THE EFFECTS OF SOCIOECONOMIC STATUS, HIGH SCHOOL START TIME, AND SLEEP HEALTH ON COLLEGE OUTCOMES IN FIRST-YEAR STUDENTS

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ABSTRACT

Students from low socioeconomic status (SES) upbringings exhibit poorer sleep health, worse academic performance, and harder transitions to college compared to high SES students. High school experience can also impact college outcomes, with high school start times being one factor that is strongly linked to sleep health and academic performance in adolescents. Students with an early start time are more likely to report suboptimal sleep health and display poor academic performance in high school, yet little is known about how the high school experience may influence performance in college. Thus, this study examines how high school start times, SES and sleep health influence college outcomes. First-semester college students (N = 607) completed online questionnaires on sleep, SES, and demographic information and gave permission to access academic records from the registrar's office. Multiple linear regressions of mediation analyses were run to test the direct and indirect effects of SES, high school start times, and sleep health on college outcomes. Our findings reveal that sleep duration mediated the association of parental income with both college outcomes of academic performance (GPA) and college adjustment. Findings suggest consideration of sleep health in first year of college, particularly for students with lower parental income.

LIST OF ABBREVIATIONS AND SYMBOLS

α	Cronbach's alpha: a coefficient of internal consistency
b	Unstandardized beta coefficient
CI	Confidence Interval
M	Mean: the sum of a set of measurements divided by the number of measurements in the set
N	Total sample size
n	Subset of total sample size
p	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
r	Pearson product-moment correlation
SD	Standard deviation
SE	Standard Error
>	Greater than
<	Less than
≤	Less Than or Equal To
=	Equal to

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INTRODUCTION

College provides adolescents with an opportunity for change that can be both exciting and challenging with increased independence and responsibilities. Multiple factors impact college outcomes, including sleep health (Trockel et al., 2000; Buboltz et al., 2006; Hershner, 2020), social support (Dupont et al., 2015), environmental variables (e.g., distance from campus, study habits; Davis, 1994; Stallings & Neppl, 2021), socioeconomic status (SES; Moore et al., 2002), and individual differences (e.g., personality traits, genetic predisposition; Knopik et al., 2017; Kovas et al., 2007; de Zeeuw et al., 2014). SES is one of the most robust factors to impact these outcomes, with low SES predicting worse academic performance in college compared to high SES (White, 1982). Other contributions, such as past sleep duration or prior sleep quality, can influence the degree to which SES influences college outcomes (Moore et al., 2002; Taylor et al., 2013).

The current study applies the socioecological model of development (Bronfrenbenner, 1979; McLeroy et al., 1988; Stokols, 1992) as an organizing framework to better understand the interactive effects of SES, sleep health, and community factors on college outcomes. The socioecological model encompasses consideration for individual characteristics in the context of their surrounding environment, such as social and interpersonal factors, as well as opportunities informed by interventions and policy (Hale et al., 2020; Stokols, 1996). It is based on a broad, overarching paradigm that bridges several different fields of research (i.e., interdependence, homeostasis, negative feedback, etc.) into the interaction between environmental conditions,

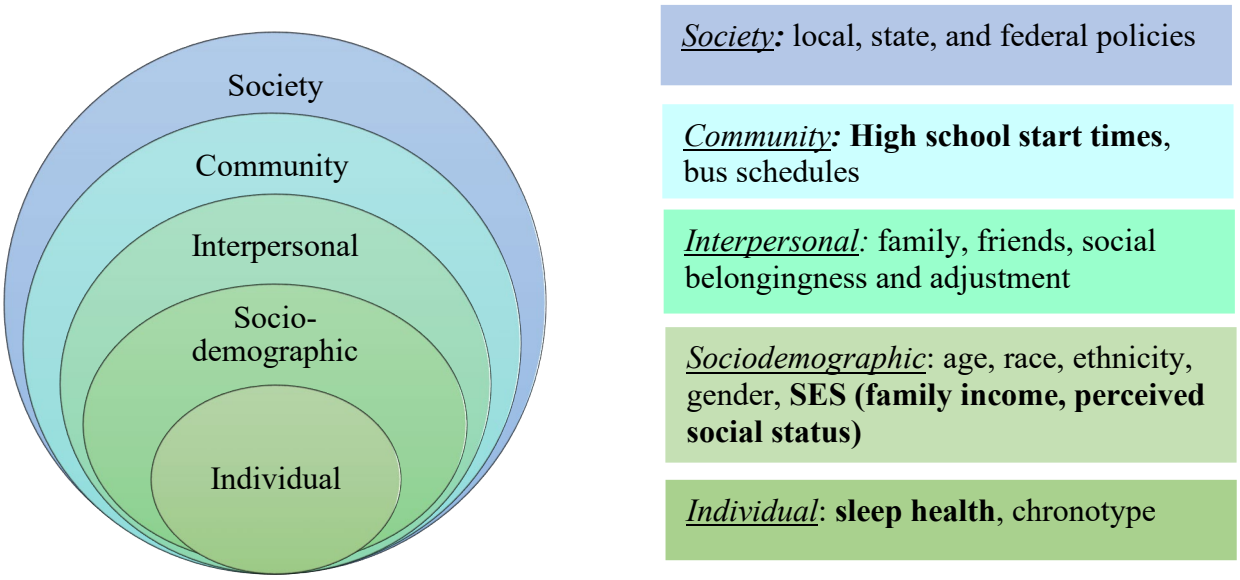
human behavior, genetic heritage, and psychological well-being (Stokols, 1996). This model has been applied to a range of research topics, including sleep health (Hale et al., 2020), healthy eating (Townsend & Foster, 2013), bullying in academic settings (Lim & Hoot, 2015), and stress on academic performance (Versaevel, 2014). Hale and colleagues (2020) applied this model to sleep health to better understand the social and environmental determinants, individual behavior, and policy differences in presenting opportunities for multilevel interventions to reduce sleep disparities. Versaevel (2014) utilized this model to evaluate how stress and health impact academic performance in post-secondary students.

Hale and colleagues' (2020) socioecological model of sleep health will be used to guide the approach of this study. Sleep health is described as a holistic framework of multiple sleep characteristics that promote physical and mental health (e.g., sleep duration, continuity, timing, alertness, and satisfaction; Hale et al., 2020). This model includes five levels of influence on sleep health: individual, sociodemographic, interpersonal, community, and societal factors (Figure 1; Hale et al., 2020). The first level depicts individual factors, which include habits, behaviors, and attitudes toward sleep. Next, sociodemographic factors including race, ethnicity, education, and socioeconomic status impact one's sleep health. Interpersonal factors include the social processes, supportive relationships, and the peer, family, and teacher interactions that contribute to sleep health. Community factors include environmental characteristics that may directly or indirectly impact sleep health, such as physical conditions of infrastructure, trees, wildlife, noise, light, or temperature, or social conditions, such as safety, socioeconomic advantage, and employment opportunities. Finally, the societal level factors include the local, state, and federal policies that affect sleep health, such as financial stress, safety concerns, individual autonomy, public policy practices, and legal regulations. All these levels overlap to

represent a different layer or component of the model, yet all impact the behavior of the individual (Stokols, 1996). For this study, this socioecological model will be applied to college outcomes of academic performance and adjustment to better understand the dynamic interplay between SES, sleep health, and high school factors on these outcomes within first-year college students.

Figure 1.

Socioecological model of college outcomes adapted from Hale et al. (2020).



At the individual level, sleep health behaviors and biological chronotype strongly influences a student's academic performance. Poor sleep health is a common problem among college students who experience more sleep difficulties than the general population (Brown et al., 2001; Coren, 1994; Lack, 1986). Approximately 70% of college students report that they are sleep deprived and about 50% endorse daytime sleepiness, an increase of 36% from adolescence (Lund et al., 2010; Oginska & Pokorski, 2006). Sleep duration and sleep timing influence several college-related outcomes. Insufficient sleep is linked to lower GPAs, poor physical and mental

health, and increased academic and emotional stress (Kelly et al., 2001; Lund et al., 2010). Inconsistent and late sleep timing impacts daytime sleepiness and leads to poor class attendance rates and worse academic performance (Lack, 1986; Buboltz et al., 2001; Trockel et al., 2000; Eliasson et al., 2010).

At the sociodemographic level, SES is significantly associated with college outcomes. Students from low SES backgrounds undergo a difficult transition from high school to college, experiencing many problems in meeting the academic demands of college work, finding suitable social belongingness, and obtaining sufficient financial resources (Pascarella et al., 2004; Walpole, 2003; Tinto, 1993). Students from low SES backgrounds tend to have worse academic performance in college and lower GPAs than students from high SES neighborhoods and more advantaged upbringings (White, 1982; Walpole, 2003). Furthermore, students of low SES upbringings also exhibit poorer cognitive domains of language, working memory, cognitive control, reward processing, spatial cognition, and visual cognition compared to their peers (Hale & Do, 2007; Farah et al., 2006). Overall, social class background is strongly related to a sense of belonging at college and predicts academic performance (Ostrove & Long, 2007).

SES is a nuanced categorization and term that encompasses many varying aspects of sociodemographic factors. Current literature presents a strong emphasis on income as the prominent factor of SES; however, there are many other forms that also can depict its measurement, including but not limited to educational attainment, occupational prestige, food insecurity, material hardship or deprivation, and perceived social status. Perceived social status evaluates how individuals feel about their relative position in the social hierarchy in both the United States and within their community (Adler et al., 2000; Singh-Manoux et al., 2003; Wilkinson, 1997). It can act as a strong indicator for SES since it encompasses a larger period of

time in one's life, such as earlier life experiences, family history, and perceived future trajectories (Wilkinson, 1997; Adler et al., 2000; Operario et al., 2004; Singh-Manoux et al., 2003). It is also highly associated with self-rated health, physical functioning, emotion regulation, and feelings of financial insecurity (Adler et al., 2000; Hu et al., 2005; Ostrove et al., 2000; Singh-Manoux et al., 2003; Stiles & Kaplan, 2004; Stiles et al., 2000). However, perceived social status is evaluated differently by diverse racial and ethnic groups (Adler et al., 2008; Franzini & Fernandez-Esquer, 2006; Ostrove et al., 2000). Thus, another objective variable, like income, could add to the measure of SES since low income is highly related to poor health, often due to limited access to goods and health care services (Saegert et al., 2007). Although, we know that SES is linked to grade point average (GPA) and adjustment, it is important to better understand other aspects of SES and their influence on college outcomes as it may help identify modifiable targets for intervening.

Components of SES at the sociodemographic level often overlap with factors found in the individual level of the model. For example, individuals from low SES neighborhoods report poor sleep health, specifically insufficient sleep duration, more sleep disturbances, greater daytime sleepiness, and poor sleep quality (El Sheikh et al., 2013; Gellis, 2011; Philbrook et al., 2018). Thus, college students from low SES communities, who also had less than ideal upbringings, may experience further disadvantage in maintaining sufficient sleep, further impacting their daytime functioning and college outcomes.

At the interpersonal and community levels of the model, college outcomes are also related to high school educational experience. Interpersonally, social interactions, teacher quality, and family support all influence a student's experience and performance in school. Furthermore, students who attend better resourced high schools report enhanced academic

success, educational attainment, and self-rated health (Walsemann et al., 2008; Frisvold & Golberstein, 2011). One such factor that is strongly linked to sleep health in high school is school start time. Early school start times require early wake times and limit sleep opportunity, which leads to suboptimal sleep health. High school students with an early start time are more likely to report insufficient and irregular sleep and exhibit poor academic performance in high school (Fisvold & Golberstein, 2011; Dexter et al., 2003; Cotti et al., 2018; Wahlstrom et al., 2014; Owens et al., 2010). It is possible that students who had an early high school start time will have even greater difficulties in college, due to sleeping out of one's circadian rhythm and building up sleep debt on the weekend; however, it is also possible that the break between high school and college washes out any effects of an early start time. Yet, little is known of the long-term impact beyond high school. The current study examines how a community level determinant (high school start times) influences a sociodemographic determinant (SES) and individual determinant (sleep health) on college outcomes (GPA and adjustment).

Background on High School Start Times and Student Outcomes

In college students, a history of early school start times is likely a proxy for poorer sleep health during high school. School start times are certainly associated with students' sleep health and academic outcomes *during* high school (Wahlstrom, 2002; Dunster et al., 2018; Widome et al., 2020). In contrast, delayed start times exhibit improved sleep health (Owens et al., 2010; McKeever & Clark, 2017). For example, a delay of 60 minutes in school start time can lead to 30 extra minutes of sleep per night (Perkinson-Gloor et al., 2013; Wahlstrom, 2002; O'Malley & O'Malley, 2008; Wolfson et al., 2007). Also, later start times were associated with more time in bed and more sleep in the morning among diverse, urban youth (Nahmod et al., 2017). Thus,

modifying sleep health by delaying start times is one potential way to improve an adolescent's long-term trajectory and lead to positive downstream effects in the model.

Currently, more than 80% of teenagers obtain less than the recommended 8.5 to 9.5 hours of sleep each night (American Sleep Association, 2019). Adolescent sleep undergoes significant transformation during puberty due to hormone fluctuations, which leads to a "perfect storm" of negative consequences that are often caused by a conflict between biologically driven changes in sleep timing and external demands on time, like early school start times (Carskadon, 2011). Forced desynchrony in one's circadian rhythm leads to insufficient sleep and social jet lag, or the misalignment of social and biological times indicating a discrepancy in one's sleep pattern between weekdays and the weekend (Wittman et al., 2006), and causes many teenagers to go to bed later on the weekends than on the weekdays. This can extend into early adulthood, lasting until the age of 23 years old for some individuals, which impacts sleep health well into college (Putilov & Verevkin, 2018). Increased awareness of the importance of sleep during adolescence, and of the potential for later school start times to improve concurrent and future outcomes, has led to a nationwide push to delay school start times (i.e., schoolstartlater.net). Inevitably, this could expand into the societal level of the model and overlaps with other layers to influence policy change for high school students.

Certainly, such improvements would be expected to have longstanding positive outcomes. Delayed school start times is one way to improve sleep health between social classes and enhance academic performance *during* high school (Minges & Redeker, 2016; Onyper et al., 2012; Wahlstrom et al., 2014). However, it is not yet clear whether school start times are associated with outcomes *beyond* high school (e.g., in the first year of college). Moreover, it is possible that first year students from low SES families and who also attended high school with

an early start time may be further disadvantaged in college. Little research has been conducted on delayed school start times in low SES populations, with most of the research being in more affluent school districts (Nahmod et al., 2017; Edwards, 2012; Bowers & Moyer, 2017; Widome et al., 2020). It is possible that because high school start times influence sleep and academic performance *during* high school, that they may also influence sleep and performance *beyond* high school. However, it is unknown whether there are indeed carryover effects of early and late high school start times into college. Since high school performance is related to college success, it is possible that high school start times influence the associations of SES, sleep health, and college performance.

Importance of Proposed Study

This study has three aims: a) Examine the relationship of high school start times and social status with college outcomes (Walpole, 2003; Ostrove & Love, 2007; Wahlstrom et al., 2014, Owens et al., 2010), b) Assess the association of sleep health with college outcomes, and c) Test whether components of sleep health mediate the association between high school start times and social status with college outcomes, either fully or partially. To address these aims, direct effects between high school start time and the SES variables with each of the college outcome variables will be examined. Next, sleep health will be added to the association between high school start time and SES with each of the college outcome variables to see if it has a mediating effect on each relationship, assessing any potential indirect effects of sleep health on each outcome variable.

It is expected that students from low SES backgrounds who report early high school start times will have poorer sleep health and worse college outcomes than students with higher SES and later high school start times. This is expected because students from low SES backgrounds,

who often experience earlier school start times, are more likely to struggle with academic performance and report poorer sleep health in college. In addition, it is expected that low SES students, both in perceived social status and reported annual parental income, will have lower GPAs and worse adjustment compared to students of higher SES upbringings (White, 1982; Ostrove & Long, 2007; Walpole, 2003). Finally, students with less total sleep time and high social jetlag will display worse GPAs and poorer adjustment in the first semester of college. Thus, this tendency toward poor sleep health will further influence and set back those with early school start times and who are from low SES backgrounds.

METHOD

Participants

First semester college students (N = 607) were recruited from the University of Alabama (UA) Department of Psychology Subject Research Pool. Mean age was 18.61 (*SD* = 0.93) and students were 73.5% female (see Table 1). This study was approved by the UA Institutional Review Board (see Appendix A). Participants were invited via email to complete an online survey for credit in their Introduction to Psychology course. Students were asked to provide permission to access academic records from the registrar's office to collect GPA data (*n* = 545). Students consented to participate before completing questionnaires. GPA data were obtained at the end of each semester from the registrar for students who consented to long-term follow-up.

Table 1.

Descriptive Statistics of the Sample (N=607)

	N (%)
Age	18.61 (SD = 0.93)
Gender	
Female	446 (73.5)
Male	159 (26.2)
Race	
White	499 (82.5)
Black/African American	63 (10.4)
Asian	24 (4.0)
American Indian	12 (2.0)
Pacific Islander	1 (0.2)
Prefer not to Respond	5 (0.8)
Parent Income	
$0-49,999	80 (13.2)
$50-99,999	125 (20.6)
$100-149,999	136 (22.4)
$150-199,999	43 (7.1)
$200+	213 (34.9)

Measures

Sleep Health

Dimensions of sleep health, such as sleep timing, social jet lag, and sleep duration, were assessed using both the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989; see Appendix B) and the Munich Chronotype Questionnaire (MCTQ; Roenneberg et al., 2003; see Appendix C). The PSQI was chosen to assess sleep duration because it examines total sleep time on average per night within the past month. Since we are assessing outcomes within the first semester of college, it seemed appropriate to utilize this questionnaire based on one month to encompass a majority of the first semester of college. The PSQI is a 19-item survey that assesses a variety of components of sleep health within the past month. As one of the most commonly

used sleep questionnaires, it has been well validated, with a good internal consistency in a general population ($\alpha = .83$) and a high test-retest reliability ($r = .85$; Buysse et al., 1989).

The MCTQ was chosen to assess social jetlag because it identifies a student's preferred sleep time based on their circadian preference. Responses on this questionnaire are computed into six components of sleep timing on workdays and work-free days, including average weekly sleep duration, chronotype, weekly sleep loss, relative social jetlag, absolute social jetlag, and average weekly light exposure. The MCTQ has been validated in multiple languages and age groups and shows strong correlations with physiological measures and other chronotype parameters, such as the Morningness-Eveningness Questionnaire ($r > 0.48$), resulting in a strong test-retest reliability ($r > 0.72$; Suh et al., 2018). Since college students undergo biologically driven changes in their sleep due to forced desynchrony and an increase in external demands, absolute social jetlag was most relevant to use from this questionnaire for analysis.

Socioeconomic Status

For perceived social status, participants completed the MacArthur Scale of Subjective Social Status, Adult Version (MacArthur SSS Scale; Adler et al., 2000; see Appendix D). In this measure, respondents are shown a picture of a ladder with 10 rungs on it and asked to place an "X" on the rung that they feel best represents their social standing with income, education, and occupation in both their community and in society, or the United States. The top of the ladder depicts people who identify with higher SES and with the most money, highest education, and best jobs, whereas the lower rungs on the ladder signify those with the least money, lowest education, and lowest paying jobs or who are unemployed. Each rung corresponds with numbers from one through ten depending on its location on the ladder, with the bottom rung representing a score of "one" and the top rung representing a score of "ten". This scale was chosen because it

measures one's perception of family and individual social standing. Perception is thought to be important because it is more predictive of health outcomes (e.g., depression, obesity, physical symptoms) and behavior compared to an objective standard SES measure (Garza et al., 2017, Curhan et al., 2014; Quon & McGrath, 2014), suggesting that perceived social status plays a causal role in shaping health and wellbeing (Lemeshow et al., 2008). Additionally, this scale takes cultural experiences into account, potentially addressing stressful immigrant experiences that might be left out by traditional SES measures (Adler et al., 2000; Garza et al., 2017).

For objective social status, participants reported their parental annual income within the self-report demographic information of the questionnaires. Income was divided into quintiles, or five groups (under $50K, $51-99K, $100-149K, $150-199K, and $200K and over), to distinguish among poverty, low-income, middle, upper middle, and wealthy.

School Start Times

Participants reported their high school start time in response to the question, "In high school, what time did you have to be at school most days?" The wording of the question is intended to include pre-school activities and account for students who did not have to arrive at the designated start time (e.g., flex schedule).

Academic Performance

Grade point average (GPA) was used to evaluate academic performance. GPA ranges between a 1.0 and 4.0 scale, with a higher number indicating better academic performance. Students' cumulative annual GPA was obtained from the university registrar office at the end of the academic year.

College Adjustment

For assessing one's feelings of the transition to college, participants completed the College Adjustment Test (CAT). The CAT is a nineteen-item survey that measures the level of comfortability in coping with and adjusting to college lifestyle. Students rate their thoughts and feelings about coming to college which yields a composite score on the ease of adjustment. The internal consistency for this measure has been found to be acceptable ($\alpha = .79$) and has a good test-retest reliability after two months with more than half the sample ($r = .65$; Pennebaker et al., 1990).

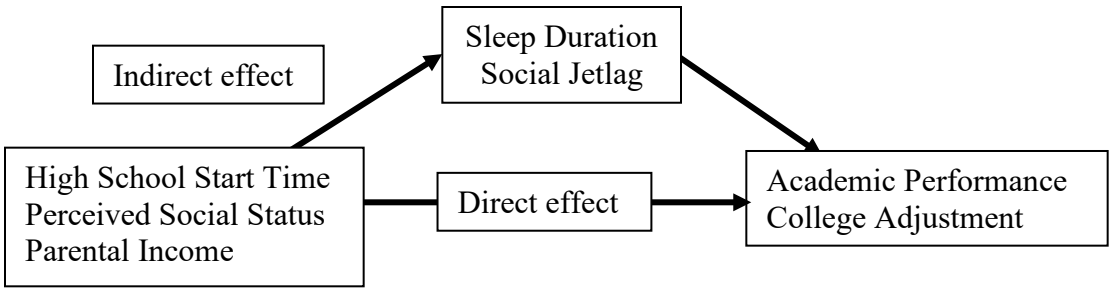
Statistical Analyses

All analyses were conducted within the IBM SPSS Statistical Software for Windows, Version 27. Direct and indirect effects were assessed in all models using bootstrapped mediation analysis within Model 4 via the PROCESS macro (Preacher & Hayes, 2020). Bootstrapping is a non-parametric method based on making new samples with a replacement methodology multiple times over and then computing each of their indirect effects. Within this method, normality is not assumed and differs from typical mediation analysis through randomly selecting and repeating sub-sampling of the data to generate an estimate for the indirect effect path coefficient. Additionally, a 95% confidence interval is generated for the bootstrapping parameter, in which if it does not encompass zero, then the hypothesized mediation is statistically significant. This model is appropriate for this data because it examines a simple mediation analysis in a parsimonious way and considers greater degrees of freedom to obtain the most power. All targeted variables were centered.

A total of twelve mediation models were tested to assess the direct effects of the three independent variables (high school start time, perceived social status, and parental income) on

each of the outcome variables (academic performance and adjustment; see Figure 2). The sleep variables, average weekly sleep duration and absolute social jetlag, were then tested as mediating variables in each model to determine if the association between the independent and outcome variables could be due to the indirect effects of sleep indices relevant to this population. These twelve models were split up into two series of six mediation models based on the outcome variable, with the first series assessing academic performance and the second assessing adjustment. In each series, three independent variables were tested separately with the outcome variable, and two mediating variables separately with each independent variable, for a total of six models.

Figure 2.
Conceptual mediation model in which the effects of high school start time and sociodemographic factors on academic performance and college adjustment are mediated by sleep health variables.



The first series tested if the influence of one of the independent variables on grade point average (GPA) during the first semester of college could be due to the indirect effects of the sleep variables, either average weekly sleep duration or social jetlag (see Figure 2). The first two models in this series tested if the influence of high school start time on grade point average (GPA) during the first semester of college could be due to the indirect effects of each of the sleep variables. The next four models in this series tested if the influence of the socioeconomic status variables (perceived social status within the United States and parental income) on first-semester

GPA could be due to the indirect effects of each of the sleep variables. Within the second series, we repeat the steps of the first series, with the only difference being the outcome variable as college adjustment during the first semester. That is, the first two models within the second series tested if the influence of high school start time on college adjustment could be due to the indirect effects of the sleep variables. And the last four models of the second series tested if the influence of each of the socioeconomic status variables on college adjustment could be due to the indirect effects of each of the sleep variables.

RESULTS

Sample Characteristics

Sample characteristics are presented in Table 1. To summarize, the mean age of the population was 18.61 years old (*SD* = 0.93). About three quarters (73.5%) of the sample identified as female, with the remainder (26.2%) identifying as male. Approximately 82.5% of the sample identified their race as being White, 10.4% as African American or Black, 4% Asian, 2% American Indian, and 1% Pacific Islander. Gender and race were covariates in all statistical models to account for their variance in the association between the independent variables of high school start time and socioeconomic factors with the outcome variables of academic performance and adjustment in the first semester of college. More than half the sample (64.4%) reported annual parental incomes over $100K, with over a third (34.9%) reporting over $200K. Only 10.7% of the sample reported annual parental incomes under $50K.

Correlational Analyses

Pearson zero-order correlations were computed to determine the relationships between the covariates, independent variables, and outcome variables (see Table 2). Among the independent study variables, parental income is significantly positively associated with perceived social status ($r = .238$, $p \leq .01$). In association with the mediating variables, parental income was significantly positively associated with sleep duration ($r = .129$, $p \leq .01$). In relation to the outcome variables, only parental income was significantly associated with first semester GPA ($r = .103$) and college adjustment ($r = .105$; both $p \leq .05$) among the independent variables. Within the mediating variables, sleep duration was positively associated with both first semester

GPA (r =.185, $p \leq .01$) and college adjustment (r = .195, $p \leq .01$). Finally, between the outcome variables, first semester GPA was significantly positively associated with college adjustment, but by a small correlation (r = .268, $p \leq .05$).

Table 2.

Pearson Zero-Order Correlation Matrix of Variables with Descriptives

		1	2	3	4	5	6	7
1	Parental Income	-	**.238****	-.003	**.129****	.018	**.103***	**.105***
2	Perceived Social Status		-	-.022	.043	.020	.071	.030
3	High School Start Time			-	-.013	-.006	-.038	.017
4	Sleep Duration (minutes)				-	-.079	**.185****	**.195****
5	Social Jetlag					-	.049	.015
6	Fall GPA						-	**.268****
7	Adjustment							-
	Mean	8.24	5.67	7:57	7.88	1:08	3.32	75.10
	Standard Deviation	3.45	2.18	0:36	2.18	0:53	.689	16.20
Note: *$p \leq .05$, **$p \leq .01$								

Mediation Series 1: Academic Performance

Associations among Socioeconomic Factors (X), Sleep (M), and GPA (Y)

Perceived social status was not associated with GPA (see Table 2). Direct effects of perceived social status within the United States on college academic performance was not statistically significant. When assessing for indirect effects of the sleep variables on this relationship, sleep duration and social jetlag did not mediate the association between perceived social status and GPA (see Table 3).

Table 3.

Separate Tests of Direct and Indirect Effects between Socioeconomic Factors and High School Start Times (X) on Academic Performance (Y) as Mediated by Sleep Factors (M).

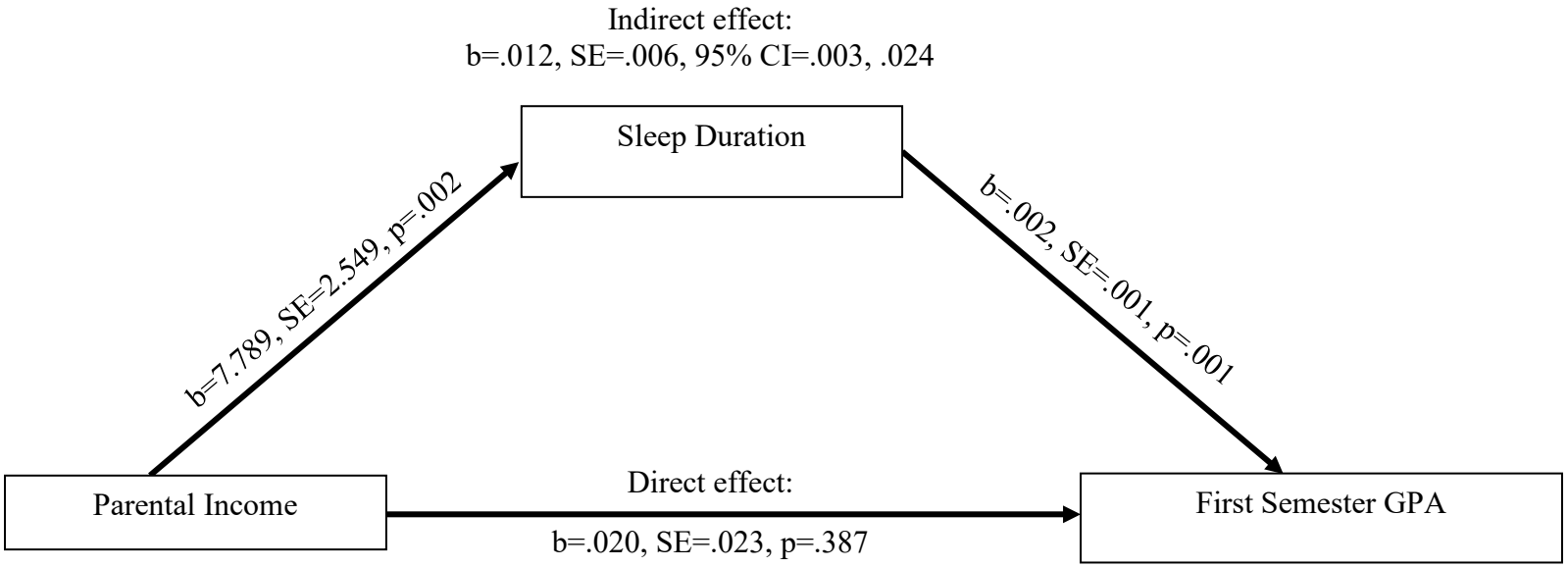
		X→M	Direct Effects on GPA	95% Confidence Intervals for Indirect Effects	
Independent Variable (X)	Mediator (M)	b (SE)	b (SE)	Lower	Upper
Perceived Social Status	Sleep Duration	1.205 (1.779)	.020 (.016)	-.004	.009
	Social Jetlag	**-.048 (.023)****	.018 (.016)	-.001	.011
Parental Income	Sleep Duration	**7.789 (2.549)**$^{+}$	.020 (.023)	**.003***	**.024***
	Social Jetlag	.001 (.034)	.032 (.023)	-.007	.007
High School Start Time	Sleep Duration	2.923 (6.454)	-.036 (.058)	-.016	.027
	Social Jetlag	-.017 (.085)	-.033 (.058)	-.013	.022

Note: *Bootstrap 95% Confidence Intervals that do not contain zero are statistically significant at $p \leq 0.05$; $^{**}p \leq 0.05$; $^{+}p \leq 0.01$.

Parental income was positively associated with academic performance (GPA: $r = .103$, $p \leq .05$; see Table 2). Higher parental income was associated with higher GPA and longer sleep duration. No direct effects were observed between parental income and first semester GPA ($b = .020$, $SE = .023$, $p = .359$; see Figure 3). When assessing for indirect effects of the sleep health variables on this relationship, sleep duration mediated the association between parental income and GPA ($b = .012$, $SE = .005$, 95% CI =.003, .024; see Figure 3). Social jetlag did not mediate the association between parental income and first semester GPA.

Figure 3.

Mediation model displaying how sleep duration (M) mediates the association between parental income (X) and first semester academic performance (Y).



Associations among High School Start Time (X), Sleep (M), and GPA (Y)

High school start time was not associated with GPA (see Table 2). Direct effects of high school start time on college academic performance indicated no statistical significance. When assessing for indirect effects of the sleep variables on this relationship, sleep duration and social jetlag did not mediate the associations between high school start times and academic performance (see Table 3).

Mediation Series 2: College Adjustment

Associations among Socioeconomic Factors (X), Sleep (M), and Adjustment (Y)

Perceived social status was not associated with college adjustment (see Table 2). Direct effects of perceived social status within the United States on college adjustment was not statistically significant. When assessing for indirect effects of the sleep variables on this relationship, sleep duration and social jetlag did not mediate the association between perceived social status and adjustment (see Table 4).

Table 4.

Separate Tests of Direct and Indirect Effects between Socioeconomic Factors and High School Start Times (X) on College Adjustment (Y) as Mediated by Sleep Factors (M).

		X→M	Direct Effects on Adjustment	95% Confidence Intervals for Indirect Effects	
Independent Variable (X)	Mediator (M)	b (SE)	b (SE)	Lower	Upper
Perceived Social Status	Sleep Duration	2.131 (1.438)	.153 (.306)	-.028	.192
	Social Jetlag	-.031 (.020)	.234 (.310)	-.107	.045
Parental Income	Sleep Duration	**7.103 (2.146)**$^{+}$	.866 (.461)	**.069***	**.453***
	Social Jetlag	.009 (.030)	**1.103 (.463)****	-.048	.074
High School Start Time	Sleep Duration	-.656 (5.259)	.550 (1.115)	-.398	.331
	Social Jetlag	-.081 (.072)	.542 (1.131)	-.263	.160

Note: *Bootstrap 95% Confidence Intervals that do not contain zero are statistically significant at $p \leq 0.05$; **$p \leq 0.05$; $^{+}p \leq 0.01$.

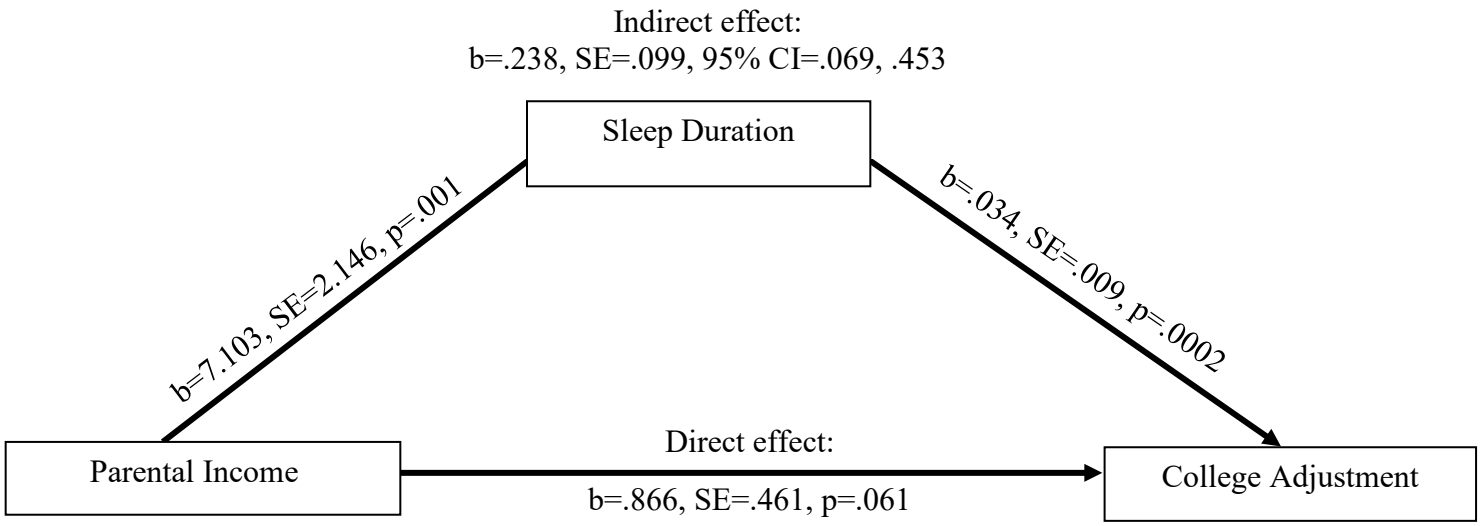
Parental income was positively associated with college adjustment ($r = .105$, $p \leq 0.05$; see Table 2). Higher parental income was associated with better adjustment and longer sleep duration. Direct effects of parental income on college outcomes revealed statistical significance between parental income and college adjustment ($b = 1.19$, $SE = .462$, $p = .017$; see Figure 4). When assessing for indirect effects of the sleep health variables on these relationships, sleep duration mediated the association between parental income and adjustment ($b = .238$, $SE = .099$, 95% CI = .069, .453; see Figure 4). Although social jetlag had a significant direct effect on the association between parental income and college adjustment, the indirect effect was not statistically significant, therefore it did not mediate the association between parental income and college adjustment.

Associations among High School Start Time (X), Sleep (M), and Adjustment (Y)

High school start time was not associated with college adjustment (see Table 2). Direct effects of high school start time on college adjustment indicated no statistical significance. When assessing for indirect effects of the sleep variables on this relationship, sleep duration and social jetlag did not mediate the associations between high school start times and college adjustment (see Table 4).

Figure 4.

Mediation model displaying how sleep duration (M) mediates the association between parental income (X) and college adjustment (Y) within the first semester.



DISCUSSION

Individual, sociodemographic, and community level characteristics have strong associations with sleep health (Hale et al., 2020). Moreover, dynamic interactions between individual characteristics, sociodemographic determinants and communities may explain the occurrence of sleep health disparities. This study examined how factors from individual (i.e., sleep health), sociodemographic (i.e., perceived social status and parental income) and community (i.e., high school start times) level characteristics contribute to college outcomes.

Parental income influenced academic performance (GPA) and adjustment only through sleep duration. Direct associations between income and GPA as well as adjustment indicate that sociodemographic factors can influence college outcomes independently. However, our findings reveal that one potential mechanism for a significant indirect effect is through short sleep. Students from low-income backgrounds display worse academic performance and poorer adjustment to college compared to students from high income backgrounds (White, 1982; Walpole, 2003; Hertel, 2002; Bernier et al., 2004). Yet, other possible factors that could influence these relationships are enhanced stress levels in college, jobs, or involvement in extracurricular activities.

Moreover, perceived social status was not associated with either of the sleep health variables or college outcomes. This reveals that starting life in a different area away from one's family and community might improve their perception of their future potential, or it might not influence these outcome variables once in college. Perceived social status is highly associated with self-rated health, physical functioning, and emotion regulation (Adler et al., 2000; Hu et al.,

2005; Ostrove et al., 2000; Singh-Manoux et al., 2003; Stiles & Kaplan, 2004). Furthermore, as an SES factor, perceived social status is highly associated with sleep (El Sheikh et al, 2013; Gellis, 2011; Philbrook et al., 2018) and academic performance (White, 1982; Ostrove & Long, 2007; Walpole, 2003). One possible reason for our results is that the majority of our sample reported being from a high socioeconomic class based on high parental incomes, such that over 64% reported annual parental incomes over $100K (see Table 2). Additionally, there could be an equalizing effect in college that allows students to feel more in line with their peers financially and thus this might not have as much of a bearing on their GPA or adjustment.

This was the first study to look at the effects of high school start time on post high school outcomes. In the current study, there was no effect of early start times in high school on sleep health, academic performance, or college adjustment. This suggests a potential "washout" effect of early school start times because many studies find that start times relate to sleep during high school (Fisvold & Golberstein, 2011; Dexter et al., 2013, Cotti et al., 2018; Wahlstrom et al., 2014; Owens et al., 2010). However, findings beyond high school are limited. The timeframe over the summer might "washout" the effects of early school start times once in college. In addition, it is possible that students who are more vulnerable to effects of early high school start times are less likely to attend college and succeed within their careers and earning potential. Also, college students may be more resilient to these effects due to choosing to attend college compared to those who do not.

Finally, social jetlag was not related to the college outcomes nor did it mediate the association between the independent variables and the outcome variables. Students who wake up later on their free days on the weekends compared to their workdays during the school week do not appear to be impacted in their academic performance or adjustment to college compared to

students who maintain consistent sleep timing on a daily basis. Social jetlag can extend into young adulthood, influencing college years (Putilov & Verevkin, 2018). However, one potential mechanism that could have compromised this relationship was students' free will to choose their class schedule during college. This could enable them to pick classes that align better with their circadian rhythms and maintain consistency in their sleep cycles during the work week and weekends.

To summarize, the first aim of this study was to examine the relationship of both sociodemographic factors and high school start times on college outcomes. The findings revealed that parental income was the only variable of the three that was significantly associated with the college outcomes. In the second aim, we examined the association of sleep health variables with college outcomes, learning that only sleep duration was significantly associated with the college outcomes. Finally, in the third aim, we tested whether components of sleep health mediate the association between the sociodemographic factors and high school start time with college outcomes. Our findings revealed that sleep duration mediated the association between parental income and the college outcomes.

These results reveal the importance of implementing programs to promote sleep health for first year college students to help improve academic performance and adjustment. Sleep duration has much variability due to the influence of various internal and external factors, so providing information to incoming college students about the importance of proper sleep health might lead to improvements in college outcomes. Offering a class, seminar, or workshop on proper sleep health could be a good first step to help promote these improvements. However, more research needs to be conducted on other sleep health variables that could impact sleep

duration (e.g., presence of a roommate, pets, environmental conditions, sleep disorders) to provide a more thorough description for these psychoeducation initiatives.

Limitations of Current Research

There were some limitations within this study that should be addressed. First, this study was cross-sectional, thus, causal relationships cannot be inferred. Also, the majority of the participant pool were Caucasian women from families with medium to high annual incomes (i.e., over $100K). Future research should expand the participant pool to consist of a more diverse sample in gender, race, socioeconomic class, and geographical origin. Next, this study only assessed the first semester of college, which provides a narrow scope on academic performance, but is beneficial for adjustment. Thus, future research should evaluate the longitudinal effects of these relationships later into college and life beyond. Furthermore, for academic performance, only grade point average was collected from the university registry; however, other forms of academic performance, including class attendance, test scores, and other modalities could expand upon a student's functioning. Finally, questionnaires provided to the students only measured current sleep health within the past month rather than inquiring about their sleep during high school. This limited the chance to compare how sleep differed between the two based on differences in class schedule.

Directions for Future Research

Other future directions for this research could assess other sleep health variables, such as sleep duration on weekdays only, sleep disturbances, chronotype differences, and sleep disorders, and their influence upon these associations. Additionally, other socioeconomic and community level factors, such as parental education, occupation, and parent's marital status, could be beneficial to assess in this association and their impact on these outcome variables.

Finally, with the national pandemic of COVID-19 impacting education in various ways throughout the past year, for example, students relocating back home due to social distancing regulations and the change in learning format from in-person classes to online, it would be beneficial to assess how the associations between the socioeconomic factors, sleep variables, and high school start times with college outcomes are impacted.

Implications for Next Steps

In summary, the findings of this study contribute to current literature that highlights the potential negative effects of sleep duration on college academic performance and adjustment. Thus, this research offers the opportunity for college administrators to recognize the detrimental effects of poor sleep health on academic performance and adjustment for those who come from households with lower parental income and implement potential changes to assist these students further and prevent setbacks earlier on.

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APPENDIX

Appendix A

Institutional Review Board Certification

THE UNIVERSITY OF ALABAMA | Office of the Vice President for Research & Economic Development
Office for Research Compliance

October 31, 2019

Heather Gunn, PhD
Department of Psychology
College of Arts & Sciences
Box 870348

Re: IRB # 19-OR-228 "School Start Times College Effects"

Dear Dr. Gunn:

The University of Alabama Institutional Review Board has granted approval for your proposed research. Your application has been given expedited approval according to 45 CFR part 46. You have also been granted the requested waiver of written documentation of informed consent. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies

The approval for your application will lapse on October 24, 2020. If your research will continue beyond this date, please submit the Continuing Review to the IRB as required by University policy before the lapse. Please note, any modifications made in research design, methodology, or procedures must be submitted to and approved by the IRB before implementation. Please submit a final report form when the study is complete.

Please use reproductions of the IRB approved informed consent form to obtain consent from your participants.

Good luck with your research.

Appendix B

Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. **Please answer all questions.**

1. During the past month, what time have you usually gone to bed at night? _____
2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night? _____
3. During the past month, what time have you usually gotten up in the morning? _____
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.) _____

5. During the past month, how often have you had trouble sleeping because you…	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe:				
6. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
	No problem at all	Only a very slight problem	Somewhat of a problem	A very big problem
8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?				
	Very good	Fairly good	Fairly bad	Very bad
9. During the past month, how would you rate your sleep quality overall?				

	No bed partner or room mate	Partner/room mate in other room	Partner in same room but not same bed	Partner in same bed
10. Do you have a bed partner or room mate?				
	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
If you have a room mate or bed partner, ask him/her how often in the past month you have had:				
a. Loud snoring				
b. Long pauses between breaths while asleep				
c. Legs twitching or jerking while you sleep				
d. Episodes of disorientation or confusion during sleep				
e. Other restlessness while you sleep, please describe:				

Appendix C

Munich Chronotype Questionnaire (MCTQ)

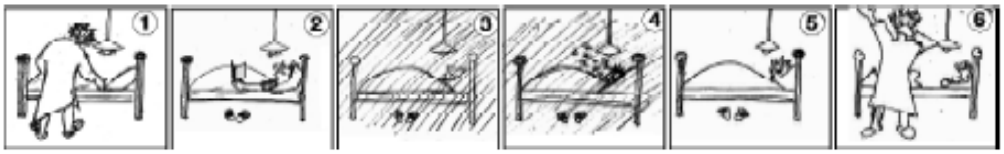
In this questionnaire, you report on your typical sleep behaviour over the past 4 weeks. We ask about work days and work-free days separately. Please respond to the questions according to your perception of a standard week that includes your usual work days and work-free days.

I have a regular work schedule (this includes being, for example, a housewife or househusband):

Yes ☐ I work on 1☐ 2☐ 3☐ 4☐ 5☐ 6☐ 7☐ days per week.

No ☐

Is your answer "*Yes, on 7 days*" or "*No*", please consider if your sleep times may nonetheless differ between regular 'workdays' and 'weekend days' and fill out the MCTQ in this respect.



Please use 24-hour time scale (e.g. 23:00 instead of 11:00 pm)!

Workdays

Image 1: I go to bed at _____ o'clock.

Image 2: Note that some people stay awake for some time when in bed!

Image 3: I actually get ready to fall asleep at _____ o'clock.

Image 4: I need _____ minutes to fall asleep.

Image 5: I wake up at _____ o'clock.

Image 6: After _____ minutes I get up.

I use an alarm clock on workdays: Yes ☐ No ☐

If "Yes": I regularly wake up BEFORE the alarm rings: Yes ☐ No ☐

Free Days

Image 1: I go to bed at _____ o'clock.

Image 2: Note that some people stay awake for some time when in bed!

Image 3: I actually get ready to fall asleep at _____ o'clock.

Image 4: I need _____ minutes to fall asleep.

Image 5: I wake up at _____ o'clock.

Image 6: After _____ minutes I get up.

My wake-up time (Image 5) is due to the use of an alarm clock: Yes ☐ No ☐

There are particular reasons why I cannot freely choose my sleep times on free days:

Yes ☐ If "Yes": Child(ren)/pet(s) ☐ Hobbies ☐ Others ☐, for example:_____

No ☐

Participant ID:

MCTQ Core, English, Version 2015-01

Appendix D

MacArthur Scale of Subjective Social Status

Q1) Instructions: Think of this ladder as representing where people stand in the United States. At the **top** of the ladder are the people who are the best off – those who have the most money, the most education, and the most respected jobs. At the **bottom** are the people who are the worst off – those who have the least money, least education, the least respected jobs, or no job. The higher up you are on this ladder, the closer you are to the people at the very top; the lower you are, the closer you are to the people at the very bottom.

Where would you place yourself on this ladder?
Please place a large **"X"** on the rung where you think you stand at this time in your life relative to other people in the United States.

Q2) Instructions: Think of this ladder as representing where people stand in their communities. People define community in different ways; please define it in whatever way is most meaningful to you. At the **top** of the ladder are people who have the highest standing in their community. At the **bottom** are the people who have the lowest standing in their community.

Where would you place yourself on this ladder?
Please place a large **"X"** on the rung where you think you stand at this time in your life relative to other people in your community.