A Concurrent and Longitudinal Analysis of Teacher Support, Stressful Life Events, and Depressive Symptoms in Early Adolescence

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Public Health

University of Washington

2019

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Abstract

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Introduction: Depression is a major public health issue globally and is associated with a variety of undesirable outcomes. This analysis examines the concurrent and prospective associations between teacher social support and depressive symptoms in middle school-aged youth and the ways that this association may depend on stressful life events and sex, as informed by the stress-buffering hypothesis and sex differences in stress and depression.

Methods: This study used three waves of data representing 6th, 7th, and 8th grade measurements for 521 adolescents in the Developmental Pathways Project cohort study. The associations were estimated using generalized estimating equations, adjusting for relevant covariates including baseline depressive symptoms in prospective associations. In addition, we assessed interactions of teacher support with stressful life events and sex.

Results: Teacher support had a statistically significant negative association with current depressive symptoms ($p < 0.001$) and subsequent depressive symptoms ($p = 0.004$). There was evidence of an interaction between stressful life events and teacher support in these associations, such that the association between higher teacher support and lower current ($p < 0.001$) and subsequent ($p = 0.029$) depressive symptom counts was diminished for adolescents with higher numbers of reported stressful life events. Sex was not a significant moderator for the association between teacher support and depressive symptoms, or for the models testing the stress-buffering hypothesis, for both the concurrent and prospective associations.

Discussion: We found concurrent and prospective associations between teacher support and depressive symptoms, both of which were moderated by stress. There was no moderation by sex. Our findings were largely consistent with the literature; inconsistencies with existing literature may be related to adjustment for baseline depressive symptoms in prospective analyses, which we explored further in a sensitivity analysis.

Conclusions: Our study indicates teacher support is associated with adolescent depressive symptoms concurrently and longitudinally. Further research is needed to elucidate the facets of teacher support that can contribute to adolescent mental health.

Introduction

Depression represents a significant public health threat worldwide. A 2017 report from the World Health Organization asserts that depressive disorders are the largest contributors to disability, representing a total of 7.5% of all years lost to disability worldwide (World Health Organization, 2017). In the United States, 11.0% of adolescents ages 13 to 18 are estimated to have had major depressive disorder in their lifetime, and 7.5% of adolescents are estimated to have had major depressive disorder in the past twelve months (Avenevoli, Swendsen, He, Burstein, & Merikangas, 2015). Furthermore, depression is known to be associated with a variety of undesirable outcomes, ranging from decreased quality of life (Sivertsen, Bjørkløf, Engedal, Selbæk, & Helvik, 2015; Zeng, Xu, & Wang, 2013) to suicide (Henriksson MM et al., 1993). Given the burden of depression and its associated adverse outcomes, identification of protective factors is of the utmost importance.

Social support has been shown to be associated with improved health outcomes, ranging from general health (Holden, Lee, Hockey, Ware, & Dobson, 2015), to decreased anxiety and depression (Muñoz-Laboy, Severson, Perry, & Guilamo-Ramos, 2014), and decreased suicidality (Ayub, 2015). In the literature, social support has been conceptualized in a variety of ways. Shumaker and Brownell have suggested social support consists of a resource exchange that is thought by the provider of support and/or the receiver of support to be beneficial to the recipient (Shumaker & Brownell, 1984). Tardy (1985) has suggested five primary elements to consider when conducting research considering social support: *direction* referring to both giving and receiving social support, *disposition* referring to the availability of social support to an individual and the provision of social support by an individual, *description/evaluation* referring to studying individuals' descriptions of social support and/or individuals' evaluations of social support,

content referring to what the social support entails, and *network* referring to the theoretical web of individuals giving and receiving social support (Tardy, 1985). A number of researchers have suggested ways of classifying different types of social support; one such categorization is provided by House, who has identified four categories: informational, appraisal, emotional, and instrumental (House, 1981). As identified by qualitative interviews, meaningful social support for individuals with depression includes support that is practical in nature, such as support with daily life provided by family members, and "invisible" emotional support (Smith, Hill, & Kokanovic, 2015).

A 2016 meta-analysis indicates significant associations between low social support from peers, close friends, family, and teachers and depression in the childhood and adolescent developmental time periods (Rueger, Malecki, Pyun, Aycock, & Coyle, 2016). The findings of this meta-analysis indicate that this association exists both cross-sectionally and longitudinally, though the cross-sectional association is stronger. Furthermore, a 2016 systematic analysis of these associations identified family, parent, and teacher support to be most consistently associated with reduced risk for depression in childhood and adolescence, with less consistent findings for friends and general perceived support (Gariépy, Honkaniemi, & Quesnel-Vallée, 2016).

Given that children and adolescents spend a substantial amount of time daily in school, teachers function as significant role models and potential sources of support. Qualitative findings suggest that teacher behaviors that are perceived to be supportive by students include welcoming questions, giving feedback on student progress, indicating investment in student learning, and employing a variety of teaching strategies (Suldo et al., 2009). However, teacher behaviors that are perceived as supportive may vary by student context. Teacher support is associated with a

variety of other adolescent outcomes including higher grade point average (Tennant et al., 2015), delayed initiation of alcohol use (McCarty, Rhew, Murowchick, McCauley, & Vander Stoep, 2012) and greater life satisfaction (Guess & McCane-Bowling, 2016).

In addition to the direct association between social support and depression, it is hypothesized that social support could act as a protective factor against potential negative impacts of stress by prevention of appraising an event as stressful or by promoting healthy behaviors and responses following appraisal of events as stressful, referred to as the "buffering model" (Cohen & Wills, 1985). Cohen and Wills posit that stress is related to health outcomes through change in health behaviors and immune and/or neuroendocrine system functioning (Cohen & Wills, 1985). Regarding this model with teacher support and depression, a recent meta-analysis found evidence for an association between low teacher support and adolescent depression, but did not support the stress-buffering hypothesis except among a subgroup of medically-ill youth (Rueger et al., 2016).

Another potential moderator of the association between support and depression outcomes among adolescents is sex, given the higher prevalence of depression among female adolescents (Merikangas et al., 2010). Meta-analytic findings indicate that sex is a significant moderator at the 85% confidence level for the cross-sectional association between the social support and depression in children and adolescents, such that the association is stronger for girls than boys (Rueger et al., 2016). However, the authors note that this finding may be due to large sample sizes. Furthermore, the same meta-analysis found no evidence for moderation by sex for longitudinal studies (Rueger et al., 2016). Regarding the stress-buffering hypothesis, given the sex differences that emerge in physiological response to stress during adolescence (Bale & Epperson, 2015), examination of the role of sex in the stress-buffering hypothesis is important.

Using longitudinal data to improve our understanding of the association between teacher support and depressive symptoms, and whether this association is particularly strong during times of more reported stressful events and if the association depends on sex, will aid design and implementation of prevention efforts for depression in the adolescent period. Due to the proximity of teachers to their adolescent students, teacher support may represent a practical and scalable prevention target against adolescent depression outcomes. Given this context, we examined both the concurrent and prospective associations between depressive symptoms and teacher support using data from the Developmental Pathways Project, a prospective cohort study of adolescents. Furthermore, we examined whether teacher support buffers against the impact of stressful life events on subsequent depressive symptoms. Lastly, we evaluated sex differences in these associations.

Study Aims

Primary Aims

1. Primary Aim 1: Assess the concurrent and longitudinal associations between teacher support and adolescent depressive symptoms, across multiple time points in adolescence.
    - Hypothesis: Across the developmental period from early to late adolescence, adolescents with higher teacher support will have significantly lower risk of depressive symptoms concurrently and approximately one year later.
2. Primary Aim 2: Assess whether teacher support buffers against the impact of stressful life events on current and subsequent adolescent depressive symptoms.
    - Hypothesis: The impact of stressful life events on current and subsequent depressive symptoms will be diminished among adolescents with high teacher

support as compared to the impact of stressful life events among adolescents with low teacher support.

Secondary Aims

1. Secondary Aim 1: Assess sex differences in the association between teacher support and current and subsequent depressive symptoms in adolescence.
    - Hypothesis: Sex will significantly modify the association between teacher support and current and subsequent depressive symptoms in adolescence, such that the association will be stronger among girls than boys.
2. Secondary Aim 2: Assess if sex is a moderator for the function of teacher support in buffering against the impact of stressful life events on current and subsequent adolescent depressive symptoms.
    - Hypothesis: Sex will significantly modify the associations among teacher support, stressful life events, and current and subsequent depressive symptoms in adolescence, such that teacher support will have a stronger buffering effect in the association between stressful life events and depressive symptoms among girls than among boys.

Methods

Study Subjects and Design

The study subjects were obtained from the source population of all 6th graders enrolled in four middle schools in the Seattle Public School District as a part of the Developmental Pathways Project. The sample was formed with a two-stage sampling process. First, between 2001 and 2004, 2,187 eligible students were given a universal classroom screening for

depression and conduct problems (Vander Stoep et al., 2011), containing the Mood and Feelings Questionnaire (MFQ; Angold & Costello, 1987) and Youth Self Report (YSR) Externalizing scale (Achenbach, 1991). Using a 0.5 standard deviation above the mean cutoff score on both scales, participants were categorized as scoring high on neither depression nor conduct problems; scoring high on depression, only; scoring high on conduct problems, only; or scoring high on both depression and conduct problems. From these categories, participants were randomly selected from the psychopathology risk groups in ratios of 2:1:1:1, with the largest group scoring high on neither depression nor conduct problems. Elevated psychopathology groups were oversampled, as the ratio in the general school population was estimated to be 6:1:1:1, with the largest group scoring high or neither depression nor conduct problems. Of the 807 individuals eligible for enrollment in the prospective cohort study, 521 (62.6%) participants were ultimately enrolled (Vander Stoep et al., 2011). The Developmental Pathways Project was approved by the University of Washington Human Subjects Division.

Data included in this analysis were collected at the following time points: baseline (early 6^{th} grade) assessment, 12-month (early 7^{th} grade) assessment, and the 24-month (early 8^{th} grade) assessment. Concurrent analyses included data for each measure from each time point. Prospective analyses included teacher support and stressful life events measures from the baseline and 12-month assessments and depressive symptom measures from the 12-month and 24-month assessments, as well as baseline depressive symptom count as an adjustment covariate (*Figure 1*). Of the available time points in the Developmental Pathways Project, these time points were chosen because they reflect time points at which measures of both teacher social support and depressive symptom count were simultaneously administered. The lowest percentage of subjects that were retained in the study waves included in this analysis was 87%.

Teacher Support

Participant-reported teacher support was measured with the Social Support Scale for Children and Adolescents (SSSCA (Harter, 1985)), also known as the People in My Life scale, collected at the baseline, 12-month, and 24-month assessments. The SSSCA evaluates teacher support with a series of six questions. Each of the six items is scored with a range of one to four, with increasing scores indicating increasing support. Subjects identify one of two statements that best describe them and then indicate whether the statement is "sort of true" for them or "really true" for them. The paired statements examine students' perceptions of support from their teachers. For example, "[s]ome kids *don't* have a teacher who *helps* them *to do* their very best" and "[o]ther kids *do* have a teacher who *helps* them to do their very best." Cronbach's alpha for the teacher support measure was 0.78, 0.83, and 0.85 for the observations in the 6^{th}, 7^{th}, and 8^{th} grade assessments, respectively. The SSSCA teacher subscale is shown to be strongly correlated with teacher support as measured by the Survey of Children's Social Support among elementary school children ($r=0.66$, $p < 0.01$) (Dubow & Ullman, 1989). For the purposes of analyses, teacher support scales were standardized with a mean of zero and a standard deviation of one. This standardization was intended to aid in interpretation of results.

Stressful Life Events

Stressful life events in the past 6 months were assessed by the Life Events Checklist (LECL), which is a self-report measure assessing life events and their impact (Johnson & McCutcheon, 1980), collected at the baseline, 12-month, and 24 month assessments. Previous research has demonstrated the validity of the LECL (Greene, Walker, Hickson, & Thompson, 1985), and its two-week test-retest reliability is estimated to be 0.69 to 0.72 in a study of 10 to 17 year olds (Brand & Johnson, 1982). Queried events span a wide range of emotionally significant

events, such as death of a loved one, illness, and moving to a new home. Subjects identify events that have occurred in their own lives, indicate whether the event was "good" or "bad", and rank the impact of the event on a four-point Likert scale from "no effect" to "lots of effect". This analysis considered total number of events indicated as "bad" by the participants at each relevant time point.

Depressive Symptoms

Past twelve-month adolescent depressive symptom count was obtained through administration of the Computerized version of the Diagnostic Interview Schedule for Children (C-DISC IV; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000) in participant homes. The C-DISC IV is a trained, lay interviewer-administered tool designed to measure occurrence of upwards of thirty psychiatric disorders based on the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 1994) and the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). The DISC IV contains interviews to be administered to both children ages nine to seventeen and caretakers of children ages six to seventeen (Shaffer et al., 2000). This analysis utilized the combined child and parent depressive symptom count from the baseline, 12-month, and 24-month assessments. At each relevant time point, combined depressive symptom count was determined by computing the average of the participant-reported and parent-reported depressive symptom counts for the Major Depressive Disorder module, by summing the two scores and dividing the combined score by two. The range of possible symptom counts is 0 to 22. This method of combining C-DISC depressive symptom counts is similar to the method utilized in two prior Developmental Pathways Project studies (Rhew et al., 2017; Wymbs et al., 2014).

Covariates

Covariates considered in this analysis included sex, race/ethnicity categorized non-Hispanic Asian, non-Hispanic Black, Hispanic, non-Hispanic Native American, and non-Hispanic White, age, parental nativity categorized as at least one parent born outside of Canada or the United States or both parents born in Canada or the United States, caregiver-reported family income, and baseline combined depressive symptom count in assessment of the prospective association, all of which were collected at the baseline early 6th grade time point. Baseline combined depressive symptom count was excluded from concurrent models. Additionally, models included an indicator for time point.

Main Analyses

Descriptive analyses of baseline characteristics included measures of central tendency, variance, and proportions where applicable. Appropriate weights were applied to the analyses, reflecting the sampling fractions utilized based on psychopathological strata used for sampling and post-stratification weights to account for differences in distribution of sex, race/ethnicity, and school program in the Developmental Pathways Project study sample compared to the population of youth who participated in the universal mental health screening. To model associations between teacher support and depressive symptoms, generalized estimating equations with a working independence correlation structure were used to account for the clustering of observations within individuals. Because the depressive symptom score measure was a non-negative integer showing a positively skewed distribution, a Poisson distribution was specified in analyses. The outcome for concurrent analyses was the average of the parent and child depressive symptom scores at the 6th, 7th, and 8th grade timepoints. The outcome for prospective one-year lagged analyses was the average of parent and child depressive symptom scores at the 7th and 8th grade timepoints.

Count ratio (CR) estimates for the association between exposure to teacher support and/or stressful life events as reported at time *t* and the outcome at concurrent time *t* for concurrent analyses and the outcome at subsequent time $t + 1$ for prospective analyses were computed for all aims. Effect modification was evaluated with Wald's tests for the interaction terms (e.g., teacher support-x-stressful life events) expressed as ratio of count ratio (RCR) estimates.

Missing data due to attrition and nonresponse were imputed through multiple imputation by chained equations, which should yield unbiased results assuming the data are missing at random (Azur, Stuart, Frangakis, & Leaf, 2011). The imputation model included sex, race/ethnicity, parental nativity and the following from each wave: reported teacher support, parent-reported depressive symptom count, participant-reported depressive symptom count, number of stressful life events indicated as "bad", an interaction term for teacher support and stressful life events, caregiver reported income, participant age, and an indicator of time. Twenty imputations were run with five iterations each. Average baseline characteristics of the imputed dataset were compared to the Developmental Pathways Project cohort to assess the comparability of the unimputed data to the imputed data. Data analyses were conducted with Stata/SE 14.2 and R Version 3.4.1.

Sensitivity Analyses

Because income, race, and ethnicity can confer stressful conditions, such as discrimination and insecurity, on families and adolescents and thus become an integral part of the stress and support constructs, a sensitivity analysis was performed for each of the primary and secondary aims, exploring the impact of removing caregiver-reported family income, race/ethnicity, and parental nativity covariates from each model.

An additional sensitivity analysis was conducted removing the baseline average parent and child depressive symptom count from the prospective models to understand the magnitude of the effect that adjustment for this variable has on the prospective association between teacher support and subsequent depressive symptom count.

Results

Participant Characteristics

The final sample for analysis consisted of 521 individuals. At baseline, the average age of the participants was approximately 12 years old (*Table 1*). The sample had an approximately equal gender distribution. There was racial and ethnic heterogeneity, as 45% of the sample was non-Hispanic White, 27% non-Hispanic Black, 17% non-Hispanic Asian, 10% Hispanic of any race, and 1% Native American. Approximately one-third of children had at least one parent born outside of the United States or Canada. The majority (64.3%) of the sample had a caregiver-reported income of $35,000 or more per year. Average baseline combined depressive symptom count was 6.1 symptoms.

Concurrent Analyses

After adjusting for baseline caregiver-reported income, baseline age, sex, race/ethnicity, and parental nativity, we found statistically significant evidence of an association between teacher support and depressive symptoms (CR = 0.858; 95% CI: 0.822, 0.895; $p < 0.001$), such that higher teacher support was associated with lower depressive symptom count (*Table 2*). Regarding the stress-buffering model, we assessed the association between teacher support and depressive symptoms while modeling an interaction between count of stressful life events considered “bad” and standardized teacher support. There was a statistically significant

interaction (RCR = 1.022; 95% CI: 1.010, 1.033; p < 0.001), such that the association between higher teacher support and lower current depressive symptom counts was diminished among adolescents with higher numbers of reported stressful life events (*Figure 3*).

Considering sex as a moderator for the association between teacher support and depressive symptoms, we found no evidence for interaction by sex (RCR = 0.938; 95% CI: 0.861, 1.022; p = 0.142) (*Table 3*). Similarly, in the stress-buffering model, we found no evidence for a three-way interaction between teacher support, stressful life events, and sex (RCR = 1.018; 95% CI: 0.995, 1.041; p = 0.135).

Prospective Analyses

After adjusting for covariates including baseline depressive symptoms, there was statistically significant evidence that teacher support had an impact on combined depressive symptom count in the following year (CR = 0.956; 95% CI: 0.927, 0.985; p = 0.004), such that higher teacher support is associated with lower subsequent combined depressive symptom count (*Table 4)*. Referencing the stress-buffering model, we modeled this association with an additional consideration of interaction between count of stressful life events and standardized teacher support predicting subsequent combined depressive symptom count. There was evidence of a statistically significant interaction (RCR = 1.009; 95% CI: 1.001, 1.018; p = 0.029), such that the negative association between teacher support and subsequent depressive symptom counts was weaker for adolescents with higher numbers of reported stressful life events (*Figure 4*).

We also considered the potential for interaction by sex. Controlling for covariates, there was no evidence of a statistically significant interaction between teacher support and sex (RCR = 0.970; 95% CI: 0.914, 1.029; p = 0.314) (*Table 5*). Again, considering the stress-buffering

model, there was no statistically significant evidence of an interaction between teacher support, sex, and stressful life events (RCR = 1.015; 95% CI: 0.999, 1.032; p = 0.067).

Each of these prospective models included baseline combined depressive symptom count as a covariate. Of note, baseline depressive symptoms was a statistically significant predictor of depressive symptoms in each of the prospective models, with all p values < 0.001, indicating that past depressive symptom count was strongly associated with future depressive symptom count.

Sensitivity Analyses

To assess the impact that stressful life circumstances can have on the association between support and depressive symptoms, we performed a sensitivity analysis of both the concurrent and prospective analyses, excluding the baseline caregiver-reported income, race/ethnicity, and parental nativity covariates. The findings of the both the concurrent sensitivity analysis (*Table* 6) and the prospective sensitivity analysis (*Table 7*) were qualitatively similar to those of the main analyses with similar estimates throughout.

Our second sensitivity analysis removed baseline depressive symptoms as a covariate from the models of the prospective association between teacher support and depressive symptom count to learn the extent of impact that adjustment for baseline depressive symptoms was having on the longitudinal prediction of later depressive symptoms by earlier teacher support. Adjusting for baseline caregiver-reported income, baseline age, sex, race/ethnicity, and parental nativity, but removing the effect of baseline depressive symptoms, yielded a somewhat stronger protective effect of teacher support on subsequent depressive symptoms (CR = 0.852; 95% CI: 0.814, 0.892; p < 0.001) (*Table 8*). There was statistically significant evidence for an interaction between teacher support and stressful life events (RCR = 1.019; 95% CI: 1.007, 1.032; p = 0.002), indicating that the negative association between teacher support and subsequent

depressive symptom counts at approximately one year later was weaker for adolescents who reported higher numbers of stressful life events. Additionally, there was evidence for moderation by sex (RCR = 0.911; 95% CI: 0.833, 0.996; p = 0.040), such that the association between increased teacher support and diminished depressive symptoms is stronger for females, and a three-way interaction between teacher support, stressful life events, and sex (RCR = 1.025; 95% CI: 1.000, 1.050; p = 0.050), such that the interaction between teacher support and stressful life events was stronger for females than for males.

Discussion

The results of our study indicate that there is evidence for an association between teacher support and depressive symptoms in middle school-aged youth. In our statistical models, we found that a one standard deviation unit increase in teacher support is associated with approximately a 14% lower current depressive symptom count and a 4% lower subsequent depressive symptom count at approximately one year later. In addition, we found evidence of moderation of this association by stressful life events in the concurrent and prospective associations, such that, contrary to our hypotheses, the negative association between teacher support and depressive symptom counts was weaker among those with higher numbers of stressful life events. There was no evidence that the concurrent or prospective associations between teacher support and depressive symptoms depend on sex, nor was there evidence to indicate a three-way interaction between teacher support, stressful life events, and sex.

Our concurrent and prospective results in the Developmental Pathways Project community-based sample are similar to existing literature on the association between teacher support and depression in children and adolescents (Gariépy et al., 2016; Rueger et al., 2016).

Furthermore, our finding of stressful life events as a moderator of the concurrent association between teacher support and depressive symptoms is similar to the existing literature, which found no evidence for the stress-buffering hypothesis and indicated that support from family and close friends may not be as protective when facing higher stress (Rueger et al., 2016). Our results suggest that the protective effect of teacher support on depressive symptoms is weaker for adolescents with higher levels of stress. As shown in Figures 3 and 4, higher levels of teacher support are protective against depressive symptoms in the lower range of stressful life events (from zero to six events), while the incremental effect of having teacher support diminishes to the null at higher levels of stress exposure (seven to nine events) for both the concurrent and prospective associations, suggesting that stressful life events may be a moderator of this association. This finding is consistent with implementation of the multi-tiered Positive Behavior Interventions and Supports (PBIS) model in schools nationwide, which recognizes that a proportion of students in every school needs emotional health support beyond what the classroom teacher alone can provide (Sprague, Biglan, Rusby, Gau, & Vincent, 2017; Stephan, Sugai, Lever, & Connors, 2015). Our findings suggest that students facing high stress may especially benefit from Positive Behavior Interventions and Supports model programs in schools.

We found no significant evidence of sex as a moderator for the association between teacher support and depressive symptoms in main analyses for both concurrent and prospective associations. While this differs from 2016 meta-analytic results indicating that there is a cross-sectional interaction between sex and support for depression outcomes at the 85% confidence level (Rueger et al., 2016), the authors noted that the difference in magnitude was small and may be due to large sample sizes. In our sensitivity analyses removing baseline depressive symptoms as a covariate for the prospective association, we found evidence for a three-way interaction

between teacher support, stressful life events, and sex, such that teacher support and stressful life events have a stronger impact on subsequent depressive symptoms for females than for males.

There are a number of factors related to measurement of teacher support that may have influenced the findings of our analyses. Namely, with regard to timing of measurement, in prospective analyses our study considered depressive symptoms that were assessed over the subsequent 12 months after the teacher support measurement was assessed. For concurrent analyses, our measure of depressive symptoms was for symptoms occurring in the prior twelve months from the time of measurement of teacher support. Therefore, there is potential for reverse causality, as depressive symptoms reported may have occurred before current perception of teacher support. Additionally, with regard to the distribution of teacher support scores, they were negatively skewed, with most students rating teacher support as high. Thus, there was little variation in perceived support across students. In the future, more specific measurements of types and variations of perceived and rendered teacher support that yield greater differentiation in range and facets of support, particularly within settings where teacher support may be relatively high, could contribute to a more nuanced understanding of this association.

Examination of this association concurrently and prospectively indicates that teacher support may influence current depressive symptoms and subsequent depressive symptoms, suggesting that the protective effect of teacher support, particularly for students with low levels of stress, may extend beyond the time at which it is conferred. Our study also sheds light on a methodological issue that can inform future research. Prospective models in our main analyses included baseline depressive symptoms as a covariate, which, as evidenced in our sensitivity analyses, strongly influenced the associations of interest, likely because of the strong association between baseline depressive symptoms and future depressive symptoms. Removing baseline

depressive symptoms as a covariate from our prospective models, we found evidence for moderation by sex and a three-way interaction between teacher support, stressful life events, and sex, which differs from our analyses including baseline depressive symptoms as a covariate. These findings suggest that future analyses, reviews, and meta-analyses should carefully delineate whether adjustment is made for baseline psychological characteristics.

Strengths of this study include the use of a racially and economically diverse community-based sample of adolescents, well-validated measures of depression symptomology from multiple raters, and the ability to estimate both cross-sectional and prospective associations. The study also has a number of limitations, particularly pertaining to the ascertainment of the exposure. The measures of social support utilized in this analysis are perceived social support, rather than social support actually provided. In middle schools children have multiple teachers each school day, and there may be substantial variation in supportive actions of teachers. Additionally, other sources of support, such as that of parents and family, may have stronger protective effects for depressive symptoms in this age group. Because the relevant measures of social support are captured through self-report of participants, there is potential for non-differential social desirability bias. Furthermore, it is possible that potential misclassification of exposure status may be associated with adolescents' depressive symptom status. Other limitations include loss to follow-up in the cohort. Due to the availability of study measures, the scope of the study was limited to middle school-aged adolescents rather than a broader range of adolescents. Lastly, because the sample consists of an urban population of middle school-aged youth in the Pacific Northwest, our findings may not be generalizable to adolescents living in rural areas or other areas of the United States or to older adolescents.

Conclusions

We found evidence of concurrent and prospective associations between teacher support and depressive symptoms in a representative sample of middle school-aged adolescents. Additionally, stressful life events, but not sex, was a moderator of both the concurrent and prospective association. Considering the results of our study, further research is needed to delineate the specific actions with positive mental health impact that constitute teacher support, differences in impact of teacher support in current depressive symptoms and the trajectory of depressive symptoms over time, and how long the impact of teacher support lasts. Our findings suggest that future meta-analyses should make explicit whether studies are concurrent or longitudinal in design. Furthermore, if included studies are longitudinal in design, meta-analyses should indicate whether baseline depressive symptoms were or were not taken into account. Our study findings highlight the important role that teachers play in promoting the mental health of their students. Additionally, our findings lend support for current efforts to scale-up school-wide Positive Behavior Intervention and Support programs (Sprague et al., 2017; Stephan et al., 2015) which may be of particular benefit to students who are facing high stress.

Tables and Figures

Figure 1. Study Measures Timeline for Prospective Association Analyses

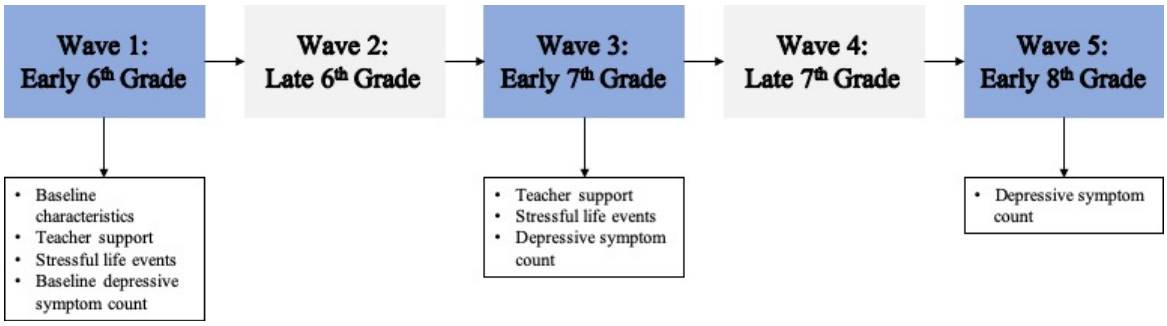


Table 1. Baseline Characteristics of the Unweighted, Unimputed Cohort and the Average of the Imputed Cohort

Characteristic*	**Unimputed Cohort (n = 521)** *mean(SD) / n(%)*	**Missingness in Unimputed Cohort** *n(%)*	**Average Imputed Cohort (n = 521)** *mean(SD) / %*
Age	12.0 (0.4)	0 (0)	12.0 (0.4)
Race/Ethnicity			
Non-Hispanic Asian	88 (16.9)	0 (0)	16.9
Non-Hispanic Black	143 (27.4)		27.5
Hispanic	53 (10.2)		10.2
Non-Hispanic Native American	5 (1.0)		1.0
Non-Hispanic White	232 (44.5)		44.5
Male	272 (52.2)	0 (0)	52.2
At Least One Parent Born Outside of US or Canada	162 (31.1)	7 (1.3)	31.9
Caregiver-Reported Income		12 (2.3)	
LESS THAN $5,000	25 (4.8)		5.0
$5,000 - $9,999	22 (4.2)		4.5
$10,000 - $14,999	35 (6.7)		7.0
$15,000 - $19,999	20 (3.8)		4.0
$20,000 - $24,999	35 (6.7)		7.1
$25,000 - $34,999	37 (7.1)		7.2
$35,000 - $49,999	82 (15.7)		16.1
$50,000 - $74,999	99 (19.0)		19.3
$75,000 - $99,999	61 (11.7)		11.9
$100,000 AND OVER	93 (17.9)		18.1
Combined Depressive Symptom Count	6.1 (3.4)	13 (2.5)	6.0 (3.4)

*Note: Percentages may not sum to one due to missingness in the unimputed cohort or rounding.

Figure 2: Density Plots of Multiply Imputed Data

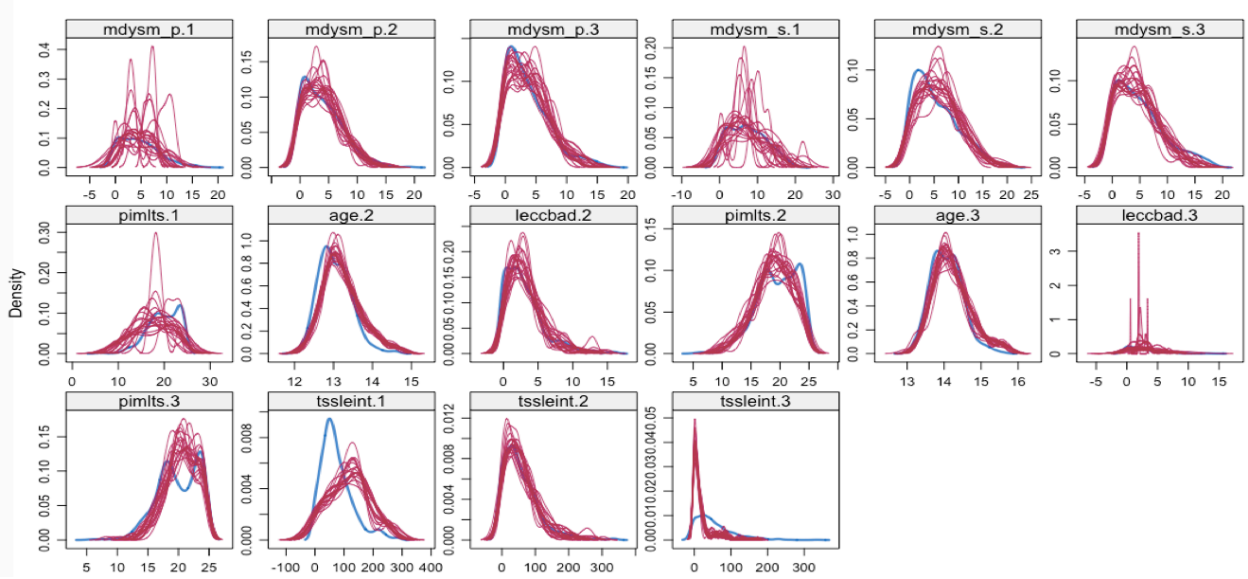


Table 2: GEE Analysis with Population Weights of the Concurrent Association Between Teacher Support, Stressful Life Events, and Combined Depressive Symptom Count

Coefficient	Primary Aim 1 Count Ratio Estimate		Primary Aim 2 Count Ratio Estimate	
	Estimate (95% CI)	P Value	Estimate (95% CI)	P Value
Teacher Support	0.858 (0.822, 0.895)	< 0.001	0.826 (0.776, 0.880)	< 0.001
Stressful Life Events	---	---	1.085 (1.070, 1.101)	< 0.001
Baseline Caregiver Reported Income	0.984 (0.961, 1.008)	0.188	0.996 (0.971, 1.021)	0.739
Baseline Age	1.018 (0.894, 1.159)	0.785	1.000 (0.892, 1.122)	0.995
Sex	1.019 (0.913, 1.137)	0.741	0.984 (0.890, 1.087)	0.749
Race/Ethnicity	0.958 (0.906, 1.013)	0.131	0.980 (0.931, 1.032)	0.440
Child of Immigrants	0.891 (0.790, 1.005)	0.060	0.918 (0.821, 1.026)	0.131
Time	0.860 (0.832, 0.888)	< 0.001	0.901 (0.871, 0.932)	< 0.001
Teacher Support *Stressful Life Events	---	---	1.022 (1.010, 1.033)	< 0.001

Figure 3: Plot of Interaction Between Teacher Support and Stressful Life Events for Concurrent Combined Depressive Symptom Count

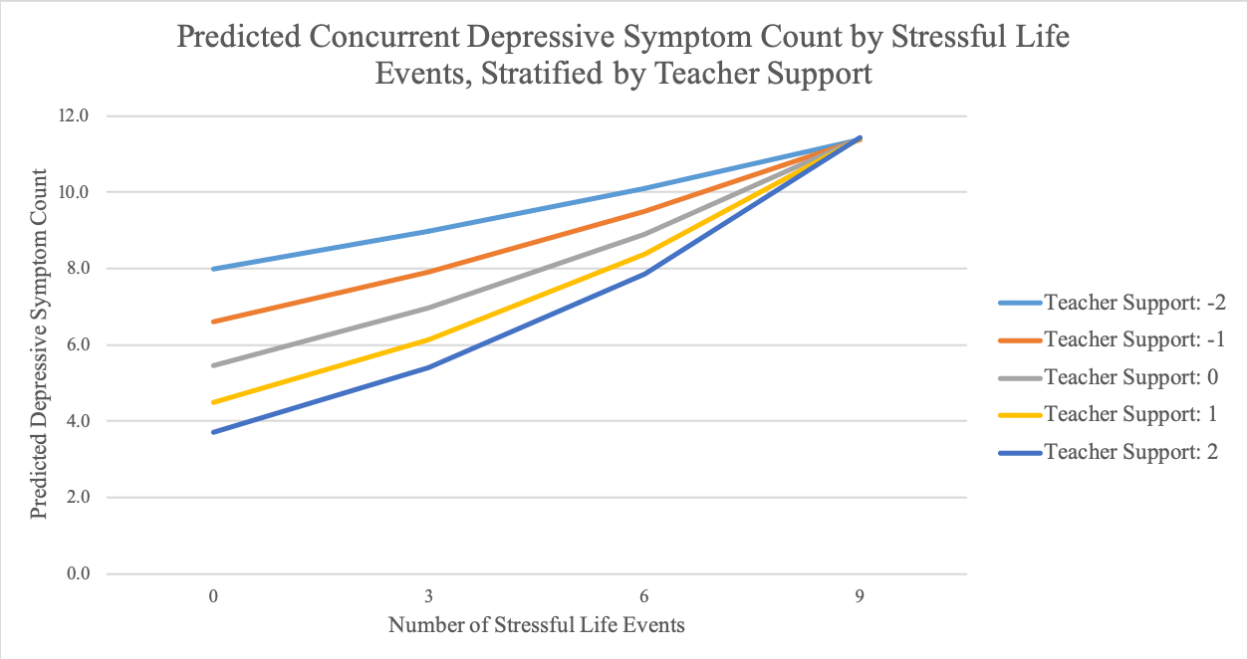


Table 3: GEE Analysis with Population Weights of the Concurrent Association Between Teacher Support, Stressful Life Events, and Combined Depressive Symptom Count Considering Interaction by Sex

Coefficient	Secondary Aim 1 Count Ratio Estimate		Secondary Aim 2 Count Ratio Estimate	
	Estimate (95% CI)	P Value	Estimate (95% CI)	P value
Teacher Support	0.943 (0.822, 1.081)	0.399	0.980 (0.803, 1.196)	0.845
Stressful Life Events	---	---	1.073 (1.028, 1.120)	0.001
Baseline Caregiver Reported Income	0.984 (0.961, 1.008)	0.181	0.996 (0.971, 1.021)	0.728
Baseline Age	1.015 (0.892, 1.155)	0.820	0.999 (0.890, 1.120)	0.980
Sex	1.014 (0.908, 1.133)	0.803	0.967 (0.832, 1.125)	0.668
Race/Ethnicity	0.959 (0.907, 1.014)	0.139	0.980 (0.931, 1.031)	0.433
Child of Immigrants	0.893 (0.792 1.007)	0.064	0.918 (0.821, 1.025)	0.129
Time	0.860 (0.833, 0.889)	< 0.001	0.900 (0.870, 0.932)	< 0.001
Teacher Support * Sex	0.938 (0.861, 1.022)	0.142	0.888 (0.780, 1.011)	0.072
Teacher Support * Stressful Life Events	---	---	0.996 (0.959, 1.033)	0.813
Stressful Life Events * Sex	---	---	1.006 (0.981, 1.032)	0.620
Teacher Support * Stressful Life Events * Sex	---	---	1.018 (0.995, 1.041)	0.135

Figure 4: Plot of Interaction Between Teacher Support and Stressful Life Events for Prospective Combined Depressive Symptom Count

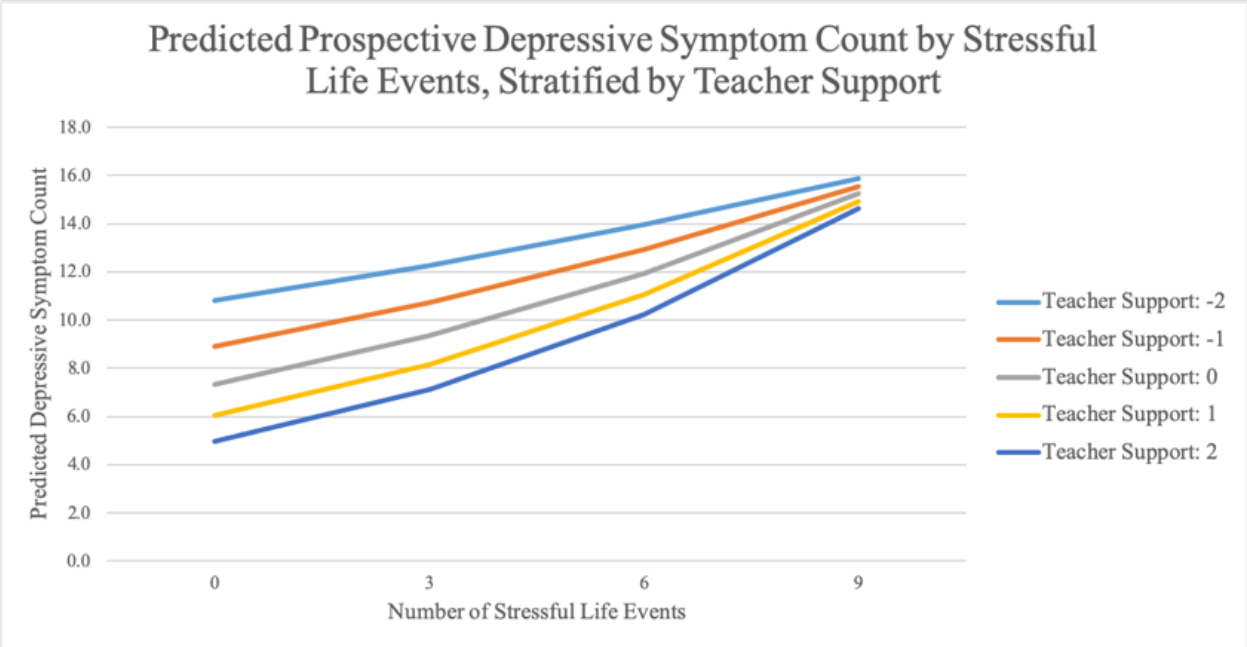


Table 4: GEE Analysis with Population Weights of the Prospective Association Between Teacher Support, Stressful Life Events, and Combined Depressive Symptom Count

Coefficient	Primary Aim 1 Count Ratio Estimate		Primary Aim 2 Count Ratio Estimate	
	Estimate (95% CI)	P Value	Estimate (95% CI)	P Value
Teacher Support	0.956 (0.927, 0.985)	0.004	0.923 (0.879, 0.970)	0.002
Stressful Life Events	---	---	1.017 (1.007, 1.028)	0.002
Baseline Caregiver Reported Income	1.002 (0.990, 1.013)	0.795	1.003 (0.992, 1.015)	0.588
Baseline Age	1.006 (0.942, 1.074)	0.862	0.998 (0.934, 1.066)	0.951
Sex	1.016 (0.960, 1.075)	0.581	1.010 (0.956, 1.067)	0.731
Race/Ethnicity	0.997 (0.968, 1.026)	0.822	1.000 (0.971, 1.030)	0.995
Child of Immigrants	0.937 (0.881, 0.996)	0.038	0.940 (0.885, 0.999)	0.046
Baseline Depressive Symptoms	1.159 (1.147, 1.171)	< 0.001	1.152 (1.140, 1.165)	< 0.001
Time	0.787 (0.743, 0.833)	< 0.001	0.795 (0.751, 0.842)	< 0.001
Teacher Support *Stressful Life Events	---	---	1.009 (1.001, 1.018)	0.029

Table 5: GEE Analysis with Population Weights of the Prospective Association Between Teacher Support, Stressful Life Events, and Combined Depressive Symptom Count Considering Interaction by Sex

Coefficient	Secondary Aim 1 Count Ratio Estimate		Secondary Aim 2 Count Ratio Estimate	
	Estimate (95% CI)	P Value	Estimate (95% CI)	P value
Teacher Support	0.999 (0.907, 1.100)	0.986	1.061 (0.916, 1.229)	0.428
Stressful Life Events	---	---	1.013 (0.984, 1.042)	0.379
Baseline Caregiver Reported Income	1.002 (0.990, 1.013)	0.795	1.003 (0.992, 1.015)	0.562
Baseline Age	1.004 (0.940, 1.072)	0.905	0.999 (0.935, 1.067)	0.977
Sex	1.014 (0.958, 1.073)	0.629	1.006 (0.916, 1.104)	0.907
Race/Ethnicity	0.997 (0.968, 1.026)	0.813	0.999 (0.970, 1.028)	0.938
Child of Immigrants	0.937 (0.881, 0.997	0.039	0.940 (0.885, 0.999)	0.045
Baseline Depressive Symptoms	1.159 (1.147, 1.171)	< 0.001	1.152 (1.139, 1.164)	< 0.001
Time	0.788 (0.745, 0.834)	< 0.001	0.796 (0.752, 0.842)	< 0.001
Teacher Support * Sex	0.970 (0.914, 1.029)	0.314	0.907 (0.826, 0.997)	0.043
Teacher Support * Stressful Life Events	---	---	0.987 (0.962, 1.013)	0.316
Stressful Life Events * Sex	---	---	1.003 (0.984, 1.022)	0.788
Teacher Support * Stressful Life Events * Sex	---	---	1.015 (0.999, 1.032)	0.067

Table 6: Sensitivity GEE Analysis with Population Weights of the Concurrent Association Between Teacher Support, Stressful Life Events, and Combined Depressive Symptom Count, Removing Socioeconomic Covariates

Coefficient	Primary Aim 1 Count Ratio Estimate (95% CI) P value	Primary Aim 2 Count Ratio Estimate (95% CI) P value	Secondary Aim 1 Count Ratio Estimate (95% CI) P value	Secondary Aim 2 Count Ratio Estimate (95% CI) P value
Teacher Support	0.855 (0.819, 0.894) < 0.001	0.827 (0.777, 0.881) < 0.001	0.946 (0.819, 1.091) 0.443	0.976 (0.796, 1.196) 0.815
Stressful Life Events	---	1.088 (1.074, 1.103) < 0.001	---	1.076 (1.032, 1.122) 0.001
Baseline Age	1.061 (0.935, 1.204) 0.356	1.017 (0.910, 1.137) 0.761	1.058 (0.933, 1.199) 0.383	1.016 (0.909, 1.135) 0.783
Sex	1.022 (0.915, 1.142) 0.696	0.983 (0.890, 1.087) 0.741	1.018 (0.910, 1.138) 0.757	0.966 (0.830, 1.123) 0.651
Time	0.860 (0.832, 0.888) < 0.001	0.903 (0.873, 0.934) < 0.001	0.861 (0.833, 0.889) < 0.001	0.902 (0.871, 0.933) < 0.001
Teacher Support * Stressful Life Events	---	1.022 (1.010, 1.033) < 0.001	---	0.998 (0.961, 1.037) 0.927
Teacher Support * Sex	---	---	0.934 (0.855, 1.020) 0.128	0.891 (0.782, 1.016) 0.084
Stressful Life Events * Sex	---	---	---	1.006 (0.981, 1.032) 0.618
Teacher Support * Stressful Life Events * Sex	---	---	---	1.016 (0.992, 1.040) 0.184

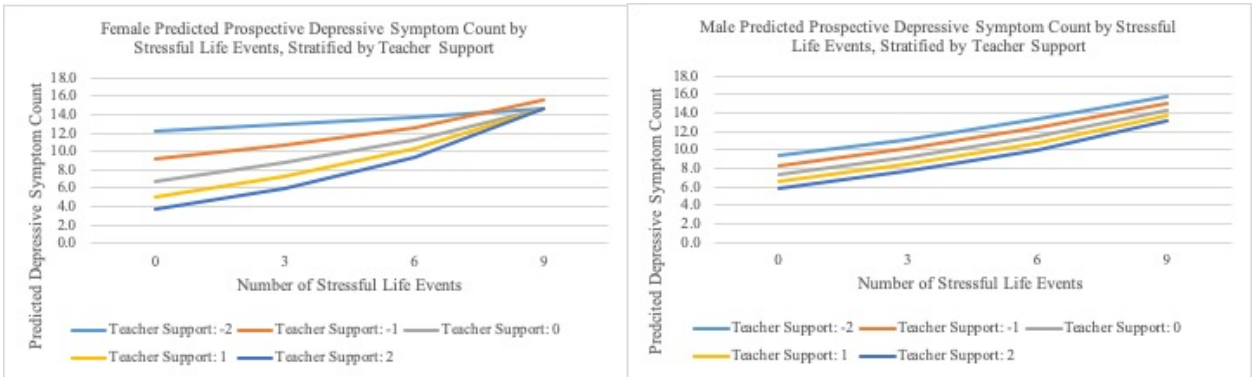
Table 7: Sensitivity GEE Analysis with Population Weights of the Prospective Association Between Teacher Support, Stressful Life Events, and Combined Depressive Symptom Count, Removing Socioeconomic Covariates

Coefficient	Primary Aim 1 Count Ratio Estimate (95% CI) P value	Primary Aim 2 Count Ratio Estimate (95% CI) P value	Secondary Aim 1 Count Ratio Estimate (95% CI) P value	Secondary Aim 2 Count Ratio Estimate (95% CI) P value
Teacher Support	0.958 (0.928, 0.988) 0.006	0.925 0.880, 0.973) 0.002	1.002 (0.909, 1.104) 0.965	1.062 (0.916, 1.231) 0.425
Stressful Life Events	---	1.017 (1.007, 1.028) 0.001	---	1.011 (0.982, 1.041) 0.441
Baseline Age	1.010 (0.945, 1.079) 0.770	0.999 (0.934, 1.068) 0.974	1.008 (0.944, 1.077) 0.811	1.000 (0.936, 1.069) 0.992
Sex	1.014 (0.957, 1.074) 0.629	1.008 (0.953, 1.066) 0.786	1.012 (0.955, 1.073) 0.678	1.000 (0.910, 1.099) 1.000
Baseline Depressive Symptoms	1.160 (1.147, 1.172) < 0.001	1.152 (1.140, 1.165) < 0.001	1.159 (1.147, 1.172) < 0.001	1.152 (1.139, 1.165) < 0.001
Time	0.787 (0.743, 0.833) < 0.001	0.795 (0.751, 0.842) < 0.001	0.788 (0.745, 0.834) < 0.001	0.796 (0.752, 0.842) < 0.001
Teacher Support * Stressful Life Events	---	1.009 (1.001, 1.018) 0.030	---	0.988 (0.963, 1.013) 0.338
Teacher Support * Sex	---	---	0.969 (0.912, 1.030) 0.312	0.908 (0.826, 0.999) 0.047
Stressful Life Events * Sex	---	---	---	1.003 (0.984, 1.023) 0.725
Teacher Support * Stressful Life Events * Sex	---	---	---	1.015 (0.998, 1.032) 0.076

Table 8: Sensitivity GEE Analysis with Population Weights of the Prospective Association Between Teacher Support, Stressful Life Events, and Combined Depressive Symptom Count, Removing Baseline Depressive Symptoms Covariate

Coefficient	Primary Aim 1 Count Ratio Estimate (95% CI) P value	Primary Aim 2 Count Ratio Estimate (95% CI) P value	Secondary Aim 1 Count Ratio Estimate (95% CI) P value	Secondary Aim 2 Count Ratio Estimate (95% CI) P value
Teacher Support	0.852 (0.814, 0.892) < 0.001	0.824 (0.768, 0.884) < 0.001	0.978 (0.845, 1.132) 0.764	1.054 (0.845, 1.315) 0.642
Stressful Life Events	---	1.085 (1.068, 1.102) < 0.001	---	1.064 (1.016, 1.115) 0.008
Baseline Caregiver Reported Income	0.984 (0.961, 1.008) 0.191	0.999 (0.973, 1.026) 0.958	0.984 (0.961, 1.007) 0.176	0.999 (0.973, 1.025) 0.921
Baseline Age	1.027 (0.903, 1.170) 0.682	0.994 (0.885, 1.116) 0.915	1.020 (0.897, 1.161) 0.760	0.991 (0.882, 1.114) 0.885
Sex	0.973 (0.872, 1.086) 0.627	0.950 (0.859, 1.051) 0.324	0.967 (0.866, 1.080) 0.556	0.918 (0.781, 1.079) 0.297
Race/Ethnicity	0.953 (0.902, 1.007) 0.090	0.975 (0.925, 1.026) 0.330	0.953 (0.902, 1.007) 0.089	0.974 (0.925, 1.026) 0.321
Child of Immigrants	0.864 (0.765, 0.977) 0.019	0.890 (0.795, 0.996) 0.043	0.868 (0.769, 0.981) 0.023	0.892 (0.797, 0.998) 0.046
Time	0.774 (0.730, 0.821) < 0.001	0.818 (0.769, 0.870) < 0.001	0.777 (0.733, 0.824) < 0.001	0.818 (0.769, 0.870) < 0.001
Teacher Support * Stressful Life Events	---	1.019 (1.007, 1.032) 0.002	---	0.984 (0.947, 1.023) 0.411
Teacher Support * Sex	---	---	0.911 (0.833, 0.996) 0.040	0.842 (0.732, 0.969) 0.017
Stressful Life Events * Sex	---	---	---	1.011 (0.984, 1.040) 0.422
Teacher Support * Stressful Life Events * Sex	---	---	---	1.025 (1.000, 1.050) 0.050

Figure 5: Plot of Interaction Between Teacher Support and Stressful Life Events for Prospective Combined Depressive Symptom Count Stratified by Sex



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