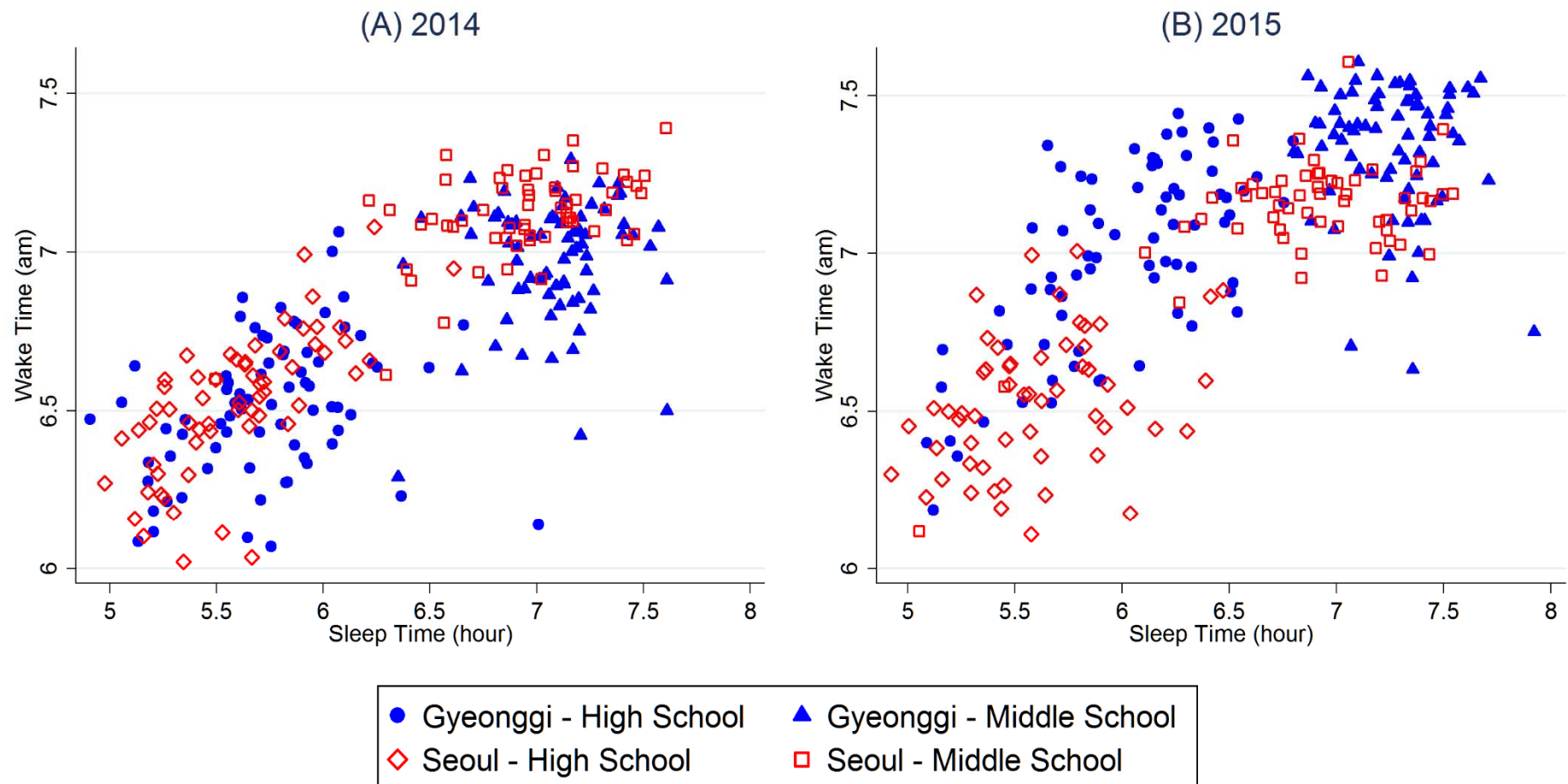
Result 2_Socioeconomic Backgrounds of Students

Korea Youth Risk Behavior Web-based Survey

❖ Survey Question: What is the economic condition of your family?

① Low (8.5%)   ② Lower-middle (27.3%)   ③ fair (45.7%)
④ Upper-middle (14.9%)   ⑤ High (3.7%)

• Classified ① Low and ② Lower-middle as **'Lower Class' (35.7%)**,
③ fair as **'Middle Class' (45.7%)**, and
④ Upper-middle and ⑤ High as **'Upper Class' (18.6%)**

	Seoul	Gyeonggi
Lower Class	28.5%	26.4%
Middle Class	43.4%	47.5%
Upper Class	18.7%	18.3%

- **Delaying school start time improved students' physical health and emotional wellbeing**
  - Heights of students in Gyeonggi increase 0.17 cm more
  - Also contributes to improvements in mental health outcomes
  (Sleep Satisfaction: **0.1 std ↑** , Subjective Health: **0.03 std ↑** , Stress Level: **0.03 std ↓**)

	Height (cm)	Weight (kg)	Body Mass Index	Sleep Satisfaction	Subjective Health	Stress Level
	(1)	(2)	(3)	(4)	(5)	(6)
Gyeonggi (Treatment Group)	-0.39*** (0.043)	-0.42*** (0.066)	-0.06*** (0.020)	-0.05*** (0.007)	-0.05*** (0.006)	0.00 (0.006)
Post (After Policy)	0.13* (0.072)	0.62*** (0.114)	0.19*** (0.035)	0.03*** (0.013)	0.03*** (0.010)	-0.02** (0.011)
Gyeonggi X Post	0.17** (0.067)	-0.16 (0.108)	-0.09*** (0.033)	0.09*** (0.012)	0.02*** (0.009)	-0.03*** (0.010)
a Set of Controls	O	O	O	O	O	O
Year FE	O	O	O	O	O	O
Constant	166.79***	57.31***	20.43***	3.19***	4.12***	2.98***
Sample	139,656	139,656	139,656	142,387	142,387	142,387
R-squared	0.470	0.270	0.065	0.068	0.062	0.059

Note: Robust standard errors are presented in parentheses. * p , 0.1; ** p , 0.05; *** p , 0.01.

Change in physical and mental health by SES

- positive correlation between increase in sleep time and improvements in physical and mental health outcomes

	Height (cm)			Sleep Satisfaction			Stress Level		
	Upper	Middle	Lower	Upper	Middle	Lower	Upper	Middle	Lower
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gyeonggi (Treatment Group)	-0.41***	-0.42***	-0.29***	-0.05***	-0.06***	-0.05***	0.01	-0.02**	0.02
	(0.076)	(0.062)	(0.092)	(0.013)	(0.011)	(0.016)	(0.011)	(0.009)	(0.014)
Post (After Policy)	0.22*	0.16	-0.14	0.01	0.04*	0.08***	-0.01	-0.04**	-0.03
	(0.117)	(0.107)	(0.176)	(0.021)	(0.018)	(0.031)	(0.018)	(0.016)	(0.026)
Gyeonggi X Post	0.20*	0.22**	0.02	0.10***	0.08***	0.06**	-0.05***	-0.00	-0.02
	(0.112)	(0.099)	(0.163)	(0.020)	(0.017)	(0.028)	(0.017)	(0.014)	(0.024)
a Set of Controls	O	O	O	O	O	O	O	O	O
Year FE	O	O	O	O	O	O	O	O	O
Constant	166.49***	166.98***	167.68***	3.32***	3.18***	2.93***	2.87***	2.99***	3.31***
Sample	50,106	64,014	25,536	50,932	65,164	26,291	50,932	65,164	26,291
R-squared	0.455	0.477	0.488	0.067	0.058	0.042	0.042	0.042	0.035

Note: Robust standard errors are presented in parentheses. * p , 0.1; ** p , 0.05; *** p , 0.01.

✓ **Leads and Lags**
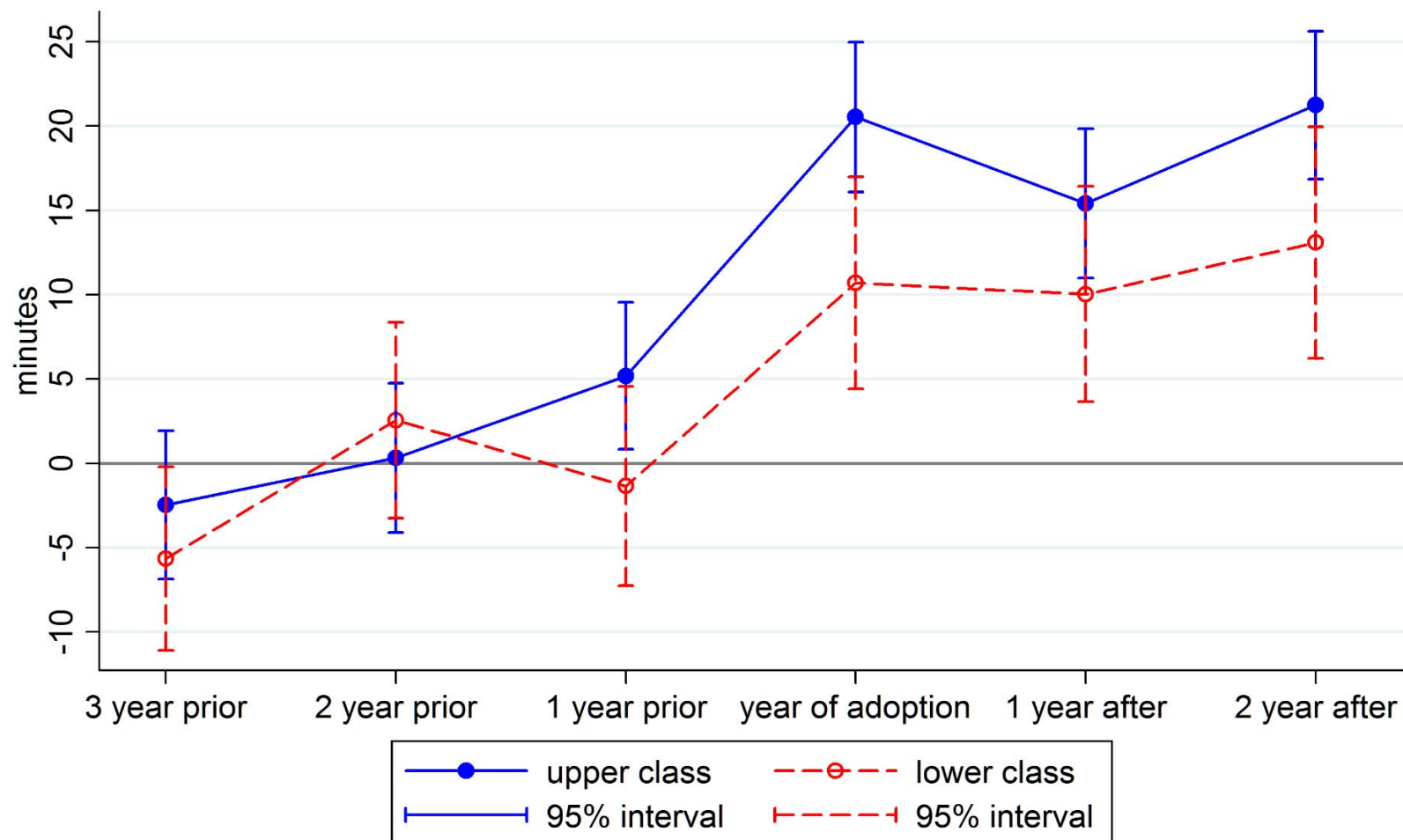
$$y_{ist} = \alpha + \beta X_{ist} + \sum_{k=-3}^{2}(\delta_{2015+k} d_{s,2015+k}) + \lambda_s + \lambda_t + \varepsilon_{ist}$$
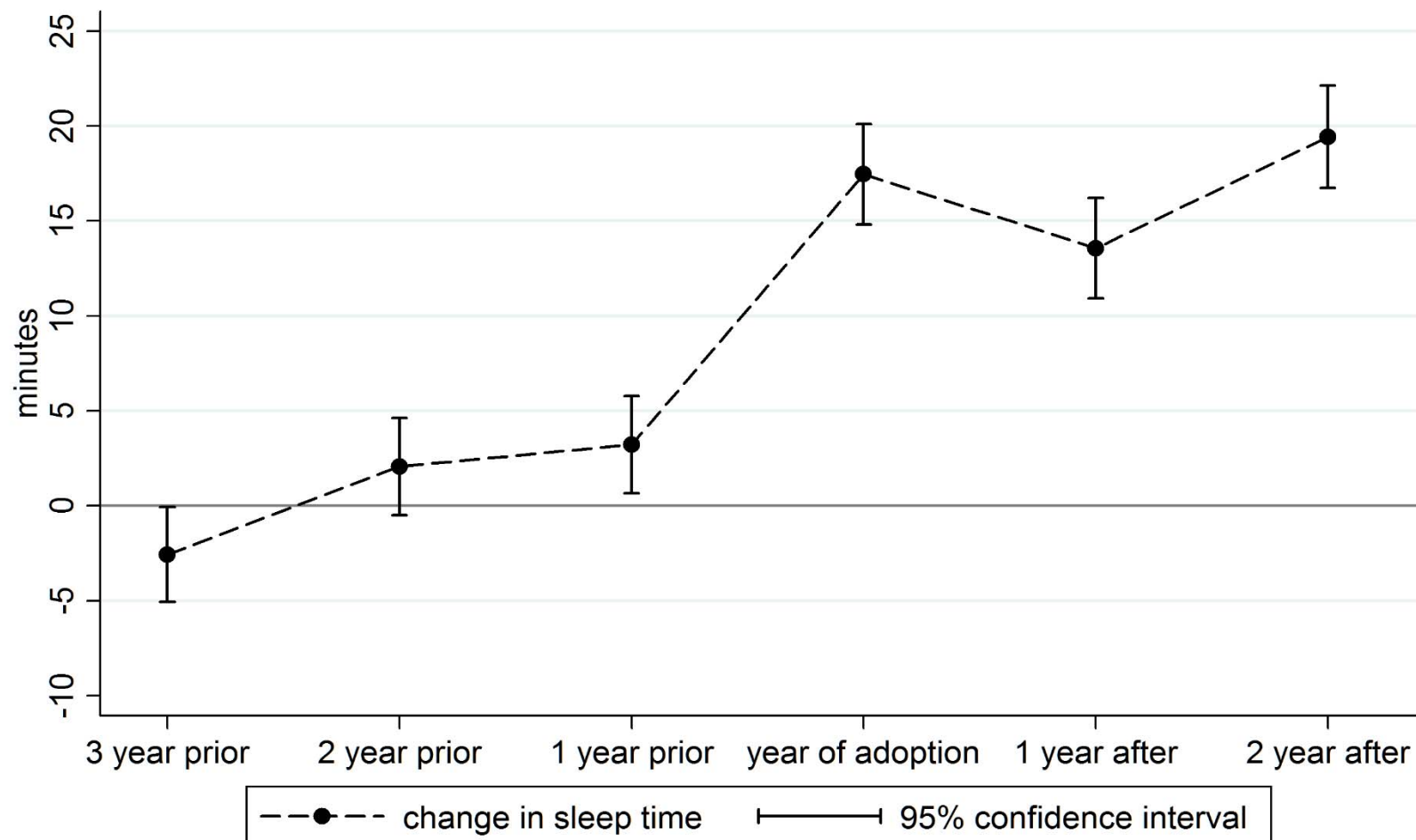
✓ Leads and Lags

- dynamics of the policy effects on sleep time by SES

Kim (2018)

Table 1: The Distribution of Attendance Time Before and After the Adoption of the 9 O'clock Attendance Policy in Gyeonggi (Sep. 2014) by Level of School and Region

(a) High School

Region	Survey Year	Attendance Time			
Gyeonggi		Before 7:40am	7:40-8:00am	8:00-9:00am	9:00am
(Treatment)	2014	37(8.2%)	237(54.8%)	167(37.0%)	0(0%)
	2015	N.A.	N.A.	N.A.	409(88.9%)
Seoul		Before 8:00am	8:00-8:30am	8:30-9:00am	9:00am
(Control)	2014	102(32.1%)	197(61.9%)	18(5.7%)	1(0.003%)
	2015	76(24.1%)	219(69.3%)	20(6.3%)	1(0.003%)

(b) Middle School

| Region	Survey Year	Attendance Time			
Gyeonggi		Before 8:00am	8:00-8:30am	8:30-9:00am	9:00am
(Treatment)	2014	18(3.0%)	577(95.5%)	8(1.3%)	1(0.002%)
	2015	N.A.	N.A.	N.A.	610(99.5%)
Seoul		Before 8:00am	8:00-8:30am	8:30-9:00am	9:00am
(Control)	2014	1(0.003%)	67(17.3%)	320(82.5%)	0(0%)
	2015	1(0.003%)	48(12.4%)	325(83.8%)	14(3.6%)

Note: The data for the above table is provided by the Seoul Metropolitan Office of Education and the Gyeonggi Provincial Office of Education. For Gyeonggi, the first survey was done in June 2014, which is before the 9 O'clock Attendance Policy. The table presents the number of schools with each attendance time and the share of the schools to total number of schools. The share of schools with each attendance time is in parenthesis. Since Gyeonggi province only surveyed the number of schools with 9:00 a.m. attendance time in 2015 and after, the numbers of schools with other attendance times in 2015 are not available for Gyeonggi province and they are presented as N.A.

Kim (2018)

Figure 1: The Share of Schools Where the Attendance Time Is 9:00am by Region and Year
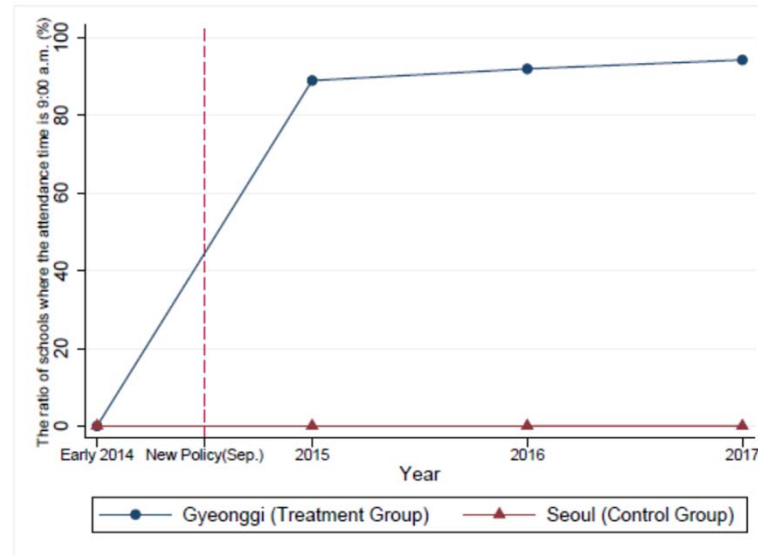
(a) High School
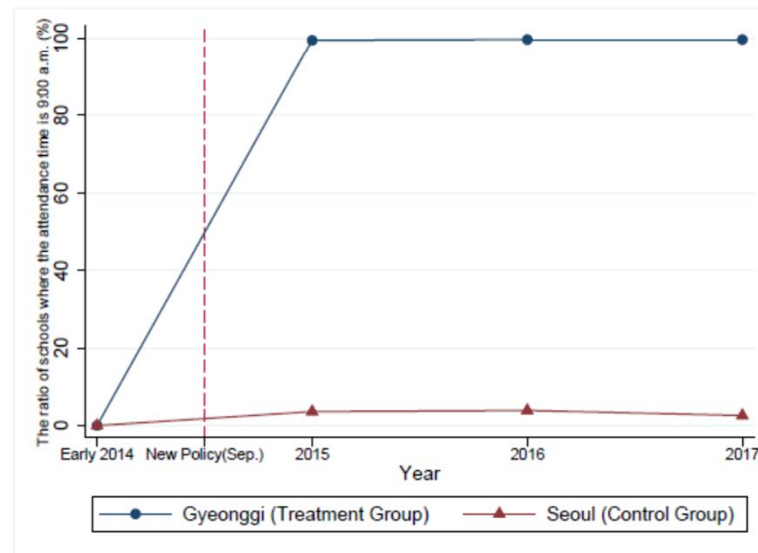
(b) Middle School

Note: Each dot in the Panel (a) presents the ratio of high schools where the attendance time is 9:00 a.m. to total number of high schools in each region. The Panel (b) represents those for middel schools. The data for the above figures is provided by the Seoul Metropolitan Office of Education and the Gyeonggi Provincial Office of Education. The "New Policy" in the figures mean the 9 O'clock Attendance Policy implemented in Gyeonggi province in September 2014.

Jung (2018)

Table 1 Implementation status of the 9 o'clock attendance policy in the Gyeonggi Province

	Fall, 2015	Spring, 2016	Fall, 2016	Spring, 2017	Fall, 2017
Elementary School	1213/1213 (100%)	1223/1223 (100%)	1263/1263 (100%)	1239/1239 (100%)	1248/1248 (100%)
Middle School	610/613 (99.5%)	617/619 (99.7%)	622/624 (99.5%)	626/628 (99.7%)	623/625 (99.7%)
High School	409/460 (88.9%)	433/470(92.1%)	432/470 (91.9%)	440/472 (93.0%)	445/472(94.2%)
Total	2232/2286 (97.6%)	2312/2273 (97.6%)	2232/2286 (97.6%)	2305/2339 (97.6%)	2316/2345 (98.8%)

[a]To calculate the specific number, I request the dataset via the governmental website (https://www.open.go.kr/), and I modify the obtained file