# School Engagement and Attendance as Pathways to Adolescent Health

by

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Adolescent health and education are closely linked and were substantially impacted by the COVID-19 pandemic. The overall goal of this dissertation was to build understanding of adolescents' emerging and interrelated health and educational needs and identify multilevel factors that contribute to or protect against chronic absenteeism and school disengagement.

First, we used group-based trajectory modeling to identify high school attendance trajectories before and after the onset of the COVID-19 pandemic and investigate the effects of school-level practices on these attendance trajectories. We identified three attendance trajectory subgroups: stable high attendance, acutely declining attendance, and chronically declining attendance. Receipt of school discipline was associated with decreasing school attendance across all subgroups. Participation in a college readiness program was associated with an increase in school attendance only in the acutely declining attendance subgroup.

Next, we used social network analysis to evaluate the relationship between adolescents' social networks and their school engagement across the transition from middle to high school. Teachers, network-based supports, and highly school engaged peers were associated with greater school engagement. Greater peer network density was associated with lower school engagement. School-based supports including teachers and highly engaged peers were more strongly associated with school engagement for males.

Finally, we used longitudinal structural equation modeling to explore the strength and directionality of associations between school engagement and psychological wellbeing throughout

the high school years. Between-person and within-person correlations between school engagement and psychological wellbeing were frequently observed. Within-person autoregressive effects of both school engagement and psychological wellbeing on future levels of these variables were identified, with more consistent effects in the later high school years. A cross-lagged effect from psychological wellbeing to school engagement across the high school transition was identified in some but not all models.

Collectively, these studies increase our understanding of school attendance and engagement during a unique developmental stage and in the context of a global pandemic that has had significant and lasting impacts on adolescent education, health, and wellbeing. Results can inform interventions at interpersonal, school, or larger structural levels to collectively promote health and education in adolescence and throughout the life course.

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## Preface

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# 1.0 Introduction

## 1.1 The Relationship Between Health and Education

Health and education are bidirectionally linked.[1] Youth who are physically and emotionally well can optimally attend and engage in school. Childhood health concerns are common causes of chronic school absenteeism, defined as missing at least 10% of school days.[1] Chronic absenteeism predicts poor educational outcomes including failure to graduate high school, and acute illnesses (e.g., group A streptococcal pharyngitis, gastroenteritis) and chronic diseases (e.g., asthma, type I diabetes, obesity) are frequently cited causes.[1-5] Further, children with special healthcare needs or exposure to structural disadvantage (e.g., housing instability, food insecurity) are more likely to be chronically absent than children without.[6,7] Conversely, educational attainment impacts social and economic opportunities that influence health throughout the life span. High school graduation is associated with lower rates of many common chronic diseases (e.g., cardiovascular disease, type II diabetes, depression) and improved overall mortality in adulthood.[8-11] Efforts to concurrently promote health and education may have substantial public health benefits and reduce health inequities.[12] National health organizations have increasingly recognized this potential. The Institute of Medicine identified high school graduation rate as a core measure of health and health care progress and the U.S. Department of Health and Human Services included reducing chronic absence among early adolescents and increasing the proportion of high school students who graduate in 4 years as Healthy People 2030 national objectives.[13,14]

## 1.2 The Importance of Adolescence

Adolescence may be a critical period to optimize health and educational trajectories throughout the lifespan.[15] This life stage can be accompanied by the onset of chronic physical (e.g., obesity) and mental health (e.g., depression) conditions, uptake of health behaviors (e.g., substance use) that can persist into adulthood, and a heightened risk of intentional or unintentional injury.[15] Academic demands increase as adolescents reach the high school years and attendance and school engagement generally decline at this time.[16] Health and education also have unique interactions during adolescence. In adolescence, low academic achievement and school disengagement have been associated with poorer mental health and higher rates of negative health-affecting behaviors including substance use, risky sexual behaviors, physical inactivity, and unhealthy diet.[17-24] Relationships between adolescent health and education may be positively reinforcing with potential for beneficial or deleterious effects.[25] Therefore, efforts to enhance health and education may have distinct and outsized advantages during adolescence by establishing virtuous cycles that amplify positive effects.[25]

## 1.3 Adolescent Health and Education and the COVID-19 Pandemic

The COVID-19 pandemic has spurred a crisis of adolescent health and education. In recent national data, 42% of U.S. high school students endorsed feeling persistently sad or hopeless and 22% reported considering suicide in the past year.[26] Youth who identified as lesbian, gay, bisexual, questioning, or another non-heterosexual identity (LGBQ+) were disproportionately affected with 37% reporting making a suicide plan in the past year.[26] Youth also endorsed signs of school

disengagement with 39% of students overall and 48% of LGBQ+ students reporting not feeling close to people at school.[26] 9% of students reported missing school in the past 30 days due to safety concerns and even higher rates of absence due to safety concerns were observed among students who identified as American Indian or Alaskan Native (13%), Black (12%), Hispanic (11%), or LGBQ+ (14%).[26] More broadly, chronic school absenteeism for any reason has drastically increased. National data collected prior to the COVID-19 pandemic in the 2017-2018 school year suggested that approximately 16% of students were chronically absent from school.[27] State-level data from the 2021-2022 school year suggests that around 30% of youth may now be chronically absent.[28-31] Collectively, these data reveal a clear and urgent need to address adolescent health and education in the wake of the COVID-19 pandemic.

### 1.4 Goals of the Dissertation

The overall goal of the projects described in this dissertation is to build understanding of adolescents' emerging and interrelated health and educational needs and identify multilevel factors that contribute to or protect against chronic absenteeism and school disengagement. First, we elucidate trajectories of school attendance throughout the high school years and across the COVID-19 pandemic. The high school years are generally accompanied by declining attendance and rates of chronic school absenteeism nationwide have spiked in the wake of the COVID-19 pandemic.[16,28-31] Using group-based trajectory modeling, we identify distinct attendance patterns during this time and investigate the effects of two school-level policies and practices on these attendance trajectories. Next, we evaluate the relationship between adolescents' social networks and their school engagement across the transition from middle to high school. The high school

transition is a critical turning point where youth may experience declining academic performance and uptake of related negative health-affecting behaviors including substance use or violence involvement.[16,32] Enhancing school engagement may be a promising means to maintain connection to school and promote positive health and educational trajectories. Using social network analysis, we identify associations between adolescents' school engagement and the quality and structure of their peer and adult social networks. Finally, we explore the strength and directionality of associations between school engagement and psychological wellbeing throughout the high school years. Using random-intercept cross-lagged panel modeling, we characterize longitudinal relationships between these adolescent health-promoting constructs at an individual level to offer potential considerations for intervention development. Collectively, these studies increase our understanding of school attendance and engagement during a unique developmental stage and in the context of a global pandemic that has had significant and lasting impacts on adolescent education, health, and wellbeing. Results can inform interventions at interpersonal, school, or larger structural levels to collectively promote health and education in adolescence and throughout the life course.

## 2.0 Impact of the COVID-19 Pandemic on Attendance Trajectories of High School Students

### 2.1 Introductions

Being present and engaged in school is critical for educational success, youth development, and adolescent and adult health[1]. School attendance is strongly associated with academic achievement including grades, test scores, and grade promotion[33,34]. Early academic achievement can bolster students' academic self-efficacy and school engagement, preparing them to overcome future academic challenges and further reinforcing educational success[16,35]. Compared to traditional measures of academic achievement, attendance alone may be a better predictor of successful high school graduation and enrollment and persistence in college[33,34]. In addition, being present in school offers important opportunities to build social connections that influence youth development[25,36]. Schools serve as primary contexts for socialization as adolescents seek greater independence from the family unit and formulate their self-identity[37]. Positive relationships with school-based adults and peers may foster school engagement, increase educational success, and surround youth with the social support needed to safely navigate adolescence[38-41]. Strong school attendance and engagement can also benefit adolescent health through supportive relationships with school-based adults and connections to healthier peer social networks[25,36,38,42-44]. School-based peer social networks can be key to promoting adolescent health by influencing a broad range of health behaviors that commonly emerge during this life stage related to nutrition, physical activity, sexual health, substance use, and violence involvement[44-49].

As a crucial pathway to increasing educational attainment, attendance also impacts adult health[1,50,51]. Achieving higher levels of education can increase employment opportunities and income, facilitate connection to healthier social networks, and bolster social supports that can buffer life stressors and enhance well-being[50-52]. These factors can improve the ability of adults with higher educational attainment to afford safe housing, obtain health insurance, and adhere to health-enhancing behaviors like eating a nutritious diet, engaging in physical activity, and avoiding substance use[52-54]. Compared to those with lower educational attainment, adults with higher educational attainment experience decreased rates of chronic conditions including obesity, cardiovascular disease, and depression[10,11,55]. Overall, successfully graduating from high school has consistently predicted longer life expectancy with evidence for widening disparities over time[56,57]. Efforts to increase school attendance can have far-reaching and long-lasting effects on education, health, and the shared drivers of both to enhance population health and equity[12,25].

Although consistent school attendance is critically important, it is also uniquely challenging[1,58]. To optimally attend school and reap the benefits of education, youth must be physically and emotionally well and have access to the health care needed to stay this way[1,59-61]. Acute and chronic health conditions (e.g., influenza, asthma) and mental health concerns (e.g., depression, anxiety) are common causes of chronic school absenteeism[1,62-67]. School-aged youth and their families must also have their social needs met[68,69]. Stable housing, adequate nutrition, and safe and reliable transportation are all necessary prerequisites to good attendance[70-73]. To facilitate school attendance, youth must also feel safe and welcome at school and connected to the school community[58]. School staff, policies, and practices have significant roles in promoting school environments that are safe, positive, and supportive[25,74]. This is especially important for youth identified as racial or ethnic minorities or sexual or gender minorities who may have more

negative perceptions of school climate compared to their same-school peers[75,76]. Overall, school attendance is a unique holistic marker of youth well-being with relevance to educators and health care providers alike.

The current state of school attendance is cause for alarm, signaling an ongoing crisis of adolescent health and education in the wake of the COVID-19 pandemic. National data collected prior to the COVID-19 pandemic in the 2017-2018 school year indicated that 8 million or nearly 16% of U.S. students were chronically absent, defined as missing at least 10% of school days[27,77]. Beginning in March 2020, school closures and shifts to virtual learning occurred around the world to limit the spread of COVID-19[78,79]. School attendance was difficult to define or monitor during this time and is yet to recover[77]. State-level data from the 2020-2021 school year suggests that up to 30% of U.S. students may now be chronically absent[28-31]. Some of this increase may be attributable to COVID-19 infection itself. Youth with a history of COVID-19 infection have been found to have decreased past 12-month school attendance as compared to peers without this history[80]. An even greater share of the observed increase in absenteeism is likely due to the broad ancillary effects of the COVID-19 pandemic on the physical and mental health, social needs, and school connectedness of all youth regardless of COVID-19 infection history[20,26,81].

Considering these findings, concerted efforts are needed to comprehensively support youth and enhance long-term education and health outcomes. Increasing our understanding of school attendance in the wake of the COVID-19 pandemic can support these goals. School attendance generally declines across school transitions (e.g., middle to high school transition) and throughout the high school years[27,32,77]. Existing research has identified unique longitudinal attendance patterns that differentially contribute to the observed population level decline, and which may represent distinct risk profiles[82-84]. However, it is unknown whether or how these attendance

trajectories shifted during the COVID-19 pandemic. Understanding the shapes, correlates, and influences of attendance trajectories during this time may support identification of youth with unique education and health needs and inform intervention.

In this study, we aimed to identify distinct attendance trajectories between the 2016-2017 and 2020-2021 school years among a sample of youth enrolled in high school at the onset of the COVID-19 pandemic. Using school administrative data from 5 public high schools in Los Angeles, we performed group-based trajectory modeling to characterize the shape of school attendance trajectories, estimate the proportion of the population following each trajectory, and identify correlates of attendance trajectory subgroup membership. We further estimated the effect of two school-level factors—school suspension and participation in a college readiness program—on the shape of each school attendance trajectory.

## 2.2 Methods

### 2.2.1 Study Design and Participants

We conducted secondary analysis of data from a randomized trial of Advancement via Individual Determination (AVID; NCT03059433), a nationwide college readiness program currently operating in approximately 20% of U.S. public high schools[85]. The larger trial investigated the effects of AVID on participating students' peer social networks, health behaviors, and psychosocial well-being[86]. Study sites were 5 high schools within a large public school district in Southern California serving predominantly low-income and minoritized youth (Table 1). Participants were enrolled at the transition to high school (end of 8$^{th}$ grade/beginning of 9$^{th}$ grade)

over two consecutive years (2017 and 2018). Participants completed a baseline survey at the transition to high school and up to 4 follow-up surveys at the end of each academic year of high school. For the group-based trajectory modeling presented here, corresponding school administrative data was collected at each time point for all students enrolled at study schools regardless of participation in the larger trial. The group-based trajectory modeling sample includes 2 cohorts of youth who completed 8th grade in any district middle school and entered 9th grade in a study high school in 2017 or 2018. Cohort 1 includes students in 8th grade in the 2016-2017 academic year through 12th grade in the 2020-2021 academic year. Cohort 2 includes students in 8th grade in the 2017-2018 academic year through 11th grade in the 2020-2021 academic year. The study was approved by the overseeing institutional review board and participating school district.

**Table 1. Characteristics of Study Schools**

| Characteristic | School 1 | School 2 | School 3 | School 4 | School 5 |
|---|---|---|---|---|---|
| Total enrollment | 1504 | 1951 | 1030 | 2020 | 1650 |
| % qualifying for free or reduced-price meals | 90 | 91 | 90 | 85 | 64 |
| % Hispanic | 93 | 93 | 73 | 99 | 68 |
| % Black | 2 | 6 | 1 | 1 | 23 |

### 2.2.2 Data Collection

Data was collected in partnership with the participating school district. School administrative data related to student attendance, academic performance (e.g., grade-point-average (GPA)), receipt of disciplinary action (i.e., in-school or out-of-school suspension), and AVID participation was recorded according to routine school district procedures for each academic year. School administrative data was deidentified and linked using unique identification numbers by a member of the school district. Deidentified data was then shared with members of the research team for further analysis.

### 2.2.3 Measures

#### 2.2.3.1 School Attendance

Our primary outcome of interest was school attendance. School attendance was defined as an attendance percentage calculated by dividing the total number of school days attended by the total number of school days enrolled for each academic year and multiplying by 100. Missed school days for any reason including excused and unexcused absences were recorded as school days absent. In alignment with California Department of Education guidelines for reporting chronic school absenteeism, attendance percentage was only calculated for students who were enrolled for at least 31 days in the academic year[87]. Data points for any academic year in which a student was enrolled for less than 31 days were excluded from the group-based trajectory modeling. For each participant, we additionally determined an overall attendance percentage for the entire study period and classified them as chronically absent overall if this percentage was $\leq 90\%$[87].

#### 2.2.3.2 Academic Performance

Measures of academic performance included high school GPA, Preliminary Scholastic Assessment Test (PSAT) score, and advanced placement (AP) course enrollment. Unweighted high school GPA was calculated in alignment with school district procedures on a 4-point scale corresponding to grades A (4.0) to F (0.0) by dividing summed grade points earned by total credits attempted in the $9^{th}$ to $12^{th}$ grade academic years. PSAT score was recorded as a participant's highest total composite score from any single PSAT attempt between grades 9-11 with a possible PSAT score range of 240 to 1520. AP course enrollment was determined from review of academic transcripts and recorded as a binary indicator (yes/no) if a participant had enrolled in an AP course

at any point during the study period. Academic performance is strongly associated with school attendance,[33] so we hypothesized that measures of academic performance would vary by identified attendance trajectory subgroups.

#### 2.2.3.3 Receipt of School Discipline

Receipt of school discipline was defined as receiving an in-school or out-of-school suspension in the academic year. This was recorded as a binary indicator of receipt of school discipline (yes/no) for each academic year within the study period. Receipt of school discipline was considered a time-varying covariate that could change across academic years for individual participants when included in group-based trajectory models. We hypothesized that receipt of school discipline would have lasting negative effects on students' attendance, mediated by disruption of school-based social networks and promotion of school disengagement. We therefore modeled receipt of school discipline as an enduring effect that could change value only once during the study period, such that all academic years prior to receipt of school discipline had an indicator of 0 and all academic years including and following the first receipt of school discipline had an indicator of 1[88]. We additionally calculated a school discipline count variable that summed suspensions for each school year which was used in a supplementary analysis to explore the cumulative effect of suspensions on attendance.

#### 2.2.3.4 AVID Participation

AVID participation was defined as course enrollment in the AVID academic skills elective in at least 1 semester within the academic year. This was recorded as a binary indicator of AVID participation (yes/no) for each academic year within the study period. AVID participation was considered a time-varying covariate when included in group-based trajectory models. We

hypothesized that AVID would improve students' attendance and have the greatest effect when students were actively engaged in AVID programming, mediated by positive adult and peer social network effects on school engagement. We therefore modeled AVID participation to freely vary throughout the study period, with an indicator of 1 only during academic years in which a student was actively enrolled in AVID[88]. We additionally calculated an AVID participation count variable that summed semesters of AVID participation for each school year which was used in a supplementary analysis to explore the cumulative effect of AVID on attendance.

### 2.2.4 Statistical Analysis

We used group-based trajectory modeling to characterize school attendance trajectories among a sample of rising high school students between the 2016-2017 and 2020-2021 academic years. Group-based trajectory models are semi-parametric, finite mixture models that allow for identification of latent subgroups of individuals with similar trajectories within a larger population[88,89]. Using group-based trajectory modeling, we can illustrate the shape of school attendance trajectories of identified subgroups, estimate the proportion of the population belonging to each subgroup, identify correlates of subgroup membership, and estimate the effect of time-varying covariates on the shape of each school attendance trajectory. Analyses were completed using the *traj* plugin for Stata v17 (StataCorp LLC, College Station, TX)[90].

Our dependent variable was school attendance in the 2016-2017 (Year 1), 2017-2018 (Year 2), 2018-2019 (Year 3), and 2020-2021 (Year 5) academic years. School attendance in the 2019-2020 (Year 4) academic year was excluded from the group-based trajectory analysis as recommended by the California Department of Education as this coincided with initial school closures during the COVID-19 pandemic and methods for defining and tracking attendance were

highly variable at this time[30]. School attendance trajectories were modeled using a censored normal distribution. Using a standard procedure, we first generated a base model without covariates by comparing models with between 1-6 subgroups and all quadratic polynomial functions specifying each subgroup trajectory[88,89]. We selected the optimal number of subgroups based on: 1) highest Bayesian information criterion (BIC) with log Bayes factor approximation ≥ 10; 2) relative entropy; 3) at least 5% of participants in each subgroup; and 4) clinical meaningfulness of the identified subgroup trajectories (i.e., each subgroup displayed a distinct school attendance trajectory)[88,89]. We next varied the order of the polynomial functions from constant to quadratic for all possible combinations. We selected the final unadjusted base model based on the criteria above and the requirement that the parameter estimate for the highest order polynomial of each subgroup was statistically significant at $p < 0.05$. We evaluated the fit of the final unadjusted base model based on the following criteria: 1) average posterior probabilities of subgroup membership ≥ 0.7; 2) odds of correct classification ≥ 5.0; 3) similarity between the estimated probability of subgroup membership and the observed proportion of the sample classified to each subgroup; and 4) relatively constant and narrow confidence intervals on visual inspection of the subgroup trajectories[88,89].

The final unadjusted base model was then adjusted for time-stable covariates of study cohort (i.e., Cohort 1 vs Cohort 2) and study high school (i.e., 5 study schools represented as 4 dummy variables) based on *a priori* knowledge of associations between grade level, school, and school attendance[33]. The fit of the final adjusted base model was evaluated according to the criteria listed above. We further assessed the performance of the final adjusted base model by constructing spaghetti plots for each attendance trajectory subgroup[91,92]. We randomly selected 200 participants assigned to each subgroup, or all participants assigned to any subgroup containing less than 200

participants, and visualized their individual attendance trajectories. We examined spaghetti plots displaying overlapping individual attendance trajectories to determine if these concentrated near the estimated subgroup attendance trajectory lines. We present details of the model selection procedure, the identified final adjusted base model including the school attendance trajectories of identified subgroups and the proportion of the study sample belonging to each subgroup, and model fit diagnostics.

Next, we explored distributions of 2 traditional measures of school attendance (i.e., overall attendance percentage, overall chronic absenteeism) and 3 measures of academic performance within each attendance trajectory subgroup using descriptive statistics. We evaluated between subgroup differences using Kruskal-Wallis tests for continuous variables or chi-square tests for categorical variables. We present these results to describe attendance trajectory subgroups and characterize the ability of the identified group-based trajectory model to distinguish clinically distinct attendance and academic performance profiles[91].

Next, we estimated the effect of two school-level structural factors on the identified school attendance trajectories. We generated separate group-based trajectory models including receipt of school discipline and AVID participation as binary time-varying covariates in the final adjusted base model[88,89]. We used Wald tests to assess for differences in the effect of each time-varying covariate between each attendance trajectory subgroup. We present estimates of the effect of each time-varying covariate on the attendance trajectory of each subgroup, results of statistical testing for between subgroup differences, and visual representations of estimated school attendance trajectories assuming exposure to each time-varying covariate beginning in Year 2. In supplementary analyses, we additionally estimated separate group-based trajectory models including count variables for school discipline and AVID participation in the final adjusted base

model to assess for cumulative effects of these variables on the observed attendance trajectory subgroups.

Finally, we conducted a post hoc sensitivity analysis[91]. Group-based trajectory analysis accounts for data missing at random using maximum likelihood estimation[88,89]. To assess for nonignorable data missingness, we explored rates of missing attendance data across 3 possible missing data patterns: 1) missing a single data point prior to COVID-19 related school closures; 2) missing a single data point in the school year after COVID-19 related school closures; or 3) missing 2 or more data points. We tested associations between the 3 missing data patterns and attendance trajectory subgroup membership using chi-square tests. We subsequently excluded participants with any missing data patterns found to be associated with attendance trajectory subgroup membership and repeated the model selection and assessment procedures outlined above. We compared results to the final adjusted base model from the overall sample.

## 2.3 Results

A total of 2,850 participants were included in this analysis including 1,698 in Cohort 1 and 1,152 in Cohort 2. Attendance data was available for 84.2% of possible data points during the study period. Data missingness varied by academic year and was 12.8% in 2016-2017, 10.0% in 2017-2018, 7.4% in 2018-2019, and 26.6% in 2020-2021.

### 2.3.1 Model Selection

The BIC improved and the log Bayes factor approximation remained greater than 10 with addition of groups between the 1-group and 6-group unadjusted base models (Table 2). However, upon review of unadjusted base models including more than 3 groups, there were multiple subgroups with estimated group proportions < 5% and more similarity and therefore less clinical meaningfulness of some identified attendance trajectories (Figure 1). The 3-group unadjusted base model had the greatest relative entropy value of 0.883, representing high precision of subgroup classification in this model. Therefore, we selected the 3-group model as the unadjusted base model. Upon varying the order of the polynomial functions of each subgroup, the 3-group model with all quadratic polynomials retained the highest BIC in addition to meeting all model selection criteria and was chosen as the final unadjusted base model. Adding time-stable covariates representing study cohort and study school improved model fit overall as evidenced by an increased BIC, log Bayes factor approximation greater than 10, and preserved entropy value of 0.884 relative to the final unadjusted base model (Table 2).

**Table 2. Base Model Selection using BIC, Log Bayes Factor, Entropy, and Estimated Group Proportions**

| Groups | BIC[a] (N=8629) | BIC[b] (N=2850) | Log Bayes Factor | Entropy | Estimated Group Proportions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | -32303.3 | -32301 | | | 100 | | | | | |
| 2 | -30413.8 | -30409.3 | 3781.2 | 0.880 | 18.8 | 81.2 | | | | |
| 3 | -29686.5 | -29679.8 | 1456.8 | 0.883 | 5.0 | 77.8 | 17.2 | | | |
| 4 | -29329.1 | -29320.3 | 716.9 | 0.861 | 4.5 | 10.0 | 72.1 | 13.4 | | |
| 5 | -29080.2 | -29069.1 | 500.1 | 0.865 | 2.2 | 5.3 | 14.5 | 70.3 | 7.6 | |
| 6 | -28865.8 | -28852.5 | 431 | 0.798 | 2.6 | 6.6 | 11.4 | 70.0 | 8.5 | 1.0 |
| 3[c] | -29645.5 | -29633.3 | 87.5[d] | 0.884 | 5.1 | 77.2 | 17.7 | | | |

BIC: Bayesian Information Criterion

[a] BIC for overall observations (N=8629)

[b] BIC for participant sample size (N=2850)

[c] Represents adjusted 3-group base model with adjustment for study cohort and high school

[d] Adjusted 3-group base model compared to unadjusted 3-group base model

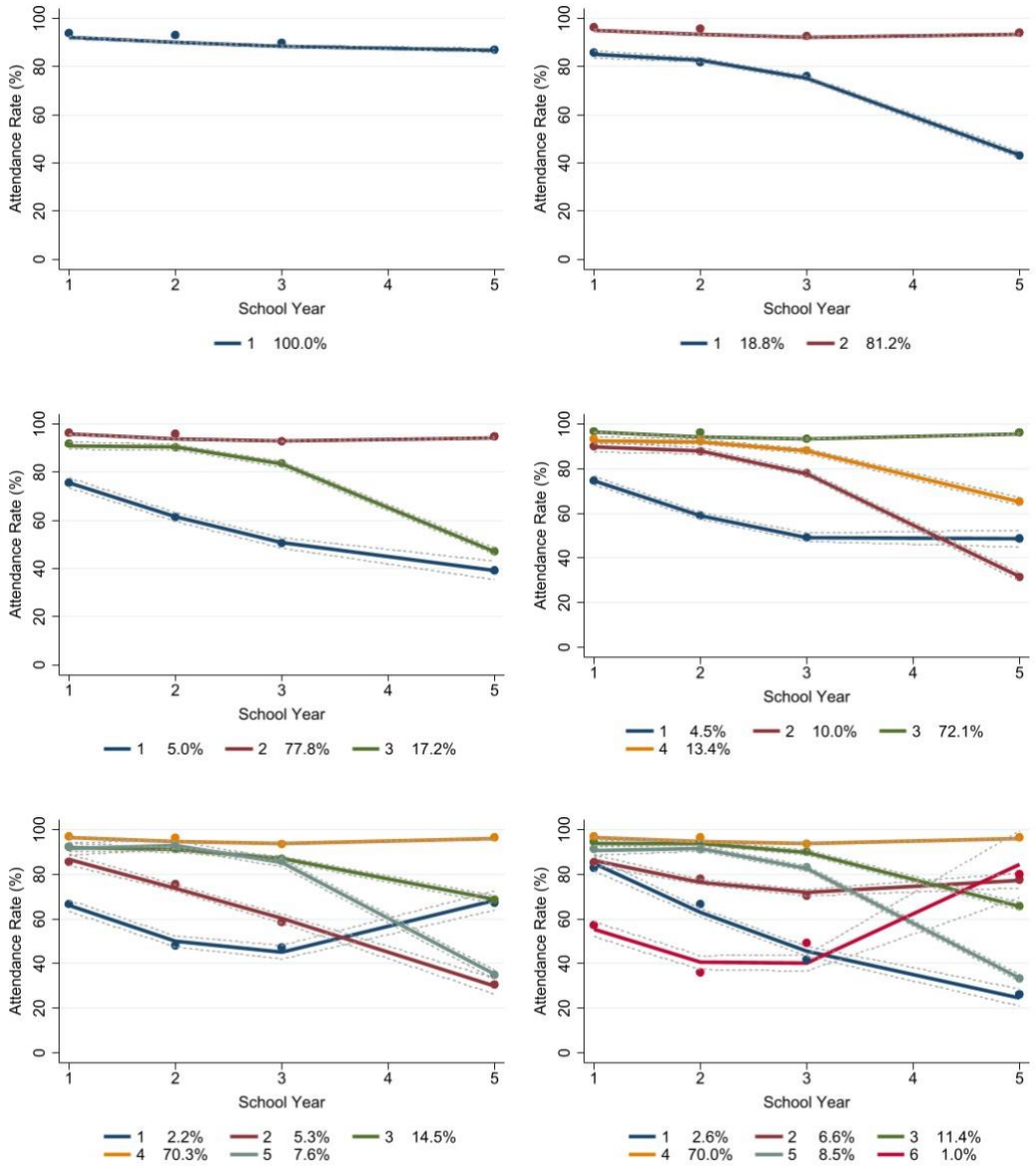



**Figure 1. Unadjusted base models with between 1 and 6 subgroups and all quadratic polynomial functions. Solid lines represent estimated attendance trajectories for each subgroup. Dashed lines represent 95% confidence intervals of the estimated probabilities of subgroup membership. Points represent average observed values at each time point with responses weighted based on posterior probabilities of subgroup membership.**

### 2.3.2 Final Model

We identified 3 attendance trajectory subgroups in the final adjusted base model (Figure 2). The *stable high attendance* subgroup included 77.2% of the study sample (n = 2250) and displayed fairly constant high attendance throughout the study period. The *acutely declining attendance* subgroup included 17.7% of the study sample (n = 455). This subgroup displayed initial high attendance with modest decline prior to COVID-19 related school closures during the 2019-2020 school year and more rapid decline after this time. The *chronically declining attendance* subgroup included 5.1% of the study sample (n = 145) and displayed continual decline in attendance throughout the study period. Details of the final adjusted base model are included in Table 3.

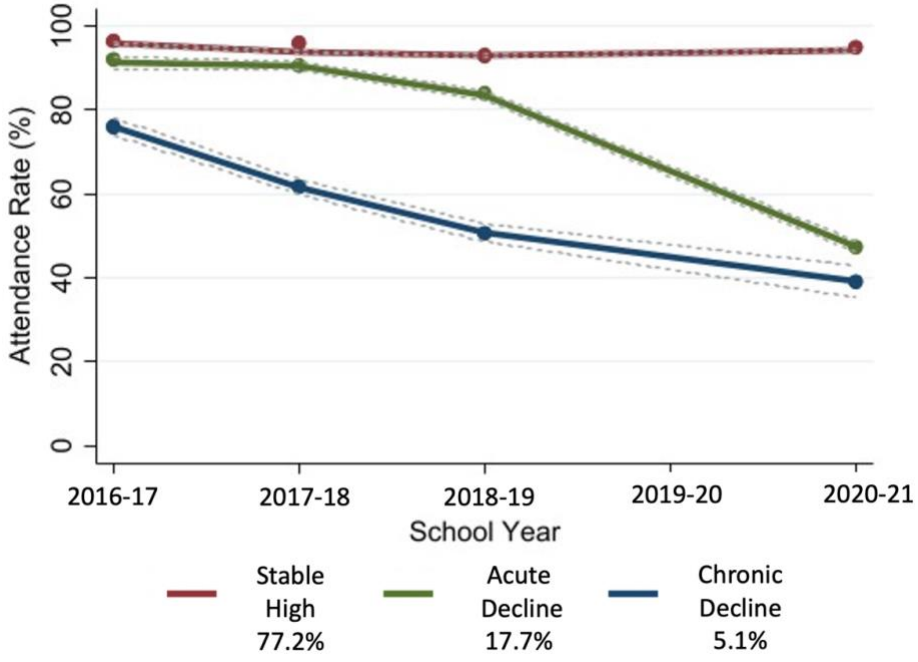



**Figure 2. Final adjusted base model including 3 attendance trajectory subgroups.**

**Solid lines represent estimated attendance trajectories for each subgroup. Dashed lines represent 95% confidence intervals of the estimated probabilities of subgroup membership. Points represent average**

**observed values at each time point with responses weighted based on posterior probabilities of subgroup membership.Table 3. Final Adjusted Base Model Including 3 Attendance Trajectory Subgroups[a]**

| Group | Parameter Estimate | Standard Error | P value |
|---|---|---|---|
| Stable high attendance | | | |
| Intercept | 103.33 | 0.62 | <0.0001 |
| Linear | -5.58 | 0.43 | <0.0001 |
| Quadratic | 0.84 | 0.07 | <0.0001 |
| Acutely declining attendance | | | |
| Intercept | 85.97 | 1.29 | <0.0001 |
| Linear | 9.51 | 0.97 | <0.0001 |
| Quadratic | -3.44 | 0.16 | <0.0001 |
| Chronically declining attendance | | | |
| Intercept | 93.85 | 2.30 | <0.0001 |
| Linear | -19.50 | 1.97 | <0.0001 |
| Quadratic | 1.71 | 0.35 | <0.0001 |

[a] Model adjusted for study cohort and high school

### 2.3.3 Model Fit Diagnostics

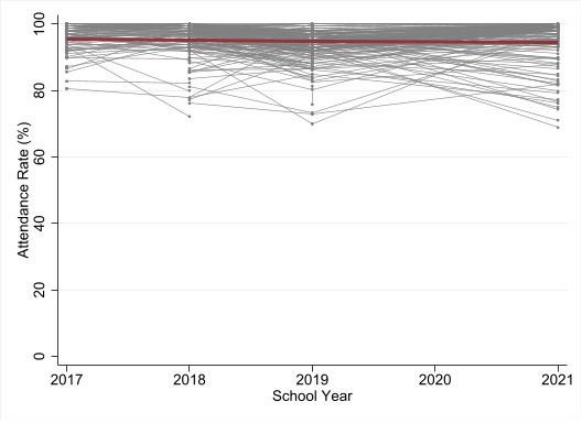
The average posterior probabilities of subgroup membership were ≥ 0.7 for all subgroups in the final unadjusted and adjusted base models, ranging from 0.880-0.958 and 0.884-0.957 respectively (Table 4). The odds of correct classification were ≥ 5.0 for all subgroups in the final unadjusted and adjusted base models, ranging from 6.45-273.08 and 6.00-251.73 respectively. For both the final unadjusted and adjusted base models, the estimated probability of subgroup membership and the observed proportion of the sample classified to each subgroup were similar and confidence intervals for all subgroup trajectories remained relatively constant and narrow.

**Table 4. Unadjusted and Adjusted Base Model Fit Diagnostics**

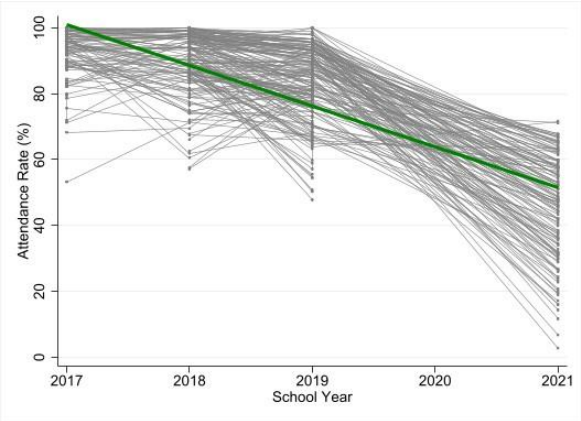
| Group | Average Posterior Probability | Odds of Correct Classification | Estimated Probability of Subgroup Membership | Observed Subgroup Membership |
|---|---|---|---|---|
| Unadjusted base model with 3 groups | | | | |
| Stable high attendance | 0.958 | 6.45 | 0.796 | 0.778 |
| Acutely declining attendance | 0.880 | 35.47 | 0.154 | 0.172 |
| Chronically declining attendance | 0.935 | 273.08 | 0.049 | 0.050 |
| Adjusted base model with 3 groups | | | | |
| Stable high attendance | 0.957 | 6.00 | 0.789 | 0.772 |
| Acutely declining attendance | 0.884 | 40.12 | 0.160 | 0.177 |
| Chronically declining attendance | 0.931 | 251.73 | 0.051 | 0.051 |

Figure 3 displays spaghetti plots of the individual attendance patterns of 200 randomly selected participants in each of the stable high attendance and acutely declining attendance subgroups and all 145 participants included in the chronically declining attendance subgroup. Attendance patterns of participants in the stable high attendance subgroup concentrated most closely to the subgroup attendance trajectory estimated in the group-based trajectory model. There was increasing dispersion of individual attendance patterns in the acutely declining attendance and chronically declining attendance subgroups but a maintained overall decline in attendance in these subgroups that mirrored that estimated in the group-based trajectory model. Overall, these findings suggest good model fitness of the 3-group base model.

**A**




**B**

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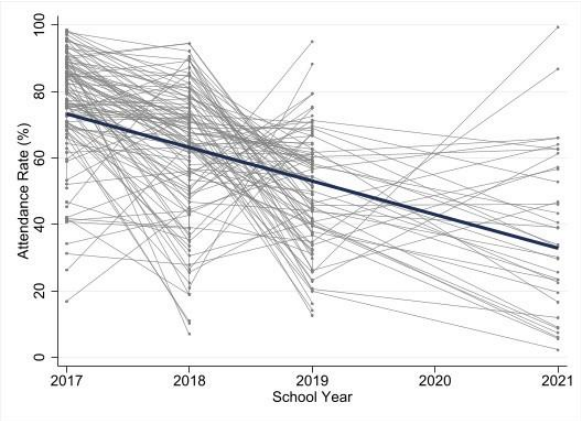



**Figure 3. Spaghetti plots of individual attendance patterns and estimated average attendance for each attendance trajectory subgroup.**

**A) stable high attendance; B) acutely declining attendance; C) chronically declining attendance. Thin gray lines represent observed attendance rates of individual participants. Colored lines represent average attendance rates of these participants estimated by linear regression.**

### 2.3.4 Distribution of Attendance and Academic Performance Measures Across Subgroups

Both traditional measures of school attendance and all academic performance measures were significantly different across identified attendance trajectory subgroups (Table 5). The median overall attendance percentage was highest in the stable high attendance subgroup (96.0%) and decreased in the acutely declining attendance (80.2%) and chronically declining attendance subgroup (64.5%) subgroups ($\chi^2$ = 1316.24; $p$ = 0.0001). The proportion of participants classified as chronically absent overall was relatively low in the stable high attendance subgroup (14.3%) and high in the acutely declining attendance (97.6%) and chronically declining attendance (100%; $\chi^2$ = 1500; $p < 0.001$). Academic performance measures displayed similar trends across subgroups. For example, median high school GPA was highest in the stable high attendance subgroup (2.55) and decreased in the acutely declining attendance (1.46) and chronically declining attendance (0.75) subgroups ($\chi^2$ = 578.72; $p$ = 0.0001).

**Table 5. Traditional attendance Measures and Academic Performance by Attendance Trajectory Subgroup**

| Characteristic<br>*median(IQR) or N(%)* | Overall<br>N = 2850 | Stable high attendance<br>N = 2250 | Acutely declining attendance<br>N = 455 | Chronically declining attendance<br>N = 145 | χ2 | P value |
|---|---|---|---|---|---|---|
| Overall percent attendance | 94.5 (87.1 – 97.6) | 96.0 (92.5 – 98.1) | 80.2 (74.2 – 84.1) | 64.5 (54.2 – 70.5) | 1316.24 | 0.0001 |
| Overall chronically absent | | | | | | |
| Yes | 911 (32%) | 322 (14.3%) | 444 (97.6%) | 145 (100%) | 1500 | <0.001 |
| No | 1939 (68%) | 1928 (85.7%) | 11 (2.4%) | 0 (0%) | | |
| High school GPA[a] | 2.31 (1.60 – 3.04) | 2.55 (1.91 – 3.19) | 1.46 (0.98 – 1.98) | 0.75 (0.34 – 1.24) | 578.72 | 0.0001 |
| PSAT score[b] | 760 (700 – 860) | 770 (710 – 870) | 720 (660 – 780) | 690 (670 – 750) | 116.99 | 0.0001 |
| Any AP class enrollment | | | | | | |
| Yes | 947 (33.2%) | 891 (39.6%) | 56 (12.3%) | 0 (0%) | 203.08 | <0.001 |
| No | 1903 (66.8%) | 1359 (60.4%) | 399 (87.7%) | 145 (100%) | | |

IQR: interquartile range

GPA: grade point average

PSAT: Preliminary Scholastic Assessment Test

[a] Unweighted high school GPA with possible range of 0.0 to 4.0

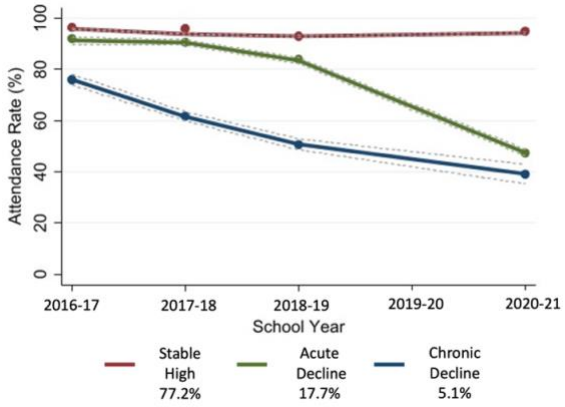
[b] Highest total composite PSAT score with possible range of 240 to 1520

### 2.3.5 Effect of Time-varying Covariates

Visual representations of the effect of receipt of any school discipline and AVID participation on school attendance trajectories are displayed in Figure 4. Receipt of school discipline was associated with lower school attendance across all attendance trajectory subgroups (stable high attendance: $\beta = -8.96$; $p < 0.0001$; acutely declining attendance: $\beta = -12.00$; $p < 0.0001$; chronically declining attendance: $\beta = -7.61$; $p = 0.025$; Table 6). These associations were not significantly different between groups ($\chi^2 = 1.57$; $p = 0.46$). AVID participation was associated with slightly lower school attendance in the stable high attendance subgroup ($\beta = -0.97$; $p = 0.025$) and higher school attendance in the acutely declining attendance subgroup ($\beta = 3.60$; $p = 0.015$; Table 7). Associations were significantly different between groups ($\chi^2 = 8.77$; $p = 0.013$).

In supplementary analyses evaluating the effect of cumulative receipt of school discipline and AVID participation, receipt of school discipline was associated with lower attendance in the stable high attendance ($\beta = -6.26$; $p < 0.0001$) and acutely declining attendance subgroups ($\beta = -4.46$; $p < 0.0001$; Table 8). Associations were significantly different between groups ($\chi^2 = 8.56$; $p = 0.014$). AVID participation was associated with higher attendance only in the acutely declining attendance subgroup ($\beta = 2.99$; $p < 0.0001$; Table 9). Associations were significantly different between groups ($\chi^2 = 22.27$; $p < 0.0001$).

**A**

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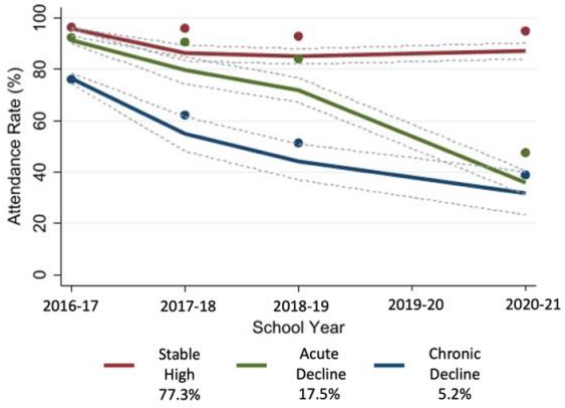


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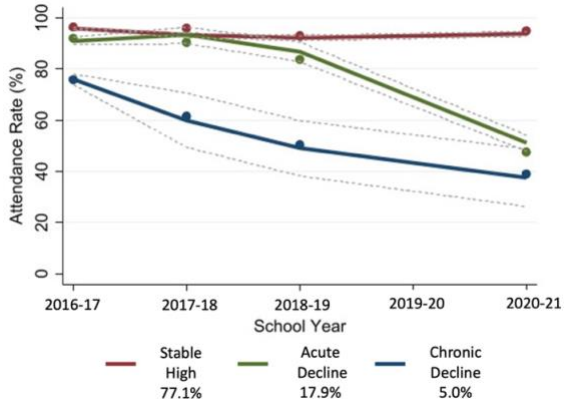


**Figure 4. Effect of Receipt of School Discipline and AVID Participation in School Year 2 on Expected Attendance Trajectories.**

**A) Final adjusted base model with 3 school attendance trajectory subgroups; B) Effect of an in-school or out-of-school suspension occurring in school year 2 on estimated school attendance trajectories; C) Effect of AVID participation beginning in school year 2 and continuing through school year 5 on estimated school attendance trajectories. Solid lines represent estimated attendance trajectories for each subgroup. Dashed lines represent 95% confidence intervals of the estimated probabilities of subgroup membership. Points represent average observed values at each time point with responses weighted based on posterior probabilities of subgroup membership.**

**Table 6. Effect of Receipt of Any School Discipline on School Attendance Trajectories**

| Group | Parameter Estimate | Standard Error | P value |
|---|---|---|---|
| Stable high attendance | | | |
| Intercept | 103.39 | 0.61 | <0.0001 |
| Linear | -5.59 | 0.43 | <0.0001 |
| Quadratic | 0.84 | 0.07 | <0.0001 |
| Suspension | -8.96 | 1.20 | <0.0001 |
| Acutely declining attendance | | | |
| Intercept | 86.37 | 1.32 | <0.0001 |
| Linear | 9.53 | 1.00 | <0.0001 |
| Quadratic | -3.45 | 0.16 | <0.0001 |
| Suspension | -12.00 | 2.38 | <0.0001 |
| Chronically declining attendance | | | |
| Intercept | 93.83 | 2.35 | <0.0001 |
| Linear | -18.88 | 2.01 | <0.0001 |
| Quadratic | 1.60 | 0.36 | <0.0001 |
| Suspension | -7.61 | 3.40 | 0.025 |

**Table 7. Effect of Any AVID Participation on School Attendance Trajectories**

| Group | Parameter Estimate | Standard Error | P value |
|---|---|---|---|
| Stable high attendance | | | |
| Intercept | 103.43 | 0.62 | <0.0001 |
| Linear | -5.59 | 0.43 | <0.0001 |
| Quadratic | 0.84 | 0.07 | <0.0001 |
| AVID participation | -0.97 | 0.43 | 0.025 |
| Acutely declining attendance | | | |
| Intercept | 85.72 | 1.28 | <0.0001 |
| Linear | 9.53 | 0.96 | <0.0001 |
| Quadratic | -3.43 | 0.16 | <0.0001 |
| AVID participation | 3.60 | 1.47 | 0.015 |
| Chronically declining attendance | | | |
| Intercept | 94.03 | 2.30 | <0.0001 |
| Linear | -19.81 | 1.98 | <0.0001 |
| Quadratic | 1.76 | 0.35 | <0.0001 |
| AVID participation | -1.42 | 5.40 | 0.793 |

**Table 8. Effect of Cumulative School Discipline on School Attendance Trajectories**

| Group | Parameter Estimate | Standard Error | P value |
|---|---|---|---|
| Stable high attendance | | | |
| Intercept | 103.38 | 0.61 | <0.0001 |
| Linear | -5.62 | 0.43 | <0.0001 |
| Quadratic | 0.85 | 0.07 | <0.0001 |
| Suspension | -6.26 | 0.95 | <0.0001 |
| Acutely declining attendance | | | |
| Intercept | 86.31 | 1.31 | <0.0001 |
| Linear | 9.51 | 0.99 | <0.0001 |
| Quadratic | -3.44 | 0.16 | <0.0001 |
| Suspension | -4.46 | 1.00 | <0.0001 |
| Chronically declining attendance | | | |
| Intercept | 93.87 | 2.31 | <0.0001 |
| Linear | -19.24 | 1.97 | <0.0001 |
| Quadratic | 1.69 | 0.36 | <0.0001 |
| Suspension | -1.87 | 1.19 | 0.116 |

**Table 9. Effect of Cumulative AVID Participation on School Attendance Trajectories**

| Group | Parameter Estimate | Standard Error | P value |
|---|---|---|---|
| Stable high attendance | | | |
| Intercept | 103.82 | 0.62 | <0.0001 |
| Linear | -5.97 | 0.44 | <0.0001 |
| Quadratic | 0.90 | 0.07 | <0.0001 |
| AVID participation | 0.01 | 0.20 | 0.970 |
| Acutely declining attendance | | | |
| Intercept | 86.72 | 1.31 | <0.0001 |
| Linear | 8.39 | 1.13 | <0.0001 |
| Quadratic | -3.23 | 0.19 | <0.0001 |
| AVID participation | 2.99 | 0.62 | <0.0001 |
| Chronically declining attendance | | | |
| Intercept | 81.19 | 3.45 | <0.0001 |
| Linear | -9.29 | 2.98 | 0.002 |
| Quadratic | -0.19 | 0.69 | 0.779 |
| AVID participation | -0.34 | 4.04 | 0.934 |

### 2.3.6 Sensitivity Analysis

Upon exploration of attendance data patterns, there were 1,696 participants (59.5%) with no missing data. 379 participants (13.3%) were missing a single data point prior to COVID-19 related school closures, 374 participants (13.1%) were missing a single data point after COVID-19 related school closures, and 401 participants (14.1%) were missing 2 or more data points. All

missing data patterns were associated with attendance trajectory subgroup membership ($\chi^2 = 16.45$, $p < 0.001$; $\chi^2 = 95.49$, $p < 0.001$; and $\chi^2 = 104.19$, $p < 0.001$ respectively) suggesting non-ignorable data missingness. We therefore repeated the model selection and assessment procedures including only participants with all attendance data available (N = 1696). The shapes of identified attendance trajectories remained similar overall in the 1-group to 4-group models and displayed more divergence with 5 or more groups (Figure 5). Using the same model selection criteria, the 3-group unadjusted base model with all quadratic polynomials was again selected as the best fitting model. Model fit improved overall with average posterior probabilities of subgroup membership ranging from 0.913-0.986, odds of correct classification ranging from 18.50-388.78, and maintained similarity between the estimated probability of subgroup membership and the observed proportion of the sample classified to each subgroup. In the final adjusted base model, most of the sample (78.6%) was again assigned to a subgroup characterized by stable high attendance throughout (Figure 6). 13.5% of the sample was assigned to a subgroup that displayed a more gradual decline and greater average predicted attendance rate in Year 5 as compared to the acutely declining attendance subgroup in the primary analysis. 7.9% of the sample was assigned to a subgroup that displayed greater average predicted attendance early in the trajectory and more rapidly declining attendance following COVID-19 related school closures as compared to the chronically declining subgroup in the primary analysis.

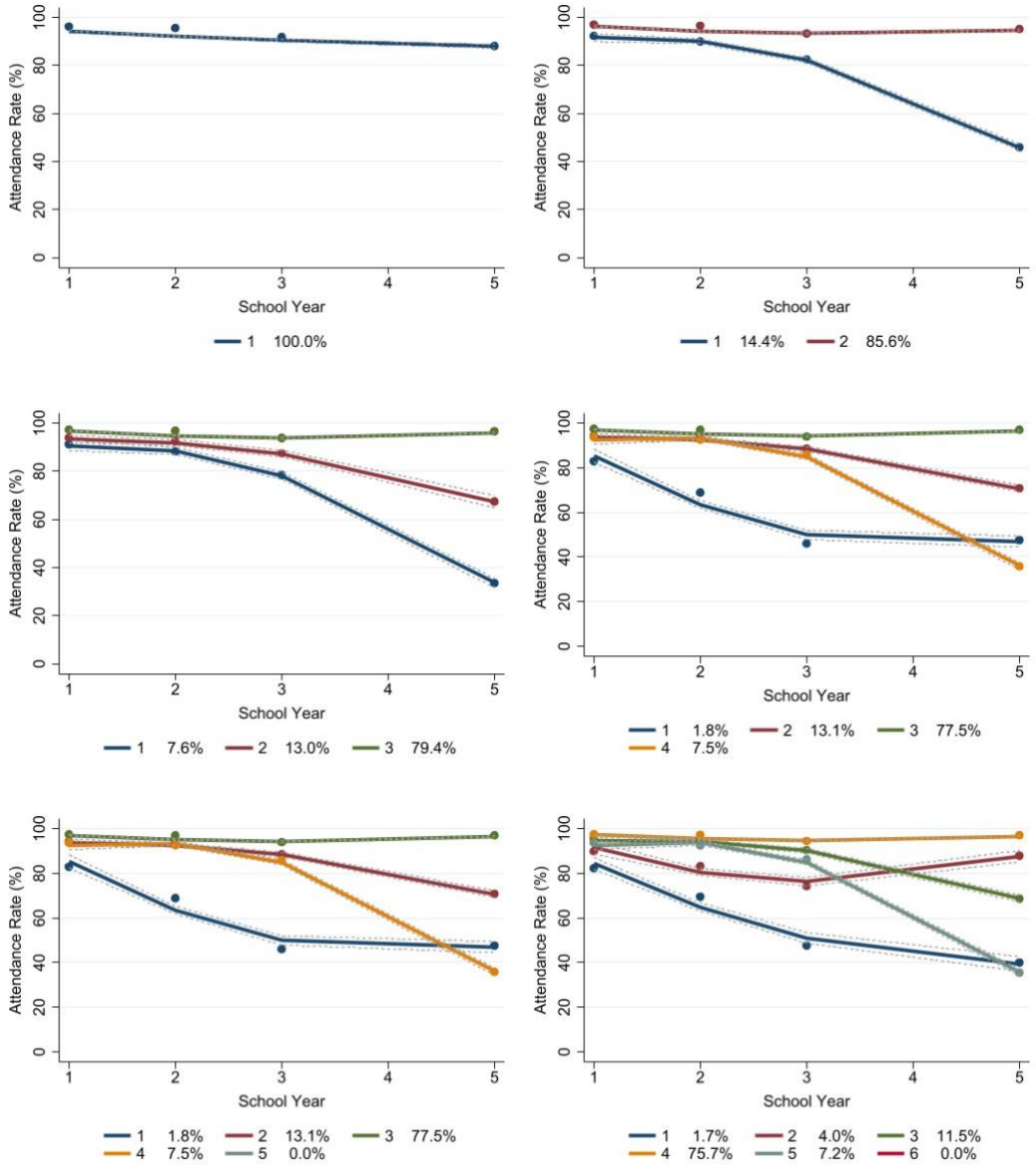


**Figure 5. Unadjusted base models with between 1 and 6 subgroups and all quadratic polynomial functions in sensitivity analysis including only participants with all available attendance data.**

**Solid lines represent estimated attendance trajectories for each subgroup. Dashed lines represent 95% confidence intervals of the estimated probabilities of subgroup membership. Points represent average observed values at each time point with responses weighted based on posterior probabilities of subgroup membership.**

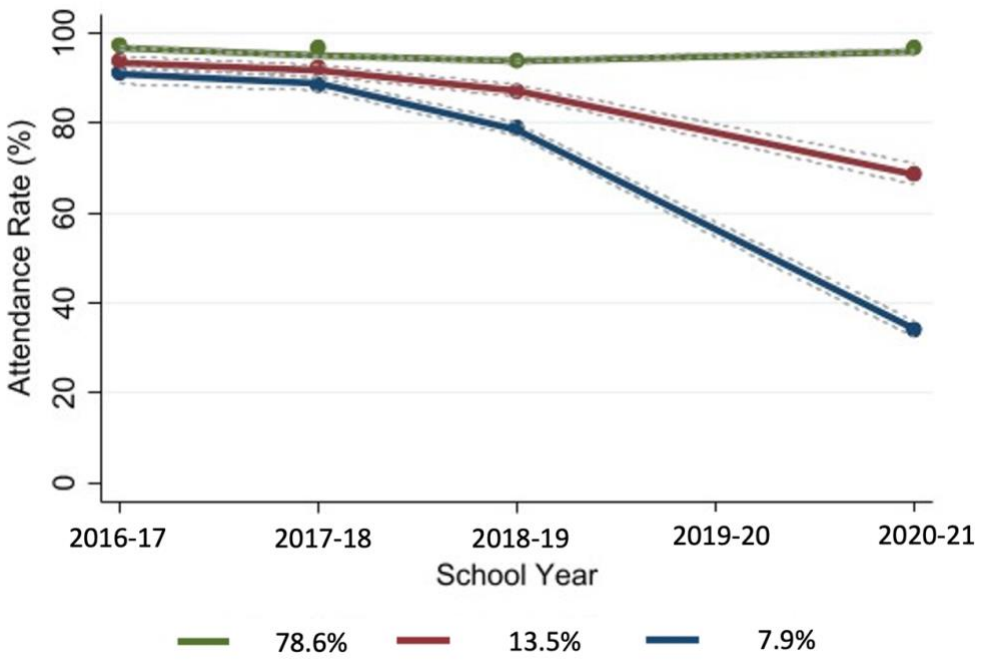


**Figure 6. Final adjusted base model identified in sensitivity analysis including only participants with all available attendance data.**

**Solid lines represent estimated attendance trajectories for each subgroup. Dashed lines represent 95% confidence intervals of the estimated probabilities of subgroup membership. Points represent average observed values at each time point with responses weighted based on posterior probabilities of subgroup membership.**

## 2.4 Discussion

We used group-based trajectory modeling to characterize the attendance patterns of rising high school students before and after the onset of the COVID-19 pandemic. We identified three distinct attendance trajectory subgroups: 1) stable high attendance, 2) acutely declining attendance, and 3) chronically declining attendance. Various model fit diagnostics confirmed good model fitness which was further supported by the ability of the model to distinguish subgroups with

significantly differing traditional measures of attendance and academic performance. School discipline was associated with lower attendance for each attendance trajectory subgroup without significant between group differences. Participation in the AVID college readiness program was uniquely associated with higher attendance in the acutely declining attendance trajectory subgroup.

Similar to prior research spanning grade ranges from kindergarten to 12th grade, this study revealed that attendance is often not stable over time and can vary in meaningful ways for different subsets of students[82-84]. This study specifically adds important nuance to better characterize the range of attendance patterns that underlie the increased rate of chronic school absenteeism observed at the population level in the wake of the COVID-19 pandemic[28-31]. In comparison to one prior study characterizing attendance trajectories of 9th to 12th grade students before the COVID-19 pandemic, results of our study display similarities and some notable differences[82]. Similarly, most students were assigned to trajectories characterized by relatively stable good attendance without progression to chronic absenteeism and fewer students were assigned to trajectories characterized by early good attendance with later progression to chronic absenteeism or early chronic absenteeism with continual worsening, corresponding to our stable high, acutely declining, and chronically declining attendance subgroups respectively[82]. Uniquely, the two declining attendance trajectories identified in our study displayed lower average predicted attendance rates in late high school and more rapidly declining attendance throughout the high school years, most apparent in the acutely declining attendance subgroup following the onset of COVID-19[82]. This suggests that although many students have had minimal lasting effects of the COVID-19 pandemic on their school attendance, a sizeable minority may now be experiencing more severely declining attendance than expected throughout the high school years.

These findings have important implications for adolescents' educational outcomes and current and future health. Prior research suggests that attendance trajectories characterized by chronic low attendance or declining attendance can predict poorer educational outcomes including school disengagement, low test scores, and failure to graduate high school[82-84]. In addition, larger drops in school attendance across the transition from middle to high school may signify greater school disengagement and can increase the probability of shifting to a more problematic attendance trajectory over time[82]. Although not a traditional school transition, the COVID-19 pandemic has generated widespread disruptions to adolescents' schooling and daily lives and may function similarly with respect to school engagement and attendance. Future research can seek to determine if the effects of the COVID-19 pandemic on school attendance are transient or reshape attendance patterns longitudinally. More immediately, educators and clinicians can monitor students' attendance patterns and understand declining attendance as an early signal to evaluate for threats to adolescent education, health, and well-being and increase support to address these[1]. In both research and clinical practice, a focus on individual-level or school-level point estimates of attendance alone may mask important variations in students' attendance trajectories over time and corresponding risk and protective factors which may be leveraged to improve education and health outcomes.

In addition to individualized interventions, school-level interventions can play a role in broadly enhancing school attendance. Prior research has shown that school structural characteristics including school size and the experience level of a school's teachers can influence students' attendance trajectories[82]. This study adds that school policies and practices related to school discipline and the availability of college readiness programming may also influence attendance trajectories. The negative association between receipt of school discipline and

attendance was clearly seen across all school attendance trajectories. Exclusionary discipline leads directly to missed learning time and indirectly impacts school attendance by disrupting positive school connections and reinforcing school disengagement[25,93]. In addition, exclusionary discipline disproportionately affects youth of color and youth with disabilities—who may also experience more severe effects of COVID-19—further driving education and health inequities[27,94]. Striving for culturally responsive learning environments and restorative justice-based approaches to attendance or behavioral concerns can build connections instead of break them and promote positive youth development and school success for all[95,96]. Participation in the AVID college readiness program had a distinctly positive association with attendance in the acutely declining attendance trajectory subgroup. AVID engages students in academic skill building and exposes them to experienced adult mentors and academically motivated peers[85]. Through its effects on students' social networks, AVID can impact educational outcomes as well as health behaviors and emotional well-being[36,43,86]. The finding that AVID participation may uniquely improve attendance in the subgroup that appeared to suffer the most amplified negative effects of the COVID-19 pandemic is meaningful. This both reinforces the utility of monitoring attendance patterns to guide tailored intervention and suggests that efforts to surround youth with supportive adult and peer networks may be important ways to restore or reroute education and health trajectories[25]. The AVID program may be one effective way to accomplish these goals and considerations could be made to include declining attendance as an additional selection criteria for AVID participation.

### 2.4.1 Limitations

This study has several limitations. The study sample is comprised of students from one large public school district in Los Angeles, California. School-level attendance rates vary widely across individual schools and school districts[77]. The magnitude of predicted attendance rates and relative distribution of students across attendance trajectory subgroups may lack generalizability, but overall shapes of identified attendance trajectories in the context of the globally-experienced COVID-19 pandemic likely hold relevant insights to guide attendance monitoring and intervention in different schools and school districts. The use of school administrative data is both a strength and limitation of this study. School attendance data is likely more accurate than student- or parent-reported attendance[97]. School attendance data also captures a wider sample of students, including students with low attendance who may otherwise be excluded in other forms of school-based data collection. However, we were limited to variables available in school administrative datasets and were unable to fully explore relevant covariates that may predict or influence school attendance trajectories. Future research should continue to explore associations between individual-, school-, community-, and larger structural-level factors and school attendance trajectories. This study uses school attendance data that combines excused and unexcused absences. Both types of absence contribute to missed school time and excused absences due to illness may be especially relevant in the context of the COVID-19 pandemic[1]. However, excused and unexcused absences may differentially impact academic outcomes and future research may seek to investigate how attendance trajectories vary based on the reason for absence[98]. The collection of data across the COVID-19 pandemic is again a strength and limitation of this work. This is a critical time to investigate shifting school attendance patterns and seek to understand and improve the resulting education and health outcomes of school-aged youth. However, questions remain as to the meaning

and reliability of attendance data during periods of virtual instruction in the 2019-2020 and 2020-2021 school years[77]. The California Department of Education recommended against the use of attendance data from the 2019-2020 school year as was done in this study and reported a state-level high school chronic absenteeism rate of 17.6% in the 2020-2021 school year and 30.1% in the 2021-2022 school year[30]. It is likely that the observed chronic absenteeism rate at the peak of the COVID-19 pandemic in the 2020-2021 is an underestimation[77]. If true, our identified attendance trajectories may also underestimate the severity of attendance decline and the proportion of youth experiencing acutely or chronically declining attendance trajectories. Finally, attendance data were not missing at random which may not have been accurately accounted for in our group-based trajectory modeling procedure. It is reassuring that a sensitivity analysis including only students with attendance data at all time points did not change the number of identified subgroups, but some differences in the shapes of attendance trajectories were seen. We recommend that readers consider the models with and without missing data collectively while also bearing in mind that the model without missing data may selectively exclude youth who transferred, were expelled, or withdrew from school during the study period.

### 2.4.2 Conclusions

In conclusion, we identified three distinct school attendance trajectories among adolescents enrolled in high school at the onset of the COVID-19 pandemic. Although many students maintained good attendance both before and after the onset of the COVID-19 pandemic, others experienced chronic or acute declines in attendance. Experiencing school discipline negatively impacted every attendance trajectory subgroup, while participation in the AVID college readiness program uniquely benefited those with acutely declining attendance following the onset of the

COVID-19 pandemic. Monitoring school attendance trajectories, providing individualized intervention, and encouraging supportive school-level policies and practices are all important pathways to foster youth connectedness, enhance educational outcomes, and promote healthy futures.

# 3.0 Adolescent Social Networks and School Engagement Across the High School Transition

## 3.1 Introduction

Education exerts an enduring influence on health throughout the life course[50,51]. Access to high quality education beginning in early childhood affects later social and economic opportunities that directly impact the health of individuals and families[50,51]. Increased years of schooling are associated with improved self-reported health, decreased rates of chronic conditions including obesity, cardiovascular disease, diabetes, and depression, and reduced overall mortality[8,12,56]. Investing in education is an important avenue to shape the health trajectories of individuals and populations, and reduce health disparities across generations[12,25]. Although level of educational attainment is a frequently studied metric known to predict adult health, the educational process, in addition to its outcomes, deserves special attention as a driver of child and adolescent health[12,99-101].

School engagement includes the extent to which students involve themselves in the academic and extracurricular activities of schooling (behavioral engagement), feel connected to school and the school community (affective engagement), and find value in the process and goals of education (cognitive engagement)[16,102]. Promoting and maintaining school engagement is key to optimizing the educational and health benefits of schooling[103]. School engagement is considered a modifiable factor that predicts academic performance and the likelihood of graduating high school[16,104]. In addition, school engagement is associated with improved mental health outcomes and can protect against negative health-affecting behaviors including substance use, involvement in violence, and risky sexual behaviors in adolescence and into adulthood[17-22]. More generally,

being highly engaged in school can increase resiliency in the face of academic challenges and foster positive youth development[105]. Establishing school engagement as a goal in its own right—outside of its relationship to educational attainment—allows a focus on recognizing youth assets and building enabling learning environments that scaffold the success of students with fewer contextual supports for education towards reducing educational disparities[12].

Social connections are key to youth well-being and may be an avenue to enhance school engagement. Peer relationships impact many adolescent health-affecting behaviors with potential for either beneficial or deleterious effects[44-49]. In contrast, supportive adult relationships are largely protective for youth and associated with health-promoting behaviors[38]. Additionally, the overarching structure of adolescents' multiple co-occurring social relationships may influence health, with some evidence linking highly interconnected social networks with health-promoting behaviors[44]. Social networks may similarly confer risk or protection for school engagement. Parents, teachers, coaches, counselors, and other adult supports have been associated with improved academic outcomes[39,40]. School peer groups are known to coalesce around and reinforce academic behaviors, whether through interpersonal processes such as selection of similar peers or through school processes including academic tracking of lower performing students into schools or classrooms with other peers who are struggling academically[25,41,106]. Further, there is growing evidence that interventions that expose youth to academically high-performing peers can impact adolescent health through reduction of related negative health-affecting behaviors like substance use[36,100,101]. Interventions that target relationships with peers and adults across family, school, and community contexts may be particularly promotive of school engagement and associated positive health outcomes by surrounding youth with robust multilevel supports[40,41].

Schools themselves are major sources of social connection and school transitions—such as the middle to high school transition—are important inflection points where these connections are in flux[32]. The high school years are generally associated with declining school engagement[16], and for some youth, the onset of co-occurring negative health-affecting behaviors that may persist into adulthood. The transition to high school can be accompanied by exposure to educators with differing expectations and levels of oversight, and peers with new education- and health-affecting behaviors that may shape adolescents' own behaviors and outcomes[32]. Adolescents' intersecting identities related to race and gender interact with these school-based social opportunities, group norms, and experiences of discrimination in school environments to impact school engagement and adolescent health and well-being[100,101,107,108]. Adolescents' shifting social networks at the high school transition present potential risks to school engagement as well as opportunities to influence health and educational trajectories, and reduce disparities[32]. However, little is known regarding how the *quality* and *structure* of adolescent social networks during this critical transition period affect school engagement. Moving beyond traditional measures of social support, identifying specific relationship qualities and social structures associated with school engagement across the high school transition can elucidate important targets for education and health intervention.

This study sought to describe the social networks of a predominantly Latino sample of adolescents at the transition from middle to high school and examine associations between social network characteristics and school engagement across this transition. Using a network-based approach, we aimed to build on prior research linking more general measures of social support to school engagement by identifying specific social network qualities and structures across multiple contexts which may protect against school disengagement and associated risks to adolescent health. We hypothesized that youth with highly school engaged peers, more network-based

supports, and highly interconnected networks would have higher school engagement maintained across the middle to high school transition. We additionally hypothesized that youth with more peers engaged in negative health-affecting behaviors including substance use and violence involvement would have lower school engagement. Knowledge of the role of social networks in school engagement can inform social network-based interventions with the potential to enhance school engagement and impact co-occurring adolescent health-affecting behaviors.

## 3.2 Methods

### 3.2.1 Study Design and Procedure

We conducted secondary analysis of survey data from a randomized trial of Advancement via Individual Determination (AVID; NCT03059433), a nationwide college readiness program aimed to prepare students from groups traditionally underrepresented in higher education for success at a 4-year university[85]. AVID generally targets students with middle school grade-point-averages of 2.0-3.5 and offers academic skills training, college preparatory classes, and personal mentoring from trained AVID instructors. The larger trial investigates the effects of AVID on students' substance use and health behaviors across 5 public high schools in Southern California serving primarily low-income Latino students. Participant recruitment and enrollment occurred in 2 cohorts in 2017-2018. Eligible students preparing for 9$^{th}$ grade enrollment at a study school who provided written parental consent and youth assent were enrolled in 1 of 3 groups: 1) those eligible for AVID and randomized to participate in their school's program via an admissions lottery, 2) those eligible for AVID but not randomized to participate, and 3) those ineligible for AVID

because their 8th grade GPA was above 3.5. The study was approved by the overseeing institutional review board and participating school district.

### 3.2.2 Data Collection

Participants completed an electronic baseline survey near the time of the high school transition at the end of 8th grade or beginning of 9th grade (April-October 2017 or 2018) and a follow-up survey after 1 year of high school at the end of 9th grade (May-June 2018 or 2019). All surveys were completed at school.

### 3.2.3 Measures

#### 3.2.3.1 Social Networks

Egocentric social networks were constructed for each participant using a standard network survey approach[109]. At baseline, each participant (ego) was asked to identify up to 20 people (alters) who they interact with including family, friends, or other important people in their lives. Participants answered a series of questions about each alter including the alter's relative age (i.e., "much younger than you", "around your age", "much older than you"), the alter's relationship to them (e.g., relative, friend or classmate, teacher, coach), and if they would go to the alter for emotional support, encouragement, or advice. Alters identified as around the ego's age were considered peers. Participants answered additional questions about each peer including if the alter attends school, if the alter has used substances (i.e., has ever been drunk on alcohol, has ever used cannabis, or has ever drunk alcohol or used cannabis with the participant), and if the alter has been in a physical fight. For peers identified as attending school, participants reported if each alter "tries

hard in school," "thinks it is important to do well in school," "thinks it is important to attend every class," "does not disrupt class," and "does not cause or get in trouble at school." Alters with all these characteristics were categorized as highly engaged in school. Finally, participants identified connections between all alters in their network by identifying if each possible combination of 2 alters knew each other. Each participant's social network was modeled using ORA-PRO v3.0.9.142 (Netanomics, Pittsburgh, PA) and network characteristics were calculated. Measures of network quality were the proportion of alters in one's network with specific characteristics related to alter age, relationship type, relationship qualities (e.g., supportive relationship), and alter behaviors (e.g., using substances). Measures of network structure were network size (total number of network members), ego betweenness centrality (extent to which the ego connects pairs of other alters by falling on the shortest path between those alters), ego constraint (extent to which the ego is restricted from acting based on the structure of connections to groups of other alters), and density (number of links present in a network divided by all possible links which could exist)[110].

#### 3.2.3.2 School Engagement

We assessed school engagement via response to 29-items of the Student Engagement Instrument[102]. Using 4-point Likert scales, participants indicated their agreement to items assessing 4 domains of affective and cognitive engagement (i.e, 9 items teacher-student relationships, 6 items peer support for learning, 9 items control and relevance of schoolwork, and 5 items future aspirations and goals). A total mean school engagement score with range 1-4 was calculated with higher scores representing higher levels of school engagement. Cronbach's alpha indicated excellent internal consistency reliability within our sample at baseline ($\alpha = 0.96$) and follow-up ($\alpha = 0.95$).

#### 3.2.3.3 Covariates

At baseline, participants were asked "What is your gender?" and given two response options (male/female). This single item did not allow for expression of a full range of gender identities and likely more closely represents sex assigned at birth as it will be considered here.[111] Participants also reported their race (White, Black or African American, Asian or Pacific Islander, American Indian or Native American), ethnicity (Hispanic or Latino/non-Hispanic or Latino), eighth grade GPA (< 2.0, 2.0-3.5, > 3.5), and participation in AVID programming in middle school (yes/no) at baseline. They additionally reported caregiver characteristics including if one of more of their primary caregivers was born in the U.S. (yes/no), graduated high school or received a GED (yes/no), and currently had any part- or full-time employment (yes/no). Study arm (AVID intervention group, control group, high-performing comparison group) and the time of baseline survey administration (end of school year/beginning of school year) was also recorded.

### 3.2.4 Statistical Analysis

Participants and caregiver characteristics and school engagement were summarized for the overall sample and compared across participant gender using t-tests for continuous variables or chi-square tests for categorical variables. Social network characteristics were calculated using ORA-PRO as above and summarized for the overall sample. Separate linear mixed-effects models accounting for clustering at the school level were used to examine the association between baseline social network characteristics at the high school transition and 1) concurrent school engagement at the high school transition, and 2) future school engagement at the end of 9$^{th}$ grade. All adjusted models accounted for gender, ethnicity, eighth grade GPA, and caregiver characteristics (i.e., any primary caregiver born in the U.S., any primary caregiver graduated high school or received a

GED, and any primary caregiver currently employed). Covariates were selected *a priori* based on associations with school engagement in the prior literature[16]. Baseline models were also adjusted for middle school AVID participation and month of baseline survey administration as school engagement is known to vary throughout the school year. Follow-up models were adjusted for study arm and baseline values of school engagement. Models including network structural characteristics were additionally adjusted for network size[110]. Exploratory analyses tested whether sex moderated observed associations between baseline social network characteristics and future school engagement using interaction terms, given prior research suggesting the relationships among school environments, social networks, and adolescent well-being may vary by gender[100,101]. When interaction terms were significant, we estimated gender-stratified models. All analyses were completed using Stata v17 (StataCorp LLC, College Station, TX).

### 3.3 Results

431 participants completed the baseline survey with 60.6% identifying as female and 82.8% identifying as Hispanic or Latino (Table 10). Approximately one-third (35.1%) had at least one primary caregiver who was born in the U.S. and one-half (53.6%) had at least one primary caregiver who graduated high school. Mean school engagement was 3.3 at the high school transition (standard deviation (SD) 0.5). Participant and caregiver characteristics and baseline school engagement were similar across female and male participants. 418 participants additionally completed the follow-up survey representing a retention rate of 97%. School engagement was lower at the end of 9$^{th}$ grade (mean 3.1, SD 0.5) compared to at the high school transition ($p$ =

.0006). Male participants reported higher overall school engagement at the end of 9th grade (mean 3.2, SD 0.5) compared to female participants (mean 3.1, SD 0.5; $p = .03$).

**Table 10. Participant Characteristics and School Engagement**

| Characteristic | All participants N (%) (N=431) | Female participants N (%) (N=261) | Male participants N (%) (N = 170) | *P* value |
|---|---|---|---|---|
| Race/Ethnicity[a] | | | | 0.56 |
| Hispanic or Latino | 357 (82.8%) | 221 (84.7%) | 136 (80.0%) | |
| Asian or Pacific Islander | 53 (12.3%) | 29 (11.1%) | 24 (14.1%) | |
| White | 19 (4.4%) | 11 (4.2%) | 8 (4.7%) | |
| Black | 18 (4.2%) | 9 (3.4%) | 9 (5.3%) | |
| American Indian or Native American | 13 (3.0%) | 6 (2.3%) | 7 (4.1%) | |
| Eighth grade GPA[b] | | | | 0.16 |
| < 2.0 | 16 (3.8%) | 8 (3.1%) | 8 (4.7%) | |
| 2.0-3.5 | 261 (61.1%) | 152 (58.2% | 109 (64.1%) | |
| > 3.5 | 150 (35.1%) | 100 (38.3%) | 50 (29.4%) | |
| Eight grade AVID participation | 95 (22.0%) | 61 (23.4%) | 34 (20.0%) | 0.41 |
| ≥ 1 caregiver who was born in the U.S. | 166 (38.5%) | 99 (37.9%) | 67 (39.4%) | 0.76 |
| ≥ 1 caregiver who graduated high school or received GED | 231 (53.6%) | 144 (55.2%) | 87 (51.2%) | 0.67 |
| ≥ 1 caregiver who is employed | 415 (96.3%) | 251 (96.2%) | 164 (96.5%) | 0.87 |
| School engagement end of 8th/beginning of 9th grade[c], *mean (SD)* | | | | |
| Overall school engagement | 3.3 (0.5) | 3.3 (0.5) | 3.2 (0.6) | 0.55 |
| Teacher-student relationships subscale | 3.1 (0.6) | 3.1 (0.6) | 3.2 (0.6) | 0.55 |
| Peer support for learning subscale | 3.2 (0.7) | 3.2 (0.7) | 3.2 (0.7) | 0.62 |
| Control and relevance of schoolwork subscale | 3.2 (0.6) | 3.2 (0.6) | 3.2 (0.6) | 0.34 |
| Future aspirations and goals subscale | 3.7 (0.6) | 3.7 (0.5) | 3.6 (0.7) | 0.07 |
| School engagement end of 9th grade[cd] | | | | |
| Overall school engagement | 3.1 (0.5) | 3.1 (0.5) | 3.2 (0.5) | 0.03 |
| Teacher-student relationships subscale | 3.1 (0.6) | 3.0 (0.6) | 3.2 (0.6) | <0.001 |
| Peer support for learning subscale | 3.1 (0.6) | 3.1 (0.7) | 3.2 (0.6) | 0.30 |
| Control and relevance of schoolwork subscale | 3.0 (0.6) | 2.9 (0.6) | 3.0 (0.6) | 0.05 |
| Future aspirations and goals subscale | 3.6 (0.6) | 3.6 (0.6) | 3.6 (0.6) | 0.56 |

[a] Participants could select more than one response.

[b] 4 participants attended middle schools that did not use letter grades to calculate GPA.

[c] Overall school engagement and all subscales have a possible range of 1-4.

[d] N=418 at follow-up

### 3.3.1 Social Network Characteristics

Almost all participants (99%) identified 20 out of 20 possible alters in their network (Table 11). Most participants (83%) identified at least one adult in their network (mean 4.9 adults, SD 4.2, range 0-18), 79% identified one or more relatives (mean 5.7 relatives, SD 5.1, range 0-20), and 15% identified a teacher or coach (mean 0.4 teachers or coaches, SD 1.1, range 0-9). Nearly

all participants (99%) identified at least one peer in their network (mean 13.7 peers, SD 5.0, range 0-20) and 95% identified a peer highly engaged in school (mean 9.8 peers highly engaged in school, SD 5.7, range 0-20). Approximately one-third (29%) identified a peer who uses substances (mean 1.3 peers who have used substances, SD 2.8, range 0-14) and one-half (47%) identified a peer who has been in a physical fight (mean 2.0 peers who have been in a physical fight, SD 3.7, range 0-20). Most participants (97%) identified at least one alter that they would go to for emotional support, encouragement, or advice with a mean of 11.1 supportive alters (SD 6.0, range 0-20), 3.1 supportive adults (SD 3.5, range 0-18), and 7.6 supportive peers (SD 5.3, range 0-20). Figure 7 displays examples of participants' social networks organized by participants' school engagement at baseline and follow-up.

**Table 11. Characteristics of Baseline Social Networks**

| Social network characteristic | mean (SD) or %[a] |
|---|---|
| Network size | 19.96 (0.51) |
| Ego betweeness centrality[b] | 0.24 (0.20) |
| Ego constraint[b] | 0.17 (0.02) |
| Overall network density[b] | 0.60 (0.21) |
| Adult network density[b] | 0.74 (0.37) |
| Peer network density[b] | 0.64 (0.23) |
| Alter's age relative to participant | |
| Younger alters | 6.8% |
| Peer alters | 68.7% |
| Older alters | 24.5% |
| Alter's relationship to participant | |
| Friend or Classmate | 66.1% |
| Parent | 5.9% |
| Sibling | 7.0% |
| Aunt/Uncle | 4.7% |
| Cousin | 7.6% |
| Grandparent | 1.9% |
| Other Relative | 1.6% |
| Teacher | 1.6% |
| Coach | 0.3% |
| Romantic Partner | 0.6% |
| Neighbor | 0.7% |
| Coworker | 0.1% |
| Other Relationship | 1.9% |
| Alters who participant would go to for support | 55.4% |
| Peer alters[c] | |
| who participant would go to for support | 55.1% |
| who have used substances | 9.1% |
| who have used substances with participant | 3.4% |
| who have been in a physical fight | 14.5% |
| Peer alters who attend school[d] | |
| who try hard in school | 93.9% |
| who think it's important to do well in school | 96.4% |
| who think it's important to attend class | 95.8% |
| who disrupt class | 9.4% |
| who get in trouble at school | 7.2% |
| who are highly engaged in school | 82.6% |

SD = standard deviation

[a] Means and standard deviations reflect average network characteristic within each ego network. Percentages reflect percentage of alters with each characteristic across all ego networks. Percentages reported as percent of all alters across all ego networks unless otherwise noted.

[b] Only available for cohort 2; N=233

[c] Percentages reported as percent of all peer alters across all ego networks (N=5906).

[d] Percentages reported as percent of all peer alters attending school across all ego networks (N=5628).

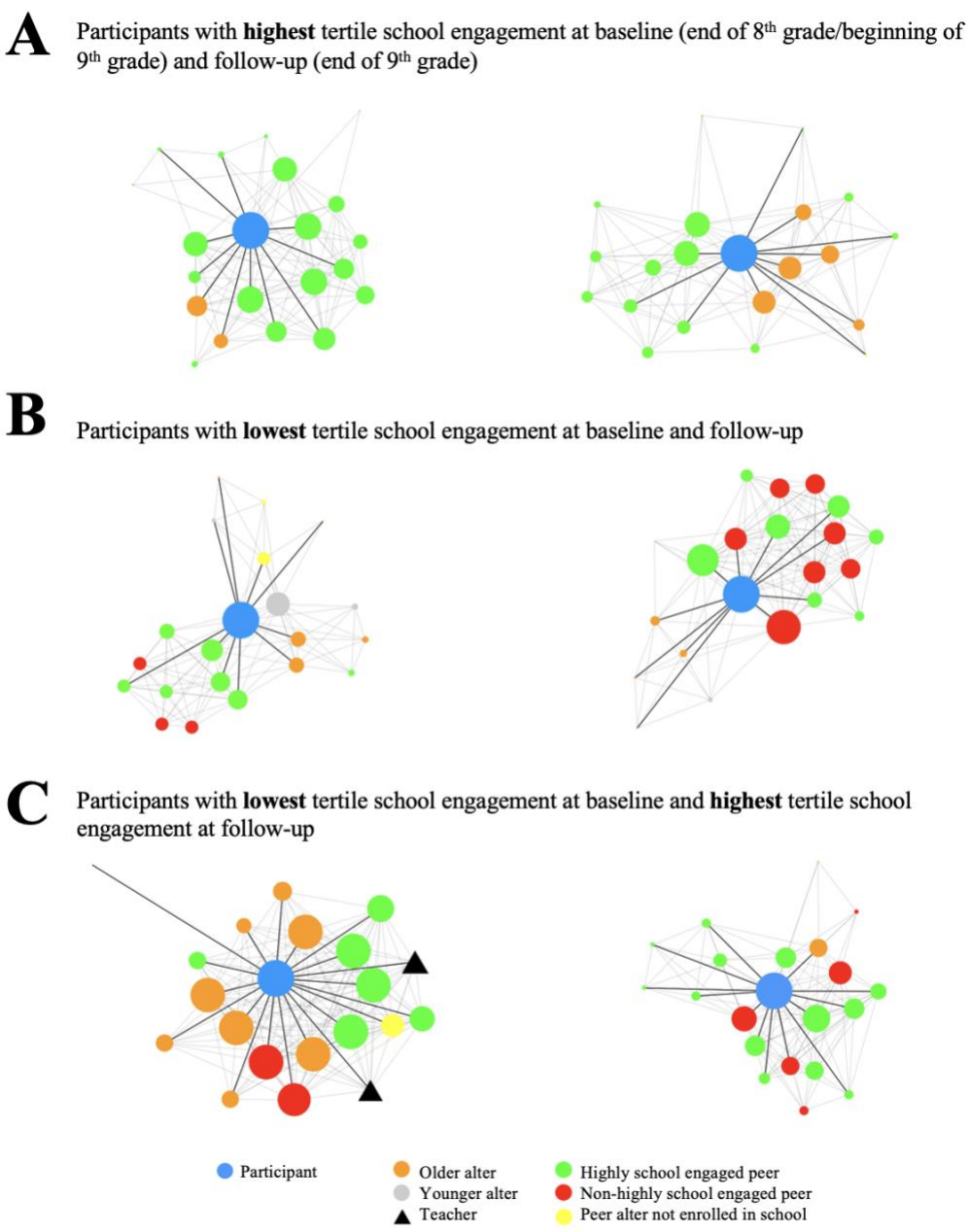


**Figure 7. Examples of participant's egocentric social networks. Each image represents a participant's (ego's) identified network of the people with whom they interact (alters) and the connections between these alters. Egos and alters are represented with circles (nodes). Teachers are highlighted as triangles. Nodes are color coded by the alter's age (i.e., adults, younger alters, peers) and characteristics (i.e., level of school engagement). Nodes are sized by total degree centrality, a measure of how highly connected a node is to other nodes in the network. Lines (links) represent connections between nodes with wider links representing connections to alters whom the ego identified as sources of support.**

### 3.3.2 Associations Between Social Network Characteristics and School Engagement

The proportion of teachers named in a network was inversely associated with concurrent school engagement (β=-1.16, 95% confidence interval (CI) -2.13- -0.18) but positively associated with future school engagement (β=1.12, 95% CI 0.16-2.09; Table 12). The proportion of supportive alters was positively associated with both concurrent (β=0.21, 95% CI 0.04-0.38) and future school engagement (β=0.29, 95% CI 0.12-0.46). The proportion of supportive peers was associated with future school engagement (β=0.19, 95% CI 0.03-0.35).

Peer behaviors related to substance use or violence involvement were not associated with school engagement, but peers' academic beliefs and behaviors were. Concurrent school engagement was positively associated with the proportions of peers thinking it is important to do well in school (β=0.54, 95% CI 0.06-1.02) and attend class (β=0.47, 95% CI 0.05-0.90) and inversely associated with the proportion of peers who get in trouble at school (β=-0.56, 95% CI -0.86- -0.26). The proportion of highly school engaged peers in a network was also associated with concurrent school engagement (β=0.24, 95% CI 0.06-0.42). The only measure of network structure associated with school engagement was peer network density which was inversely associated with concurrent school engagement (β=-0.37, 95% CI -0.69- -0.05).

**Table 12. Associations between Baseline Social Network Characteristics and Concurrent and Future School Engagement**

| Network characteristic | Concurrent School Engagement[a] | | | Future School Engagement[b] | | |
|---|---|---|---|---|---|---|
| | β | 95% CI | P value | β | 95% CI | P value |
| Network size | 0.04 | -.06 - .13 | 0.48 | -0.04 | -.22 - .15 | 0.70 |
| Ego betweenness centrality[c,d] | 0.14 | -.23 - .50 | 0.46 | -0.27 | -.63 - .09 | 0.15 |
| Ego constraint[c,d] | -2.21 | -6.78 - 2.35 | 0.34 | 2.33 | -2.14 - 6.81 | 0.31 |
| Overall network density[c,d] | -0.17 | -.52 - .18 | 0.34 | 0.15 | -.20 - .50 | 0.40 |
| Adult network density[c,d] | 0.13 | -.06 - .33 | 0.18 | 0.03 | -.17 - .22 | 0.79 |
| Peer network density[c,d] | **-0.37** | **-.69 - -.05** | **0.02** | -0.09 | -.41 - .24 | 0.59 |
| Peer alters | 0.07 | -.14 - .28 | 0.53 | -0.14 | -.34 - .07 | 0.19 |
| Adult alters | -0.20 | -.45 - .05 | 0.11 | 0.22 | -.02 - .46 | 0.07 |
| Relatives | -0.10 | -.30 - .11 | 0.38 | 0.03 | -.17 - .23 | 0.78 |
| Friends or classmates | 0.11 | -.08 - .30 | 0.27 | -0.08 | -.27 - .11 | 0.42 |
| Teachers | **-1.16** | **-2.13 - -.18** | **0.02** | **1.12** | **.16 - 2.09** | **0.02** |
| Coaches | 2.97 | -.00 - 5.94 | 0.05 | 1.53 | -1.33 - 4.40 | 0.29 |
| Alters who participant would go to for support | **0.21** | **.04 - .38** | **0.02** | **0.29** | **0.12 - .46** | **0.001** |
| Peer alters: | | | | | | |
| who participant would go to for support | 0.16 | -.00 - .32 | 0.05 | **0.19** | **.03 - .35** | **0.02** |
| who have used substances | -0.21 | -.47 - .05 | 0.11 | -0.11 | -.37 - .14 | 0.38 |
| who have used substances with participant | -0.13 | -.57 - .31 | 0.57 | -0.16 | -.58 - .27 | 0.47 |
| who have been in a physical fight | -0.19 | -.42 - .04 | 0.10 | -0.12 | -.35 - .11 | 0.30 |
| Peer alters who attend school: | | | | | | |
| who try hard in school | 0.37 | -.02 - .75 | 0.06 | 0.23 | -.14 - .60 | 0.23 |
| who think it's important to do well in school | **0.54** | **.06 - 1.02** | **0.03** | 0.24 | -.23 - .71 | 0.31 |
| who think it's important to attend class | **0.47** | **.05 - .90** | **0.03** | 0.21 | -.20 - .63 | 0.31 |
| who disrupt class | -0.25 | -.54 - .04 | 0.09 | -0.24 | -.52 - .04 | 0.10 |
| who get in trouble at school | **-0.56** | **-.86 - -.26** | **<0.001** | -0.02 | -.32 - .28 | 0.91 |
| who are highly engaged in school | **0.24** | **.06 - .42** | **0.01** | 0.13 | -.05 - .30 | 0.15 |

CI = confidence interval

Bold indicates statistical significance ($p < .05$)

[a] Separate models adjusted for participant characteristics (sex, ethnicity, eighth grade GPA, eighth grade AVID participation), parent/caregiver characteristics (birthplace, education level, employment status), and month of survey administration

[b] Separate models adjusted for participant characteristics (sex, ethnicity, eighth grade GPA), parent/caregiver characteristics (birthplace, education level, employment status), study arm, and baseline school engagement.

[c] Only available for cohort 2; N=233

[d] All models including network structural characteristics additional adjusted for network size

Analyses stratified by gender revealed differing associations between network characteristics and future school engagement (Table 13). For females, only the proportion of adult alters was positively associated with future school engagement (β=0.38, 95% CI 0.03-0.73). In contrast, for males, both school-related adult and peer network characteristics were associated with school engagement. For example, among males the proportion of teachers was positively

associated with future school engagement (β=2.01, 95% CI 0.63-3.39). In addition, nearly all of the peer alter characteristics, including the proportion of peers highly engaged in school (β=0.23, 95% CI 0.00-0.45), were associated with future school engagement among males.

**Table 13. Table 13. Associations between Baseline Social Network Characteristics and Future School Engagement Stratified by Sex**

| Network characteristic | Females[a] | | | Males[a] | | |
|---|---|---|---|---|---|---|
| | β | 95% CI | P value | β | 95% CI | P value |
| Adult alters | **0.38** | **.03 - .73** | **0.03** | 0.15 | -.18 - .48 | 0.38 |
| Teachers | 0.51 | -.80 - 1.83 | 0.45 | **2.01** | **.63 – 3.39** | **0.004** |
| Peer alters who attend school: | | | | | | |
| who try hard in school | -0.03 | -.53 - .46 | 0.90 | **0.56** | **.02 – 1.09** | **0.04** |
| who think it's important to do well in school | -0.04 | -.63 - .54 | 0.88 | **0.94** | **.17 – 1.70** | **0.02** |
| who think it's important to attend class | -0.08 | -.62 - .46 | 0.78 | **0.73** | **.12 – 1.34** | **0.02** |
| who disrupt class | -0.09 | -.49 - .31 | 0.66 | **-0.47** | **-.85 - -.09** | **0.02** |
| who get in trouble at school | -0.05 | -.46 - .35 | 0.78 | 0.005 | -.43 - .44 | 0.98 |
| who are highly engaged in school | 0.03 | -.23 - .28 | 0.84 | **0.23** | **.00 - .45** | **0.05** |

CI = confidence interval

Bold indicates statistical significance ($p < .05$)

[a] Models adjusted for participant characteristics (ethnicity, eighth grade GPA), parent/caregiver characteristics (birthplace, education level, employment status), study arm, and baseline school engagement.

## 3.4 Discussion

We described the social networks of a sample of predominately Latino youth at the high school transition, a time when school environments are in flux and supportive social networks may be especially critical in maintaining school engagement. We demonstrated associations between school engagement across this transition and measures of social network *quality* such as the proportions of teachers, supportive alters, and peers with prosocial school behaviors and social network *structure* such as the density of peer connections.

The proportion of teachers named in a network at baseline had a strong association with school engagement, but the direction of this relationship varied across the high school transition.

While we cannot determine the reasons for these findings in this study, it is possible that the inverse relationship between teachers and concurrent school engagement is due to teachers identifying signs of school disengagement such as disruptive behaviors or academic difficulties and responding by increasing support to these students. The strong positive effect of teachers on future school engagement aligns with this theory and supports the central role of teachers, not only in instruction, but in actively fostering school engagement. Longitudinal studies that measure changes in network connections over time could evaluate the ways in which teachers move into networks and introduce or reinforce network-based supports to improve outcomes for youth at risk of negative educational and health trajectories. Although teachers clearly play an important role in fostering school engagement, only a relatively small percentage of participants (12%) named a teacher in their network. Given the multiple competing demands on teachers to meet students' complex educational and social-emotional needs, teachers may prioritize intensive relational support for students with the most apparent signs of disengagement. Interventions that reduce total student load or increase the relational capacity of school-based adults may be ways to transmit the protective value of teachers to a greater number of students.

Although no other type of relationship was independently associated with school engagement, the overall level of network-based support emerged as a consistent predictor of concurrent and future school engagement. Social support is broadly promotive of positive adolescent health and educational outcomes[17,38], as is echoed in this study. Social network analysis offers a powerful method to quantify this support and map the distribution and interlinking of supportive connections in a way unique from traditional measures of social support. As assessed in this study, supportive connections that span multiple contexts and that link family, school, and community supports may be especially valuable for promoting school engagement, a key outcome

that can buffer adverse experiences and promote thriving[112]. Additionally, supportive peers independently predicted future school engagement. Studies of school engagement and adolescent health-affecting behaviors often conceptualize peers mainly as sources of negative behavioral influence[39-41,44]. This finding serves as a reminder that adolescents themselves can be valuable sources of support and may garner important benefits from both providing and receiving peer support.

Similar to prior studies, we found adolescents' school engagement was influenced by the behaviors of peers in their social networks[39-41]. Concurrent school engagement was positively associated with the proportion of peers with prosocial school behaviors and inversely associated with the proportion of peers who get in trouble at school. This finding is likely a result of multiple network-based processes including peer selection (i.e., adolescents choose close friends with similar behaviors to them) and peer influence (i.e., adolescents adopt the behaviors of close friends). Notably, peer behaviors related to substance use or violence involvement were not associated with school engagement despite common co-occurrence of these behaviors in prior studies and evidence that interventions that expose youth to highly school engaged peers may reduce the risk of substance use[36,100,101]. The relationship between school engagement, substance use, and violence involvement may differ throughout the high school years as more youth experiment with negative health-affecting behaviors. Together, these findings continue to emphasize the promise of the high school transition as an inflection point to shape health and educational trajectories through interventions that expose youth to academically motivated peers. Intentionally surrounding youth with supportive networks in schools may be a powerful strategy to create positive feedback loops that simultaneously enhance education and health outcomes[25].

Contrary to our hypothesis, we found an inverse association between concurrent school engagement and the density of peer networks. Although denser networks can be a source of support and have been associated with lower risks of other negative adolescent health-affecting behaviors[44], highly interconnected peer networks can also serve to constrain adolescents from adopting attitudes or behaviors that differ from their tightknit peer group[25]. Therefore, the relationship between peer network density and school engagement may be moderated by factors such as the school engagement or academic achievement of peers. Further, there is some evidence that the cohesiveness of adolescents' social networks and the value of network cohesion as a protective factor varies as a function of race/ethnicity and gender[113,114], with male youth and Latino youth having less cohesive networks and experiencing fewer benefits of this cohesion. This study provides important insight into the relationship between network cohesion and school engagement in a sample of predominantly Latino youth. This finding merits further exploration with particular attention to the ways in which youth's intersecting identities and experiences of discrimination—especially school-based experiences of discrimination—affect opportunities to form social connections and mediate associations between social network characteristics and health and educational outcomes.

Our exploratory gender stratified analyses similarly detected differing associations among male and female youth, with male youth alone displaying positive associations between teacher support, pro-academic peers, and future school engagement. It is possible that males are more likely to receive intensive support from teachers due to gendered manifestations of school disengagement that make this more likely to be detected in boys. For example, males may display more externalizing behaviors that are readily detected and intervened upon. An alternative hypothesis supported by a growing body of research is that school environments have differential

effects on male and female students. For example, several studies employing interventions aimed to improve educational environments have resulted in more consistently positive effects on male youth's health-affecting behaviors and health outcomes[101,115,116]. Notably, this study included a binary measure of gender and may not adequately describe the experiences of youth who are nonbinary, transgender, or have other gender diverse identities. Future research in this area should use comprehensive measures of gender identity and sexual orientation and prioritize inclusion of sexual and gender minority youth for whom supportive social connections and affirming school environments may be key pathways to health and educational equity[117,118].

### 3.4.1 Limitations

This study has several other limitations. The study sample consists of students within one large public school district in Southern California who were either academically high performing in middle school or who were performing in the academic middle and applied to a college readiness program prior to high school entry. Students with the lowest levels of academic performance and school engagement in middle school were likely not included, which may limit the generalizability of our findings. However, focusing this study on a sample of primarily low-income, first-generation, Latino students allows for more nuanced investigation of the relationship between social network characteristics and school engagement in a population for whom interventions targeting school engagement may be particularly beneficial to reduce co-occurring health and educational disparities. Next, our measure of school engagement is focused only on affective and cognitive engagement which may have different social network correlates than behavioral engagement. Future studies should investigate the effect of social network quality and structure on indicators of behavioral engagement relevant to adolescent health including school attendance and

receipt of school discipline. Although measures of peer school behaviors did include indicators of behavioral engagement (i.e., disrupting class, getting in trouble at school), these measures were based on participants' reports of peer behavior which may differ from peers' self-report or other more objective measures of peer behavior such as teacher reports or school administrative records. However, other studies have suggested that adolescents' health-affecting behaviors may be more strongly influenced by perceived peer behavior than actual peer behavior[119]. Additionally, for feasibility of data collection and analysis our network survey methods somewhat artificially constrained participants' egocentric social networks to include 20 alters. Nearly every participant named 20 alters which resulted in ceiling effects that may have obscured relationships between school engagement and network size or other measures of network membership. Finally, this study includes multiple tests of association which may increase the probability of observing a statistically significant effect where none exists. Overall, the use of social network analysis is a strength of this study that allows a detailed exploration of multiple co-occurring social connections and their relationship to school engagement across the high school transition. As this analysis includes only static measures of social network characteristics, future work may seek to use dynamic social network analysis methods to evaluate the ways in which peers and adults move into networks over time and introduce or reinforce network-based supports to influence education and health trajectories.

### 3.4.2 Conclusions

In summary, we examined associations between social network characteristics and school engagement across the high school transition in a sample of predominately Latino youth. We found positive associations between school engagement and the proportion of teachers, supportive alters,

and peers with prosocial school behaviors in adolescents' social networks, and a negative association between school engagement and peer network density. School-based connections including teachers and peers with prosocial school behaviors were more influential for male adolescents. These findings increase our understanding of the ways in which social connections across multiple contexts can impact adolescents' school engagement and may inform interventions to enhance school engagement and promote positive youth development. Social network-based interventions that concurrently target school engagement and associated network-mediated behaviors including substance use and violence involvement may be particularly promising avenue to impact interrelated health and educational trajectories.

# 4.0 Longitudinal Relationships Between School Engagement and Psychological Wellbeing in Adolescence

## 4.1 Introduction

Education influences health trajectories from childhood through adulthood and has a unique relationship with health in adolescence.[50,51] The adolescent years are accompanied by the emergence of some chronic physical or mental health conditions, the onset of health-affecting behaviors that may persist into adulthood, and a heightened risk of intentional or unintentional injury.[15] School engagement generally declines during this life stage, sometimes resulting in significantly worsened educational outcomes including failure to graduate high school.[16] School disengagement and resulting low academic achievement in adolescence have been commonly linked to worsened mental health and increased health-affecting behaviors that may be detrimental to adolescent health including substance use, risky sexual behaviors, low physical activity, and unhealthy diet.[50] The high school years are a critical time to intervene to maintain school connection and enhance adolescent health and wellness. Addressing adolescents' interrelated health and educational needs can reduce co-occurring health and educational inequities, support youth to thrive, and promote healthy adulthood.[12]

School engagement is the extent to which students ascribe value to the process and goals of education (cognitive engagement), feel connection to their school and school community (affective engagement), and participate in the academic and extracurricular activities of schooling (behavioral engagement).[16,102] Psychological wellbeing includes, but is not limited to, the absence of emotional distress and presence of positive affect, and is critical for positive youth

development.[120] Adolescent school engagement has been linked with symptoms of anxiety or depression and general mental health in numerous prior cross-sectional studies.[23,24] Some longitudinal studies have suggested reduced risk of future mental health concerns among highly school engaged youth but other studies have failed to identify significant associations.[23,24] Some prior studies have investigated bidirectional relationships between school engagement and adolescent mental health using cross-lagged panel models (CLPMs), a form of structural equation modeling suited to examine longitudinal associations from a between-person perspective.[121-123] These results have largely suggested bidirectional relationships between various measures of school engagement and components of mental health or wellbeing, with varied strength and directionality of associations across age and gender.[121-123] One study suggested that school connectedness may buffer future mental health concerns only for males while mental health concerns may impair future school connectedness only for females.[121] Another study revealed associations between depressive symptoms and future school connectedness for males and females but again suggested a stronger association for females.[123] Associations between school connectedness and future depressive symptoms were generally stronger for males but were observed only among females across the transition from primary to secondary school.[123] Notably, observed associations in these studies may be a result of unmeasured confounders, such as social support or community resources, which may not be adequately accounted for in traditional CLPMs.

A bidirectional relationship between school engagement and psychological wellbeing is theoretically plausible. Being physically and psychologically well can increase students' ability to regularly attend and meaningfully engage in school.[1] Conversely, students who are highly engaged in school may have increased opportunities to form social connections with supportive peers and

adult mentors or achieve academic success which can enhance wellbeing.[25,36,38] School engagement and psychological wellbeing are individually promotive of positive health and educational outcomes and may be uniquely powerful targets for intervention if positive and bidirectionally reinforcing interactions exist.

Increased understanding of the directionality of associations between school engagement and psychological wellbeing at the individual level may help educators and clinicians prioritize interventions to concurrently promote adolescents' connection to school and mental health and wellness. Using longitudinal structural equation modeling techniques that distinguish between- and within-person effects, we can more accurately gauge how changes in school engagement or psychological wellbeing may influence future outcomes for individual students while controlling for unobserved confounders which may not be adequately accounted for in traditional CLPMs.[124,125] To accomplish this aim, we used a 4-wave random-intercept cross-lagged panel model (RI-CLPM) including 431 adolescents surveyed annually from the transition to high school to the end of 11$^{th}$ grade to investigate whether greater school engagement improves wellbeing or diminished wellbeing impairs engagement in learning. We hypothesized that school engagement and psychological wellbeing would be bidirectionally and positively reinforcing throughout the high school years.

## 4.2 Methods

### 4.2.1 Study Design and Procedure

We conducted secondary analysis of survey data from a randomized trial of Advancement via Individual Determination (AVID; NCT03059433), a college readiness program operating in middle and high schools nationwide.[85] Study participants were students across 5 public high schools within a large urban school district in Southern California. In the study school district, the high school AVID program focuses on interested students with middle school grade point average (GPA) of 2.0 to 3.5 from backgrounds under-represented in higher education, such as those identifying as Black or Latino. Study participants were recruited in two cohorts in 2017 and 2018. Eligible students were those entering 9$^{th}$ grade at a study high school who either: 1) applied for AVID and were selected to participate via their school's AVID admission lottery, 2) applied for AVID and were not selected to participate, or 3) were ineligible for AVID based on a middle school GPA above 3.5. Parent consent and student assent were required for participation. The larger trial investigated the effects of AVID on students' social networks, substance use, and health behaviors with further details of study procedure and results presented elsewhere.[86] The study was approved by the overseeing institutional review board and participating school district.

### 4.2.2 Data Collection

Participants completed electronic surveys at 4 time-points each approximately 1 year apart. Time points of survey collection were: 1) at the high school transition at the end of 8$^{th}$ grade or beginning of 9$^{th}$ grade (April-October 2017 or 2018), 2) at the end of 9$^{th}$ grade (May-June 2018 or

2019), 3) at the end of 10th grade (May-June 2019 or 2020), and 4) at the end of 11th grade (May-June 2020 or 2021). All surveys were conducted at school prior to 2020. The 2020 and 2021 surveys were conducted remotely due to the COVID-19 pandemic. Schools closed to in-person learning in March 2020 and instruction continued remotely for the vast majority of students through June 2021.

### 4.2.3 Measures

#### 4.2.3.1 School Engagement

We assessed school engagement at all time points via 29 items of the Student Engagement Instrument.[102,126,127] Participants indicated their agreement to items assessing 2 domains of affective engagement (i.e., teacher-student relationships, peer support for learning) and 2 domains of cognitive engagement (i.e., control and relevance of schoolwork, future aspirations and goals). All item responses were on a 4-point scale ranging from "strongly disagree" to "strongly agree". A total mean school engagement score was calculated by averaging all items and ranged from 1-4 with higher values representing greater school engagement. Cronbach's alpha indicated excellent internal consistency reliability within our sample at all time points ($\alpha_{T1} = 0.96$; $\alpha_{T2} = 0.95$; $\alpha_{T3} = 0.95$; $\alpha_{T4} = 0.95$).

#### 4.2.3.2 Psychological Wellbeing

Psychological wellbeing was assessed at all time-points with the 5-item version of the Mental Health Inventory (MHI-5).[128,129] The MHI-5 is considered a measure of general mental health with scores representing a continuum of psychological distress to psychological wellbeing.[128,129] Participants indicated how frequently they experienced each of 5 different aspects

of psychological wellbeing in the past month (e.g., How much of the time have you felt calm and peaceful?"). All item responses were on a 6-point scale ranging from "none of the time" to "all of the time". The MHI-5 provides a scaled total score ranging from 0-100 with higher values representing greater psychological wellbeing. Cronbach's alpha indicated good internal consistency reliability within our sample at all time points ($\alpha_{T1} = 0.81$; $\alpha_{T2} = 0.82$; $\alpha_{T3} = 0.82$; $\alpha_{T4} = 0.85$).

#### 4.2.3.3 Demographic Characteristics

Participants self-reported their demographic characteristics at baseline. Participants were asked to identify their gender with response options including male or female. This single question did not allow for expression of a full range of gender identities and is likely more closely aligned with participants' sex assigned at birth as it will be considered here.[111] Participants were asked to describe their race and ethnicity by selecting one or more of the following identities: White non-Hispanic, Hispanic, Black or African American, Asian or Pacific Islander, or American Indian or Native American. Participants additionally reported caregiver characteristics including if at least one of their primary caregivers was born in the U.S. (yes/no), graduated high school or received a GED (yes/no), and currently had any part- or full-time employment (yes/no). School, cohort (cohort 1 recruited in 2017, cohort 2 recruited in 2018), and study arm (AVID group, control group, high performing group) were recorded from study records.

### 4.2.4 Statistical Analysis

School engagement, psychological wellbeing, and demographic characteristics were summarized for the overall sample and compared across male and female participants using t-tests

for continuous variables or chi-square tests for categorical variables. Correlations between school engagement and psychological wellbeing at all time points were calculated. These analyses were completed using Stata v17 (StataCorp LLC, College Station, TX).

All remaining analyses were conducted in Mplus version 8.7 (Muthén & Muthén, Los Angeles, CA). We examined reciprocal associations between school engagement and psychological wellbeing using RI-CLPMs.[124] Traditional CLPMs evaluate longitudinal relationships between two or more variables including autoregressive effects (i.e., the influence of a variable on future occurrences of that variable) and cross-lagged effects (i.e., the influence of a variable on future occurrences of a different variable).[124] RI-CLPMs extended this approach by controlling for unmeasured time-stable trait-like covariates to more appropriately distinguish within-person and between-person effects.[124] Following the modeling procedure described by Hamaker and colleagues[124] and subsequent extensions,[125] we first established a standard RI-CLPM as a base model to examine the relationship between school engagement and psychological wellbeing. In this model, grand means are calculated from all observed scores of school engagement and psychological wellbeing for each time point. Next, a random intercept for school engagement and a random intercept for psychological wellbeing were established and modeled as latent variables with the observed measures of school engagement and psychological wellbeing at all time points as their respective indicators. Random intercepts account for individual's time stable deviation from grand means or between-person effects. Random intercepts were allowed to covary, and their covariance represents the extracted stable between-person association between the school engagement and psychological wellbeing. By decomposing these between-person effects, the within-person component of the RI-CLPM can be understood to evaluate how observed deviations in individual-level school engagement or psychological wellbeing influence future

values of these variables relative to an individual-level expected score. Within-person centered variables were established by modeling a latent variable for each repeated measure of school engagement and psychological wellbeing with factor loading constrained to 1 and measurement error variance constrained to 0. The within-person component included autoregressive effects among school engagement and psychological wellbeing over time, cross-lagged effects between school engagement and psychological wellbeing over time, and covariances between school engagement and psychological wellbeing at each singe time point, which were all allowed to freely vary within the base RI-CLPM. We next established various nested models constraining assumptions regarding autoregressive effects, cross-lagged effects, covariance, and grand means of school engagement and psychological wellbeing over time to test assumptions about these effects.

All models used full information maximum likelihood to account for missing data and maximum likelihood estimation with robust standard errors to account for non-normality of data.[130] Fit statistics were calculated for all models and assessed for goodness of fit based on Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), comparative fit index (CFI) $\geq$ 0.95, Tucker-Lewis index (TLI) $\geq$ 0.95, root mean square error of approximation (RMSEA) $\leq$ 0.06 and confidence interval from 0.00 to 0.8, and standardized root mean square residual (SRMR) $\leq$ 0.08.[131] Satorra-Bentler scaled chi-square values are reported and nested models were compared to the base model using chi-square difference testing, with the absence of a significant test indicating that a constrained model is tenable.[132]

Finally, we constructed a multi-group RI-CLPM to test if sex assigned at birth moderated relationships between school engagement and psychological wellbeing based on prior research suggesting that relationships among school experiences and wellbeing may vary between male and

female students.[100,101,121,123] A base multi-group RI-CLPM with fully unconstrained autoregressive and cross-lagged effects was compared to a nested multi-group RI-CLPM with autoregressive and cross-lagged effects constrained to be equal across groups using overall fit statistics and chi-square difference testing.[125] The absence of a significant chi-square difference test between the two models indicates that the constrained model is tenable and the autoregressive and cross-lagged effects between school engagement and psychological wellbeing are the same between males and females.[125]

### 4.3 Results

431 participants completed the initial survey (T1). Participant retention was 418 at T2 (97%), 377 at T3 (87%), and 324 at T4 (75%). 261 participants identified as female (61%) and 170 as male (39%; Table 14). 357 participants identifying as Hispanic/Latino (83%). 35% had at least one primary caregiver who was born in the U.S. and 54% had at least one primary caregiver who graduated high school. Mean school engagement was 3.3 (standard deviation (SD) 0.5) at T1 and remained relatively stable throughout high school (Table 15). Male participants reported higher overall school engagement (mean 3.2, SD 0.5) compared to female participants (mean 3.1, SD 0.5; $p$ = .03) at T2. Mean psychological wellbeing was 68.0 (SD 20.6) at T1 and generally declined throughout high school. Male participants reported higher psychological wellbeing as compared to female participants at all time points. Bivariate correlations between school engagement and psychological wellbeing at all timepoints are shown in Table 16.

**Table 14. Participant Demographic Characteristics**

| Characteristic | Participants N (%) (N=431) |
|---|---|
| Female | 261 (61%) |
| Race/Ethnicity[a] | |
| Hispanic/Latino | 357 (83%) |
| Asian or Pacific Islander | 53 (12%) |
| White | 19 (4%) |
| Black | 18 (4%) |
| American Indian or Native American | 13 (3%) |
| ≥ 1 caregiver who was born in the U.S. | 166 (39%) |
| ≥ 1 caregiver who graduated high school or received GED | 231 (54%) |
| ≥ 1 caregiver who is employed | 415 (96%) |
| Cohort | |
| Cohort 1 | 198 (46%) |
| Cohort 2 | 233 (54%) |
| Study arm | |
| AVID Group | 124 (23%) |
| Control Group | 146 (34%) |
| High Performing Group | 161 (37%) |

[a] Participants could select more than one response.

**Table 15. School Engagement and Psychological Wellbeing Overall and by Sex Assigned at Birth**

| Variable | Time | N | Overall | Males | Females | P value |
|---|---|---|---|---|---|---|
| School engagement[a] | T1 | 430[b] | 3.3 (0.5) | 3.2 (0.6) | 3.3 (0.5) | 0.55 |
| School engagement | T2 | 418 | 3.1 (0.5) | 3.2 (0.5) | 3.1 (0.5) | 0.03 |
| School engagement | T3 | 377 | 3.2 (0.5) | 3.2 (0.5) | 3.2 (0.5) | 0.65 |
| School engagement | T4 | 324 | 3.2 (0.5) | 3.2 (0.5) | 3.1 (0.5) | 0.25 |
| Psychological wellbeing[c] | T1 | 430[b] | 68.0 (20.6) | 73.3 (17.8) | 64.5 (21.5) | <0.0001 |
| Psychological wellbeing | T2 | 418 | 64.4 (21.0) | 71.2 (18.9) | 60.1 (21.1) | <0.0001 |
| Psychological wellbeing | T3 | 377 | 65.7 (21.2) | 72.9 (17.7) | 61.3 (21.8) | <0.0001 |
| Psychological wellbeing | T4 | 324 | 61.0 (21.1) | 68.5 (18.7) | 56.8 (21.2) | <0.0001 |

[a] School engagement has a possible range of 1 (low) to 4 (high).

[b] One participants did not complete school engagement or psychological wellbeing measures at T1.

[c] Psychological wellbeing has a possible range of 0 (low) to 100 (high).

**Table 16. Bivariate Correlations Between School Engagement and Psychological Wellbeing Overall and by Sex Assigned at Birth**

| Variable | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. |
|---|---|---|---|---|---|---|---|---|
| 1. School engagement T1[a] | - | | | | | | | |
| 2. School engagement T2 | 0.506 | - | | | | | | |
| 3. School engagement T3 | 0.500 | 0.561 | - | | | | | |
| 4. School engagement T4 | 0.437 | 0.507 | 0.613 | - | | | | |
| 5. Psychological wellbeing T1 | 0.295 | 0.336 | 0.319 | 0.245 | - | | | |
| 6. Psychological wellbeing T2 | 0.195 | 0.384 | 0.328 | 0.248 | 0.579 | - | | |
| 7. Psychological wellbeing T3 | 0.129 | 0.270 | 0.336 | 0.214 | 0.499 | 0.457 | - | |
| 8. Psychological wellbeing T4 | 0.086[c] | 0.216 | 0.239 | 0.260 | 0.376 | 0.410 | 0.541 | - |
| 1. School engagement T1[b] | - | 0.549 | 0.513 | 0.414 | 0.194 | 0.197 | 0.088[c] | 0.047[c] |
| 2. School engagement T2 | 0.481 | - | 0.569 | 0.510 | 0.293 | 0.344 | 0.292 | 0.151[c] |
| 3. School engagement T3 | 0.485 | 0.549 | - | 0.596 | 0.226 | 0.266 | 0.362 | 0.242 |
| 4. School engagement T4 | 0.448 | 0.495 | 0.619 | - | 0.199 | 0.164 | 0.200 | 0.206 |
| 5. Psychological wellbeing T1 | 0.376 | 0.344 | 0.383 | 0.268 | - | 0.640 | 0.411 | 0.308 |
| 6. Psychological wellbeing T2 | 0.212 | 0.401 | 0.374 | 0.298 | 0.506 | - | 0.354 | 0.251 |
| 7. Psychological wellbeing T3 | 0.175 | 0.255 | 0.341 | 0.208 | 0.511 | 0.463 | - | 0.519 |
| 8. Psychological wellbeing T4 | 0.110[c] | 0.222 | 0.244 | 0.279 | 0.362 | 0.412 | 0.516 | - |

[a] Spearman correlation coefficients for the overall sample appear in the top pane.

[a] Spearman correlation coefficients stratified by sex assigned at birth appear in the bottom pane. Correlation coefficients for males are above the diagonal and females below the diagonal.

[c] Not statistically significant at $p < 0.05$. All other values are statistically significant at this threshold.

### 4.3.1 RI-CLPM of School Engagement and Psychological Wellbeing

The base RI-CLPM of school engagement and psychological wellbeing had good model fit overall with RMSEA = 0.042, CFI = 0.985, TLI = 0.955, and SRMR = 0.04 (Table 17). Models that constrained the random intercept to 0 with and without constraining autoregressive and cross-lagged effects to be equal over time fit the data more poorly than the base RI-CLPM ($\Delta \chi2(11) = 62.69$, $p < 0.0001$ and $\Delta \chi2\ (3) = 35.83$, $p < 0.0001$ respectively). These model constraints approximate the invariant CLPM and CLPM respectively and the significant chi-square difference tests suggest that these models should be rejected in favor of the base RI-CLPM. RI-CLPMs that constrained grand means of school engagement and psychological wellbeing over time also fit more poorly than the base RI-CLPM ($\Delta \chi2(6) = 55.85$, $p < 0.0001$) suggesting that on average

school engagement and psychological wellbeing are not constant throughout the study period. The RI-CLPM that constrained autoregressive effects alone had worsened fit than the base RI-CLPM ($\Delta\ \chi2(4) = 11.57$, $p = 0.02$) suggesting that within-person autoregressive effects of school engagement and psychological wellbeing are not constant throughout the study period. The RI-CLPMs with constrained cross-lagged effects alone and constrained autoregressive and cross-lagged effects were tenable based on the X2 difference test ($\Delta\ \chi2(4) = 3.86$, $p = 0.43$ and $\Delta\ \chi2(8) = 15.03$, $p = 0.06$ respectively). On review of overall model fit statistics, the RI-CLPM with constrained cross-lagged effects alone had better fit and was retained as a plausible model along with the base RI-CLPM. This model implies that the within-person cross-lagged effects between school engagement and psychological wellbeing are constant over time.

**Table 17. Model fit statistics for RI-CLPM and multi-group RI-CLPM**

| Model | AIC | BIC | RMSEA | CFI | TLI | SRMR | $\chi2$ | $\Delta\ \chi2$ |
|---|---|---|---|---|---|---|---|---|
| RI-CLPM | 15394.74 | 15537.05 | 0.042 | 0.985 | 0.955 | 0.040 | $\chi2(9) = 15.76$ (p=0.07) | Base model |
| CLPM constrained RI | 15462.15 | 15592.26 | 0.104 | 0.877 | 0.724 | 0.073 | $\chi2(12) = 67.52$ (p<0.0001) | $\chi2(3) = 35.83$ (p<0.0001) |
| CLPM constrained RI, AR, CL | 15469.77 | 15567.36 | 0.087 | 0.857 | 0.807 | 0.089 | $\chi2(20) = 84.73$ (p<0.0001) | $\chi2(11) = 62.69$ (p<0.0001) |
| RI-CLPM constrained AR | 15403.03 | 15529.08 | 0.052 | 0.967 | 0.930 | 0.065 | $\chi2(13) = 28.10$ (p=0.009) | $\chi2(4) = 11.57$ (p=0.02) |
| RI-CLPM constrained CL | 15391.10 | 15517.14 | 0.034 | 0.986 | 0.969 | 0.053 | $\chi2(13) = 19.59$ (p=0.11) | $\chi2(4) = 3.86$ (p=0.43) |
| RI-CLPM constrained AR, CL | 15397.73 | 15507.51 | 0.043 | 0.970 | 0.951 | 0.063 | $\chi2(17) = 30.86$ (p=0.02) | $\chi2(8) = 15.03$ (p=0.06) |
| RI-CLPM constrained means | 15439.04 | 15556.96 | 0.091 | 0.884 | 0.783 | 0.065 | $\chi2(15) = 68.94$ (p<0.0001) | $\chi2(6) = 55.85$ (p<0.0001) |
| Multi-group RI-CLPM | 15345.26 | 15629.89 | 0.014 | 0.998 | 0.994 | 0.044 | $\chi2(18) = 18.79$ (p=0.40) | Base model |
| Multi-group RI-CLPM constrained | 15340.78 | 15576.61 | 0.028 | 0.989 | 0.979 | 0.055 | $\chi2(30) = 34.94$ (p=0.24) | $\chi2(12) = 15.78$ (p=0.02) |

RI-CLPM: Random intercept cross-lagged panel model

CLPM: Cross-lagged panel model

RI: Random intercept

AR: Autoregressive effects

CL: Cross-lagged effects

Unstandardized parameter estimates of the base RI-CLPM and nested RI-CLPM with constrained cross-lagged effects are presented in Table 18. In the base RI-CLPM autoregressive effects of school engagement were significant only at T4 (Figure 8; standardized $\beta = 0.24$, standard error (SE) .10; $p = 0.02$) suggesting that individuals with greater school engagement at T3 relative to their expected score will likely experience greater school engagement at T4. Autoregressive effects of psychological wellbeing were significant at T2 and T4 (T2: $\beta = 0.213$, SE .10; $p = 0.04$; T4: $\beta = 0.285$, SE .08; $p < 0.001$) suggesting that individuals with greater psychological wellbeing at T1 and T3 relative to their expected mean will likely experience greater psychological wellbeing at T2 and T4 respectively. There were no significant cross-lagged effects of school engagement on psychological wellbeing ($\beta$ range: 0.005 – 0.122) suggesting that transient elevations in school engagement relative to an individual's expected score do not influence subsequent changes in psychological wellbeing. There was a single significant cross-lagged effect of psychological wellbeing on school engagement at T2 ($\beta = 0.170$, SE .08; $p = 0.04$) suggesting that individuals with transient elevations in psychological wellbeing at T1 relative to their expected score will likely experience relatively greater school engagement at T2. Within-person correlations between school engagement and psychological wellbeing were significant at T1, T2, and T3 (T1: $\beta = 0.130$, SE .07; $p = 0.05$; T2: $\beta = 0.266$, SE .08; $p = 0.003$; T3: $\beta = 0.219$, SE .08; $p = 0.004$). The random intercepts were significantly positively correlated ($\beta = 0.454$, SE .08; $p < 0.001$) suggesting that individuals with greater school engagement also have greater psychological wellbeing on average. In the nested RI-CLPM with constrained cross-lagged effects autoregressive effects of school engagement and psychological wellbeing remained significant only at T4 (Table 18; Figure 9; T4 school engagement: $\beta = 0.206$, SE .10; $p = 0.03$; T4 psychological wellbeing: $\beta = 0.285$, SE .08; $p < 0.001$). No significant cross-lagged effects were identified ($\beta$ range: 0.028 –0.089). Within-

person correlations between school engagement and psychological wellbeing remained significant at T2 and T3 (T2: $\beta = 0.171$, SE .08; $p = 0.02$; T3: $\beta = 0.200$, SE .08; $p = 0.007$). The random intercepts remained significantly correlated ($\beta = 0.494$, SE .08; $p < 0.001$).

**Table 18. Unstandardized parameter estimates for RI-CLPM and multi-group RI-CLPM**

| | | RI-CLPM | Group RI-CLPM | | Group RI-CLPM |
|---|---|---|---|---|---|
| | RI-CLPM | constrained CL | Male | Female | constrained |
| Parameter | Estimate (SE)[a] | Estimate (SE)[a] | Estimate (SE)[a] | Estimate (SE)[a] | Estimate (SE)[a] |
| AR effects | | | | | |
| E1→E2 | -0.042 (.07) | 0.013 (.08) | -0.008 (.10) | -0.042 (.10) | -0.026 (.07) |
| E2→E3 | 0.068 (.09) | 0.082 (.08) | 0.134 (.24) | 0.053 (.09) | 0.073 (.09) |
| E3→E4 | 0.253 (.10) | 0.209 (.10) | 0.301 (.16) | 0.200 (.14) | 0.250 (.11) |
| W1→W2 | 0.221 (.11) | 0.160 (.13) | 0.505 (.12) | 0.079 (.14) | 0.238 (.12) |
| W2→W3 | 0.042 (.11) | 0.008 (.12) | -0.083 (.14) | 0.080 (.13) | 0.016 (.11) |
| W3→W4 | 0.310 (.09) | 0.310 (.09) | 0.355 (.15) | 0.248 (.11) | 0.288 (.09) |
| CL effects | | | | | |
| E1→W2 | 1.517 (2.77) | 1.395 (2.23) | 4.180 (3.23) | 0.903 (3.51) | 1.833 (2.64) |
| E2→W3 | 4.432 (3.35) | 1.395 (2.23) | 15.091 (5.14) | -0.719 (3.24) | 0.073 (.09) |
| E3→W4 | 0.237 (3.75) | 1.395 (2.23) | 3.649 (5.45) | -2.106 (5.15) | 0.250 (.11) |
| W1→E2 | 0.005 (.002) | 0.001 (0.001) | 0.007 (.004) | 0.003 (0.003) | 0.004 (.002) |
| W2→E3 | 0.004 (.002) | 0.001 (0.001) | 0.006 (.004) | 0.003 (0.002) | 0.004 (.002) |
| W3→E4 | 0.000 (.002) | 0.001 (0.001) | 0.002 (.005) | -0.001 (0.002) | 0.000 (.002) |
| Covariances | | | | | |
| RI E – RI W | 1.829 (.43) | 2.111 (.45) | 0.480 (.72) | 2.482 (.52) | 1.287 (.50) |
| E1 – W1 | 0.884 (.45) | 0.815 (.42) | 0.327 (.75) | 1.381 (.56) | -0.073 (.69) |
| E2 – W2 | 1.47 (.49) | 1.023 (.56) | 1.126 (.58) | 1.351 (.70) | 0.573 (.53) |
| E3 – W3 | 1.253 (.48) | 1.134 (.46) | 2.261 (.82) | 0.644 (.55) | 1.682 (.79) |
| E4 – W4 | 0.428 (.42) | 0.568 (.39) | 0.763 (.60) | 0.218 (.56) | 0.675 (.58) |

RI-CLPM: Random intercept cross-lagged panel model

AR: Autoregressive

CL: Cross-lagged

SE: Standard error

E: School engagement

W: Psychological wellbeing

RI E: Random intercept of school engagement

RI W: Random intercept of psychological wellbeing

[a] Bolded estimates are significant at $p < .05$.

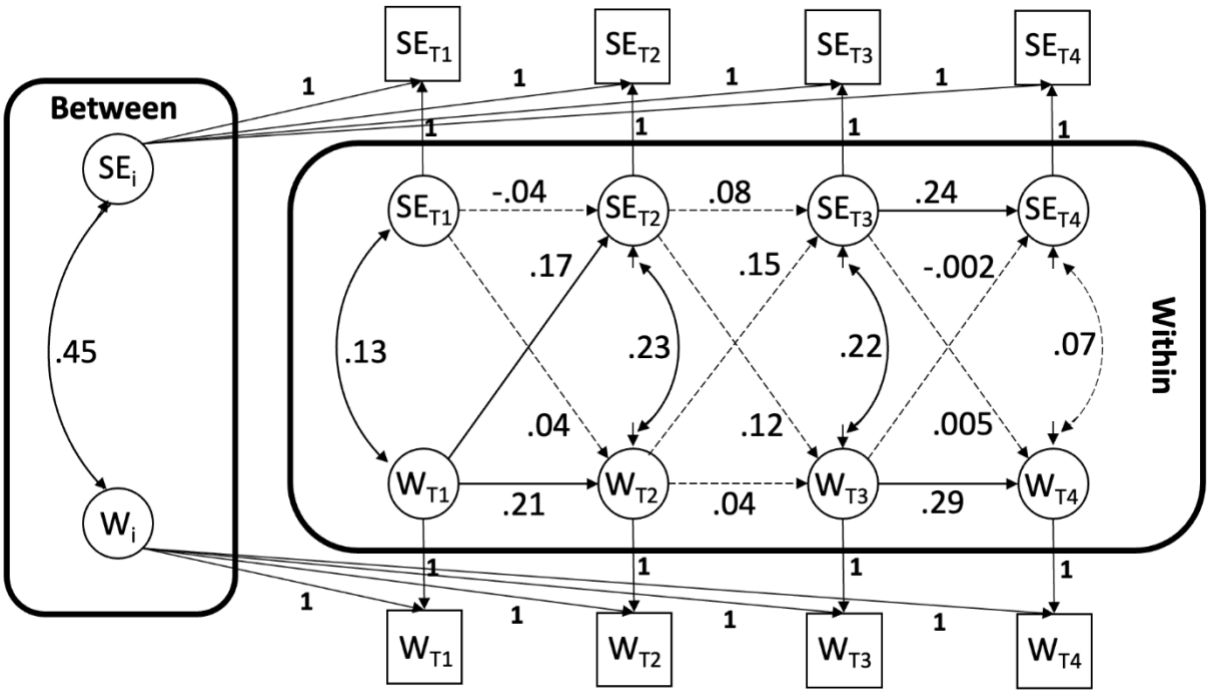


**Figure 8. Random intercept cross-lagged panel model of school engagement (SE) and psychological wellbeing (W) across 4 time points.**

**Standardized parameter estimates are shown. Bolded arrows represent statistical significance at p < .05. Dotted arrows represent non-statistically significant relationships.**

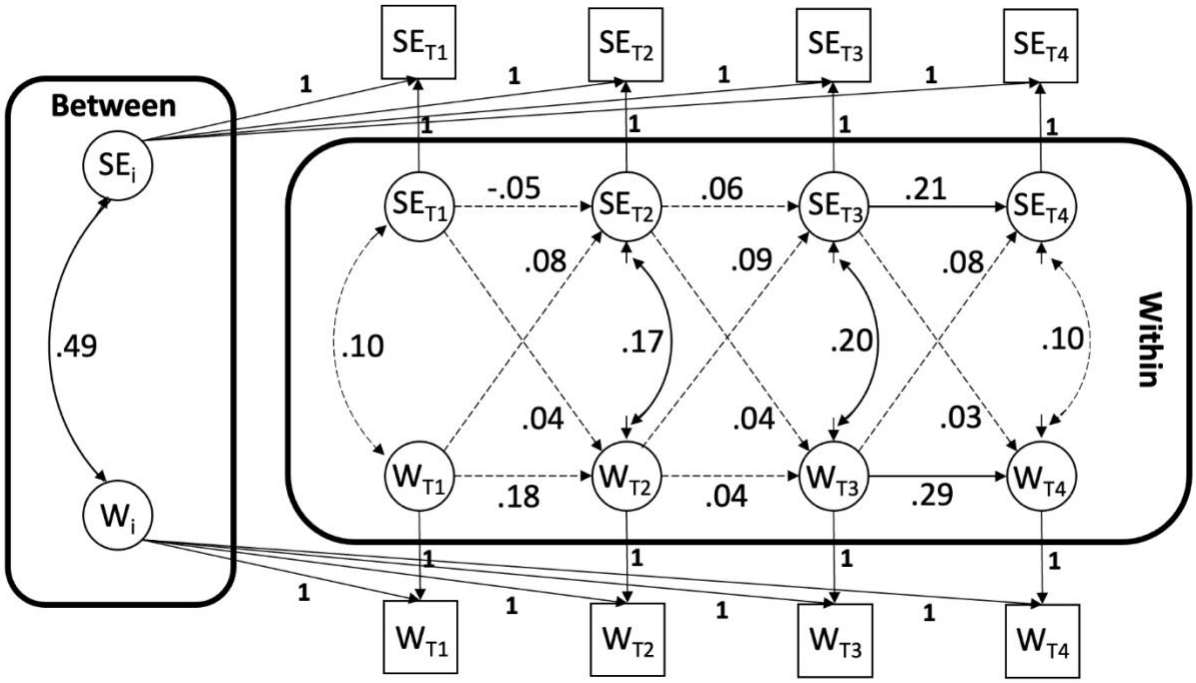


**Figure 9. Random intercept cross-lagged panel model of school engagement (SE) and psychological wellbeing (W) with constrained cross-lagged effects across 4 time points.**

**Standardized parameter estimates are shown. Bolded arrows represent statistical significance at p < .05. Dotted arrows represent non-statistically significant relationships.**

### 4.3.2 Multi-group RI-CLPM of School Engagement and Psychological Wellbeing

Fit statistics and unstandardized parameter estimates of the base RI-CLPM and nested RI-CLPM with constrained cross-lagged effects are presented in Table 17 and Table 18 respectively. The chi-square difference test of these models was $\Delta \chi 2(12) = 15.78$ ($p = 0.02$) indicating similar lagged effects of school engagement and psychological wellbeing among male and female students.

## 4.4 Discussion

In this study, we used random intercept cross-lagged panel modeling to examine longitudinal relationships between school engagement and psychological wellbeing from the high school transition to the end of 11th grade among a sample of predominantly Hispanic- or Latino-identified youth. We identified a best fitting base RI-CLPM and a nested RI-CLPM with constrained cross-lagged effects which assumed constant prospective associations between school engagement and psychological wellbeing over time. Between school engagement and psychological wellbeing, between-person time-invariant correlations (i.e., individuals with greater school engagement on average also have greater psychological wellbeing on average) and within-person correlations across time points (i.e., individual-level changes in school engagement are positively associated with changes in psychological wellbeing at the same time point) were frequently observed. Within-person autoregressive (i.e., individual-level changes in school engagement or psychological wellbeing are positively associated with subsequent changes in the same variable) or cross-lagged effects (i.e., individual-level changes in school engagement or psychological wellbeing are positively associated with subsequent changes in the other variable) were less often significant. Autoregressive effects varied by time point across the two models with more consistently significant effects from T3 to T4. A single significant cross-lagged effect was observed from psychological wellbeing at T1 to school engagement at T2 in the base RI-CLPM suggesting that individuals with transient elevations in psychological wellbeing relative to their expected score experience relatively greater subsequent school engagement. Procedures testing multi-group RI-CLPMs did not reveal significant moderation of autoregressive or cross-lagged relationship by sex assigned at birth.

Despite frequently observed declines in school engagement throughout high school at the population level, overall mean school engagement in our sample remained relatively constant across all time points and observed values reflected those found in prior studies using the Student Engagement Instrument among high school students.[126,133] Overall mean psychological wellbeing in our sample generally declined throughout the study period from 68 at T1 to 61 at T4. Notable differences were observed by sex assigned at birth, with females experiencing lower psychological wellbeing at all time points ranging from 64.5 at T1 to 56.8 at T4. Although the MHI-5 was used to represent a continuum of psychological wellbeing in this study, various prior studies have sought to establish cutoffs for the MHI-5 to aid in the diagnosis of psychiatric conditions among adults with typically suggested cut-offs ranging from 52 to 76.[134,135] If these findings hold for adolescents, our results suggest that there may be a substantial amount of clinically significant mental health concerns within this sample. This finding echoes recent national data collected in the wake of the COVID-19 pandemic in the fall of 2021 shortly after our final time point in this study.[26] This data revealed that 42% of U.S. high school students felt persistently sad or hopeless and 22% seriously considered suicide in the past year.[26] Female youth and youth who identified as lesbian, gay, bisexual, questioning, or another non-heterosexual identity (LGBQ+) experienced higher rates of psychological distress with 24% and 37% having made a suicide plan in the past year respectively.[26] There is a clear and urgent need to improve youth mental health which reinforces the importance of research that seeks to identify untapped pathways for intervention such as that presented here.

Our RI-CLPM results regarding autoregressive and cross-lagged associations between school engagement and psychological wellbeing diverge from prior studies using traditional CLPMs which have more consistently revealed longitudinal and bidirectional interactions.[121-123]

This discrepancy is not entirely surprising as these related but distinct methodologies support theoretically different hypothesis testing.[124,125] Our findings indicate that changes in school engagement or psychological wellbeing relative to a predicted individual-level score may influence later relative within-person changes in these constructs but these associations are likely weaker and less consistent than previously assumed. Our findings specifically suggest variable autoregressive effects of school engagement and psychological wellbeing most consistently observed in later high school years (i.e., end of 10th to end of 11th grade). Autoregressive effects may emerge or strengthen in later years of high school as youth establish reinforcing patterns of school engagement or mental health that may be nurtured with support, or allowed to dwindle in its absence, as youth navigate the challenges of emerging adulthood. Future research can seek to establish if these effects are sustained or increased through the final year of high school and across the transition to postsecondary education or careers. Our findings also suggest a possible but inconsistently observed cross-lagged effect of psychological wellbeing on school engagement in early high school (i.e., high school transition to end of 9th grade). The transition to high school can be an important inflection point in adolescents' health and education trajectories.[32] There is growing understanding of the potential for school-based interventions to concurrently enhance adolescent health and education and the transition to high school may be a critical time to leverage these.[86,100,101] Interventions that target psychological wellbeing as a pathway to improved school engagement and educational success may be promising. Interventions should seek to expand beyond promoting only the absence of diagnosable mental health conditions towards a goal of comprehensively fostering adolescent wellbeing and supporting youth to thrive.

These findings also have relevance for educators and clinicians. Educators can recognize that education and health are closely interrelated and specifically consider that school

disengagement and its potential manifestations including disruptive school behaviors or school absenteeism may be a signal of diminished wellbeing or inadequately addressed mental health concerns as opposed to willful disobedience.[1] Signs of school disengagement can be considered calls to increase support to youth who may be struggling and facilitate referral to school- or community-based health care providers to support any physical or mental health needs.[1] Clinicians can consider school engagement as a "vital sign" of youth wellbeing and regularly ask about school attendance and performance.[1] Clinicians treating youth for mental health conditions can recognize their potential educational impacts and provide anticipatory guidance or any needed documentation to ensure that students receive appropriate academic supports.[1]

### 4.4.1 Limitations

Our study has several limitations. The study sample includes students within one large public school district in Los Angeles, California and most participants identified as Hispanic or Latino. This may limit the generalizability of findings but allows us to investigate relationships between school engagement and psychological wellbeing in a population that may experience co-occurring health and educational inequities. Additionally, the recruitment strategies for the larger trial selected a sample of students who were either academically high performing in middle school or who sought entry to a college readiness program in their high school. Students in these groups may not be representative of the larger student population including with respect to school engagement or psychological wellbeing profiles. Although we did not identify significantly different autoregressive or cross-lagged effects between males and female, we included a binary measure of sex assigned at birth that cannot adequately identify youth who are nonbinary, transgender, or have other gender diverse identities. Future research should include comprehensive

measures of gender identity and sexual orientation and emphasize inclusion of sexual and gender minority youth in light of known inequities in both school experiences and mental health outcomes among these groups.[26,117,118] Data collection for this study was partially following the onset of the COVID-19 pandemic (T4 for cohort 1, T3 and T4 for cohort 2). High school students' education and mental health have been deeply impacted during the COVID-19 pandemic which speaks to the relevancy of this work but also may somewhat limit the generalizability of these findings during other times.[20,26,81] Additionally, although RI-CLPMs offer some unique benefits not accomplished with traditional CLPMs, there is still much debate about the relative appropriateness of these two methods and results should be considered within these confines.[136,137] Overall, the use of RI-CLPMs is a strength of this study that allows a nuanced exploration of longitudinal relationships between school engagement and psychological wellbeing throughout the high school years in a manner not previously accomplished.

### 4.4.2 Conclusions

In conclusion, we assessed longitudinal relationships between school engagement and psychological wellbeing from the transition to high school through 11$^{th}$ grade using random intercept cross-lagged panel modeling. We identified within-person autoregressive effects of both school engagement and psychological wellbeing on future levels of these variables, with suggestion of a more significant effect in the later high school years. We identified a significant cross-lagged effect from psychological wellbeing to school engagement across the high school transition that was not consistently reproduced in all models. These results have implications for intervention design and educational and clinical practice aimed to collectively promote educational success, good health, and wellbeing in adolescence and beyond.

# 5.0 Conclusion

## 5.1 Principal Findings

Health and education are intricately linked during adolescence and efforts to concurrently enhance these factors may have significant public health benefits in this life stage and beyond. To collectively promote adolescent health and education, we sought to build understanding of adolescents' emerging and interrelated health and educational needs and identify multilevel factors that contribute to or protect against chronic absenteeism and school disengagement. Across three projects, we elucidated distinct high school attendance trajectories in the context of the COVID-19 pandemic, explored the role of social network-based connection in fostering school engagement, and investigated the strength and directionality of associations between school engagement and psychological wellbeing throughout the high school years. Collectively, these studies increase our understanding of school attendance and engagement during adolescence and suggest multiple future pathways for intervention to enhance adolescent health and educational outcomes and equity.

In project 1, we used group-based trajectory modeling to identify distinct attendance trajectories throughout the high school years and across the COVID-19 pandemic. We identified three attendance trajectory subgroups. Some youth (5.1%) experienced chronically declining attendance throughout the study period but most youth (77.2%) maintained stable high attendance during this time. A sizeable minority of youth (17.7%) experienced acutely declining attendance after the onset of the COVID-19 pandemic which appeared to negatively deviate from their prior trajectory. We additionally estimated the effects of two school policies and practices—school

discipline and a college readiness program—on identified attendance trajectories. Receipt of school discipline was associated with lower attendance across all attendance trajectory subgroups without significant differences between groups. Participation in the AVID college readiness program was associated with differentially higher attendance only in the acutely declining attendance trajectory subgroup. These findings increase our understanding of the lasting and variable impacts of the COVID-19 pandemic on adolescents' school attendance. The educational impacts of the COVID-19 pandemic have not been uniformly severe and both tailored individual and universal school-level interventions will be needed to support all youth to thrive.

In project 2, we used social network analysis to identify associations between adolescents' social network characteristics at the transition to high school (end of 8$^{th}$ grade/beginning of 9$^{th}$ grade) and their concurrent and future (end of 9$^{th}$ grade) school engagement. Teachers were inversely associated with school engagement at the transition to high school but positively associated with school engagement at the end of 9$^{th}$ grade. Network-based supports were positively associated with school engagement at both time points. Peer academic behaviors including peers highly engaged in school were associated with concurrent school engagement only. Peer network density was the only network structural characteristic associated with school engagement, with greater density predicting lower concurrent school engagement. School-based supports including teachers and highly school engaged peers were more strongly associated with future school engagement for males. These findings offer new knowledge of the relationship between school engagement and specific qualities and structures of adolescents' social networks. Like other adolescent health behaviors, school engagement may be influenced by the behaviors of peers in adolescents' social circles. Building connections to supportive adults and supportive and academically motivated peers may enhance adolescents' school engagement.

In project 3, we used structural equation modeling to investigate the strength and directionality of associations between school engagement and psychological wellbeing as students entered and persisted in high school. In 4-wave random-intercept cross-lagged panel models, between-person time-invariant correlations and within-person correlations across time points between school engagement and psychological wellbeing were frequently observed. This suggests that individuals with greater school engagement on average also have greater psychological wellbeing on average and individual-level changes in school engagement are positively associated with changes in psychological wellbeing at the same time point. Within-person autoregressive or cross-lagged effects between school engagement and psychological wellbeing were less often observed as compared to prior studies using traditional cross-lagged panel modeling techniques.[121-123] This reflects the ability of the RI-CLPM to isolate within-person effects over time and is a unique contribution of this study in the context of the existing literature. This study specifically revealed autoregressive effects of school engagement and psychological wellbeing that remained consistently significant only between time 3 (end of 10$^{th}$ grade) and time 4 (end of 11$^{th}$ grade). This suggests that individual-level changes in school engagement or psychological wellbeing are positively associated with subsequent changes in the same variable across these timepoints. A single significant cross-lagged effect was observed from psychological wellbeing at time 1 (end of 8$^{th}$ grade) to school engagement at time 2 (end of 9$^{th}$ grade) in the base RI-CLPM but was not consistently reproduced across models. This suggests that individuals with transient elevations in psychological wellbeing relative to their expected score may experience relatively greater subsequent school engagement across these timepoints. These findings improve our understanding of the relationship between school engagement and psychological wellbeing throughout the high

school years and offer relevant insights to inform intervention timing and targets to concurrently promote adolescent health and education.

## 5.2 Implications for Practice, Programming, and Policy

Findings of these projects have numerous implications for clinical and educational practice, programming and intervention development, and policy. Regarding clinical and educational practice, project 1 displays the ability to identify unique attendance trajectories which may hold important information about students' education, health, and overall wellbeing. Clinicians and educators can monitor attendance for school-aged youth and consider longitudinal attendance patterns as opposed to point estimates alone which may obscure meaningful changes. Project 3 describes the relationship between school engagement and psychological wellbeing which we encourage clinicians and educators to recognize. Signs of school disengagement can be understood as signals to increase support to youth and consider the possibility of unmet health and mental health needs. Clinicians caring for youth with known mental health concerns can inquire about and monitor the educational impacts of these and ensure appropriate academic supports are in place. These practices of monitoring attendance and school engagement and increasing support to youth as needed may themselves bolster school engagement by surrounding youth with caring adults as suggested in project 2.

Results of these projects can also inform programming and policy at interpersonal, school, and larger structural levels. At the interpersonal level, project 2 reveals that interventions that increase adolescents' connection to supportive peers and adults or surround them with academically motivated peers may be effective ways to enhance school engagement. At the school

level, this may include formal mentoring programs or offering in-school or after-school activities that encourage youth to build connections with adult support or highly school engaged peers. College readiness programs such as the AVID program investigated in project 1 may be particularly effective means to improve attendance and school engagement through multiple social network-mediated processes and academic untracking strategies. Programming and policy considerations at the larger structural level can include efforts to bolster the teacher workforce and limit teacher-student ratios which will serve to transmit the protective value of teachers identified in project 2 to the greatest number of students. Finally, results of multiple projects presented here suggest that policies that encourage the avoidance of exclusionary discipline in favor of restorative justice-based approaches that rebuild connection to the school community have potential to improve attendance and school engagement while broadly promoting health and educational equity.

## 5.3 Future Research Directions

Much of the research presented here investigated adolescent health and educational outcomes at the peak of the COVID-19 pandemic. The COVID-19 pandemic has had substantial and lasting impacts on the daily lives, schooling, health, and wellbeing of adolescents. This is both a critical and complicated time to conduct this research, posing challenges to collection and interpretation of school-based survey and school administrative data. Future research can seek to replicate and expand upon these results using different or multiple measures of attendance and school engagement in other school settings. Additionally, future research can aim to determine if observed results are transient or maintained following the COVID-19 pandemic or at other points

in the course of schooling (e.g., late high school and the transition to college). The cross-sectional associations between adolescent social network characteristics and school engagement can specifically be expanded using longitudinal dynamic social network analysis. An additional important next step of this research is to investigate if observed effects differ for adolescents who may experience barriers to building supportive and affirming connections in school settings, specifically youth who identify as LGBTQ+.[117,118] Finally, results of this research can begin to inform intervention. Youth, school, community, and health system constituents will be important partners in the design, implementation, and evaluation of interventions aimed to enhance attendance or school engagement as a pathway to improved adolescent health.

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