Retrospective study of MSU undergraduate students shows a significant impact of time-of-day of class start time on GPA

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Introduction

Adolescence and young adults experience sleep-wake delays by up to 3 hours as compared to adults, due to hormonal and physiological changes associated with puberty.
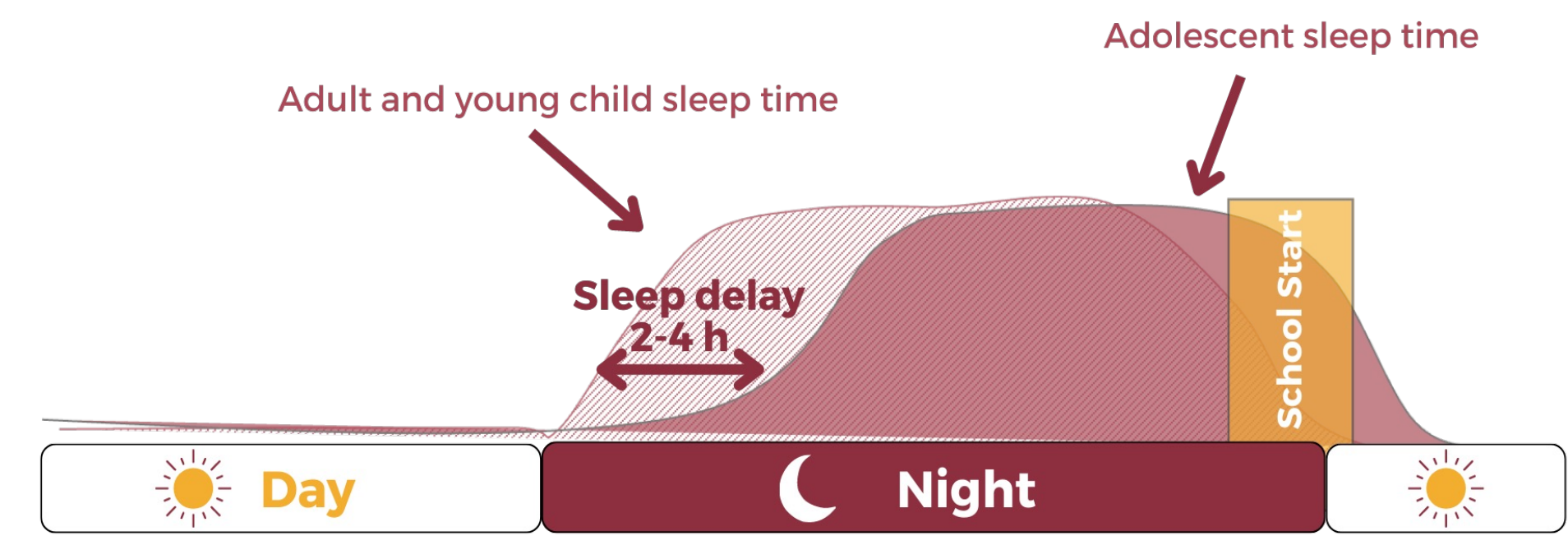

Figure 1. Sleep-wake time is delayed by ~3h in teenagers and young adults. During puberty hormonal and physiological changes in the body causes the bodies internal time-keeping system to run slower than adults. In practical terms this means that teenagers can't fall asleep until ~2h-3 after most adults.

- Sleep depravation is particularly determinantal to the maturing teenage and young adult brain, and associated with:
  - Depression
  - Aggression
  - Memory
  - Academic and sports performance
  - Accidents (sports and car)
- It is well established that high school students with school start time before 8.30AM cuts short their sleep in the morning. Early high school start time is causing chronic sleep deprivation in ~70% of this student population.
- Delaying high school start time to 8.30AM or later improves sleep and all the negative outcomes of sleep depravation.
- It remains **unknown** how class start time in undergraduate students impact their GPA, in a gender and race/ethnicity specific manner.
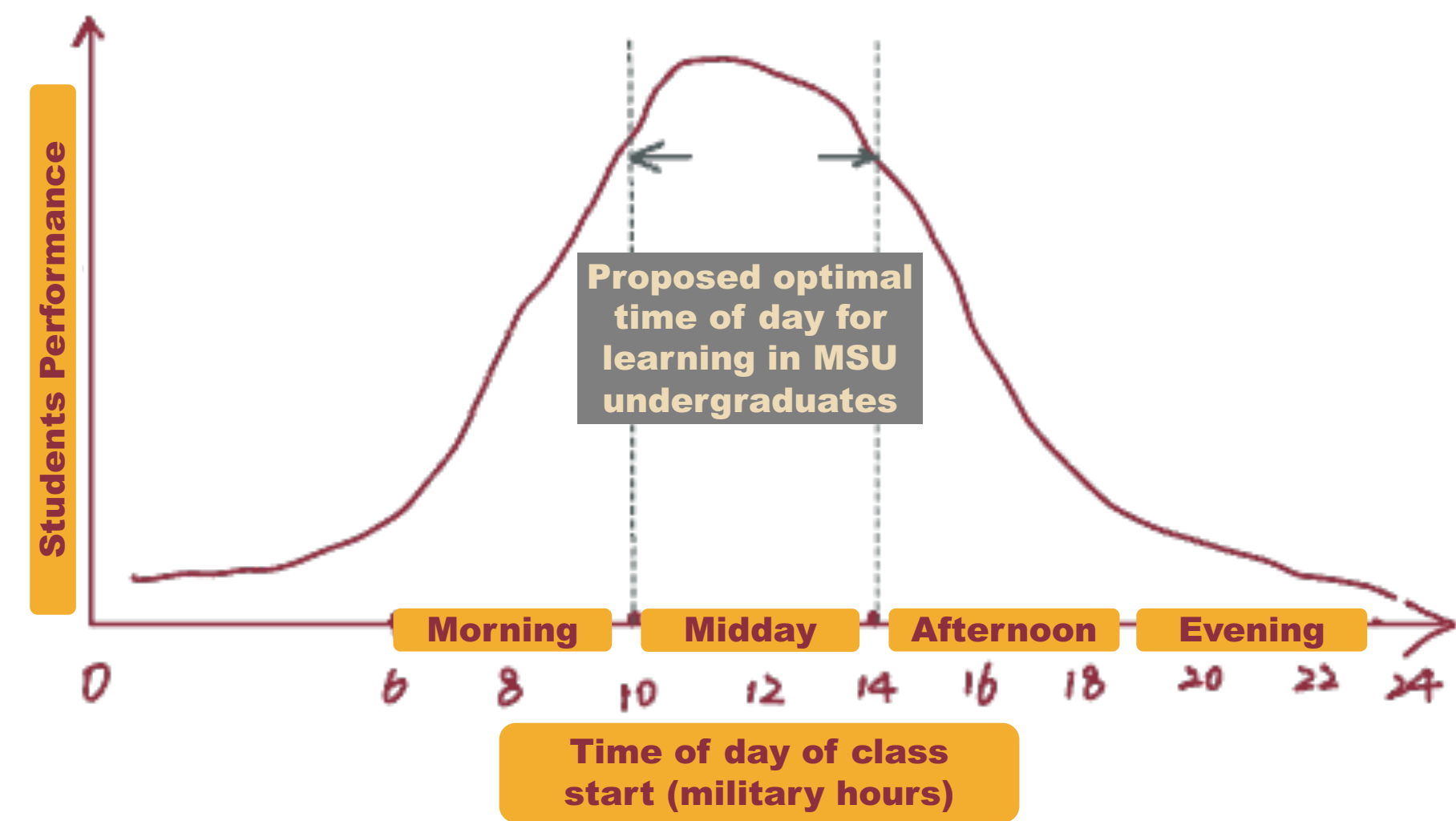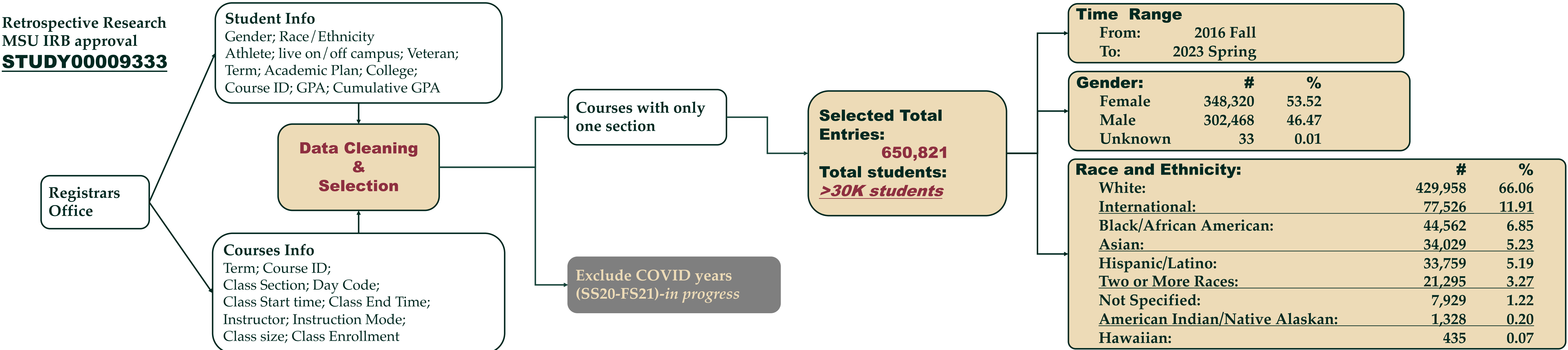
Hypothesis

Figure 2. I hypothesize that undergraduate students at MSU will achieve a higher GPA in classes that start between the late morning (>10.00h) and early afternoon (<14.00h), as compared to classes starting in the early morning (<10.00h), and afternoon (>14.00h).

Study Design and Data Collection

Retrospective Research
MSU IRB approval
STUDY00009333

Student Info
Gender; Race/Ethnicity
Athlete; live on/off campus; Veteran;
Term; Academic Plan; College;
Course ID; GPA; Cumulative GPA

Registrars Office

Data Cleaning & Selection

Courses Info
Term; Course ID;
Class Section; Day Code;
Class Start time; Class End Time;
Instructor; Instruction Mode;
Class size; Class Enrollment

Courses with only one section

Exclude COVID years (SS20-FS21)-*in progress*

Selected Total Entries: 650,821
Total students: >30K students

Time Range
From:	2016 Fall
To:	2023 Spring

Gender:
	#	%
Female	348,320	53.52
Male	302,468	46.47
Unknown	33	0.01

Race and Ethnicity:
	#	%
White:	429,958	66.06
International:	77,526	11.91
Black/African American:	44,562	6.85
Asian:	34,029	5.23
Hispanic/Latino:	33,759	5.19
Two or More Races:	21,295	3.27
Not Specified:	7,929	1.22
American Indian/Native Alaskan:	1,328	0.20
Hawaiian:	435	0.07

Results
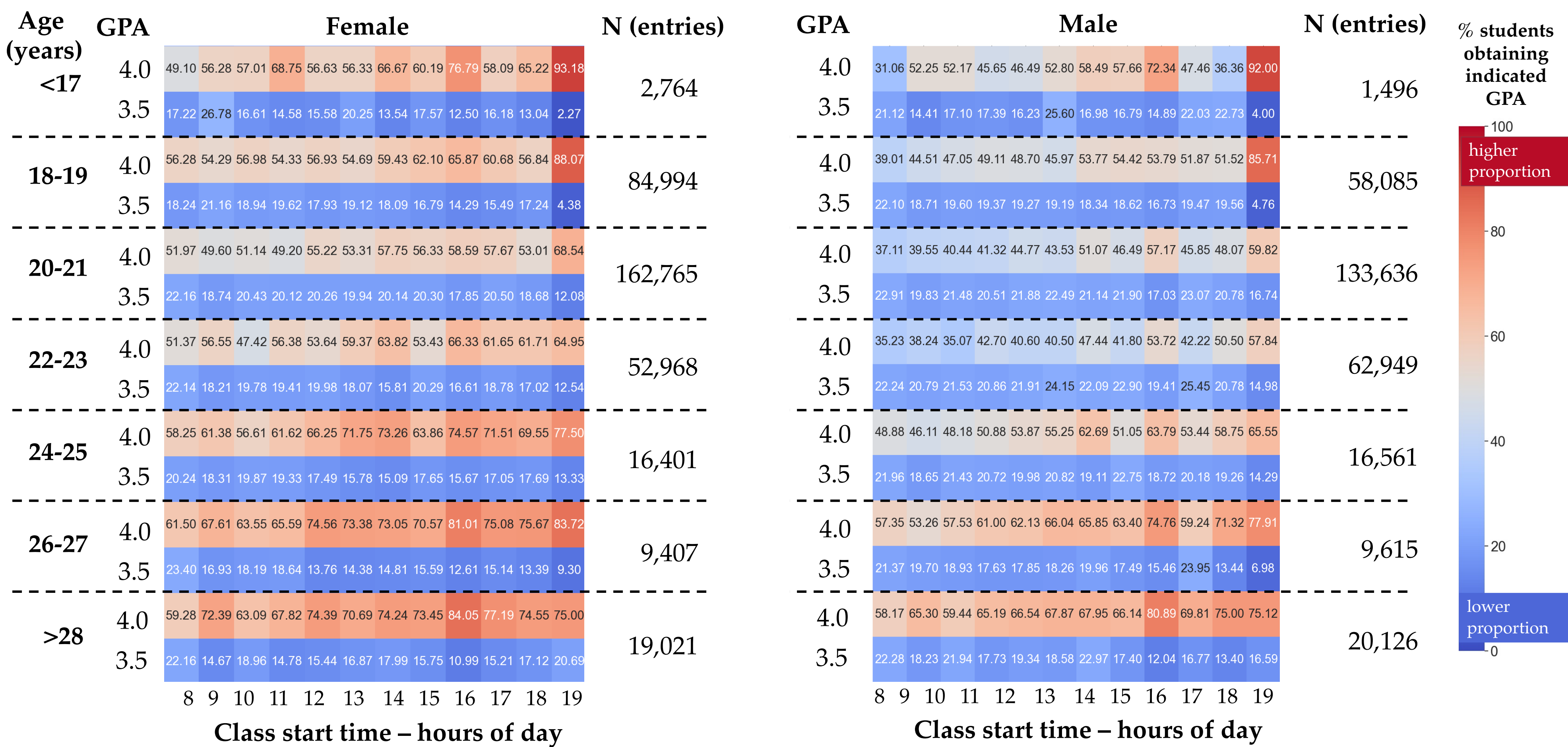
Heatmap of average GPA by age and gender

Figure 3. The number in each cell, represented the percentage(%) of student obtaining a GPA of 3.5 or 4. The % is calculated as follows: The count of students who attended the class during a specific hour and received a particular GPA for that class, divided by the total number of students who attended the class during that hour. As the class hours get later in the day, there is an increase in the proportion of students achieving a GPA of 4.

FEMALE

	8	9	10	11	12	13	14	15	16	17	18	19	20
< 17	3.38	3.40	3.43	3.45	3.47	3.49	3.52	3.54	3.56	3.58	3.61	3.63	3.65
18-19	3.47	3.48	3.49	3.50	3.51	3.52	3.52	3.53	3.54	3.55	3.56	3.57	3.58
20-21	3.43	3.44	3.45	3.46	3.47	3.48	3.50	3.51	3.52	3.53	3.54	3.56	3.57
22-23	3.39	3.41	3.43	3.44	3.46	3.48	3.49	3.51	3.52	3.54	3.56	3.57	3.59
24-25	3.50	3.53	3.55	3.57	3.59	3.61	3.63	3.65	3.67	3.70	3.72	3.74	3.76
26-27	3.63	3.64	3.65	3.66	3.68	3.69	3.70	3.71	3.72	3.73	3.75	3.76	3.77
>28	3.65	3.67	3.69	3.71	3.73	3.75	3.77	3.79	3.81	3.83	3.85	3.87	3.89

MALE

	8	9	10	11	12	13	14	15	16	17	18	19	20
< 17	3.31	3.35	3.39	3.43	3.47	3.51	3.56	3.60	3.64	3.68	3.72	3.76	3.81
18-19	3.23	3.25	3.28	3.31	3.33	3.36	3.39	3.42	3.44	3.47	3.50	3.53	3.55
20-21	3.19	3.22	3.25	3.27	3.3	3.33	3.36	3.38	3.41	3.44	3.47	3.49	3.52
22-23	3.10	3.14	3.17	3.2	3.23	3.26	3.3	3.33	3.36	3.39	3.42	3.46	3.49
24-25	3.35	3.37	3.39	3.41	3.44	3.46	3.48	3.50	3.52	3.55	3.57	3.59	3.61
26-27	3.52	3.54	3.55	3.57	3.59	3.60	3.62	3.64	3.65	3.67	3.69	3.70	3.72
>28	3.60	3.62	3.64	3.65	3.67	3.69	3.71	3.72	3.74	3.76	3.78	3.79	3.81

Table 1. Summary of the average GPA by student age and class hour. The data was analyzed using a linear regression model. Each color box represents different GPA thresholds, with the lighter to darker colors representing average GPAs ranging from 3.3 to 3.9 in 0.1 steps. In **Female Table**, if the class is arranged later morning (>11.00h), **18 to 19 group** average GPA will higher than 3.5, if the class arranged in early afternoon (>14.00 h), **20 to 23 (inclusive) groups** average GPA will higher than 3.5. In **Male Table**, if the class is arranged later morning (>11.00h), **18 to 19 group** average GPA will higher than 3.3, if the class arranged at noon (>12.00 h), **20 to 21 group** average GPA will higher than 3.3; if the class arranged in early afternoon(>14.00 h), **22 to 23 group** average GPA will higher than 3.3.

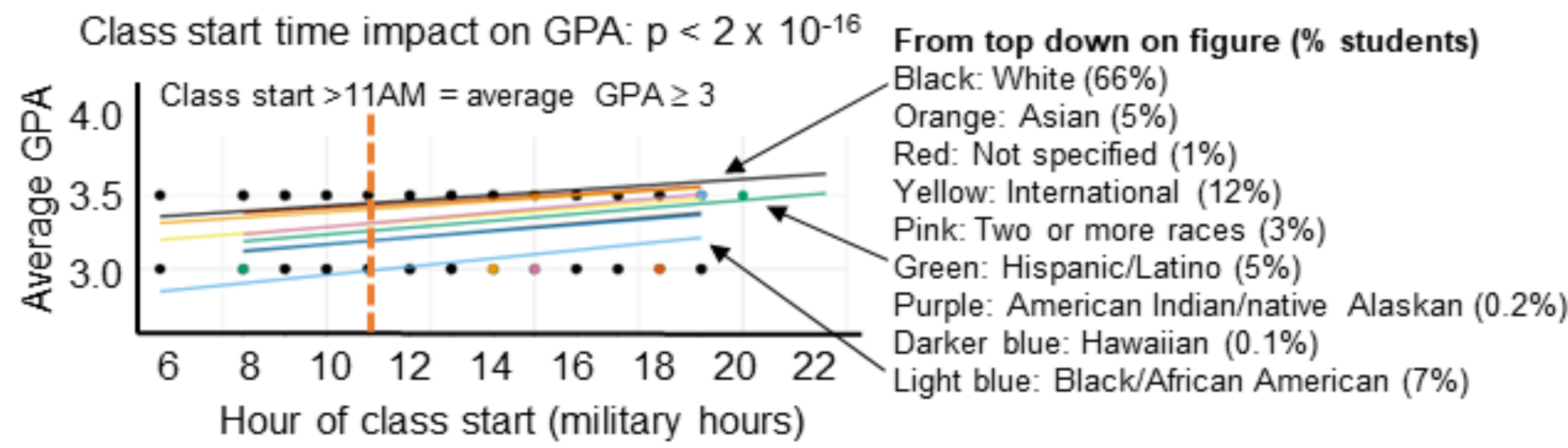### Class start time impacts GPA in a race/ethnicity specific manner

Figure 4. The plot display the trend of each ethnicity group overall average GPA (Y-axis) changes along with the hour of class start time (X-axis). Each line represents different ethnicity group. For each ethnicity, the intercept and the slope of the function as **Table 2.**

	Intercept	p	Slope	p
White (Comparison Group)	3.25	***	0.018	***
Asian	3.20	*	0.018	
Not Specified	3.25		0.018	
International	3.07	***	0.021	**
Two or More Races	3.04	***	0.025	*
Hispanic/Latino	3.00	***	0.023	**
American Indian/Native Alaskan	2.93	**	0.018	
Hawaiian	3.25		0.018	
Black/African American	2.68	***	0.028	***

Table 2. The p-value indicates the significance of the difference in intercept and slope compared to whites. In the p-value, more "*"'s indicate more significant differences.

Limit of study

- Study did not control for : class size, instructor, instruction mode (virtual, flipped classroom, lectures, lab etc), sleep, chronotype, socio-economic status, student interest in class.
- Current analyses includes COVID years (inflates grades) – data analysis excluding COVID is in progress

Conclusion

- The later the class starts in the day, independent of gender and race/ethnicity, the greater the GPA.
- Study confirms gender and ethnicity/race differences in GPA.
- We identify that GPA increases in afternoon classes to a greater degree in minority students than white (As shown in **Figure 4 and Table 2.** African Americans group line is the lowest, but the steepest.)
- **Main finding:** Universities should carefully consider the time of day when required undergraduate classes are scheduled to increase equity and GPA in undergraduates.