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Does Music Participation Impact Mental Health and Academic Performance in High School Students?

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ABSTRACT

In an increasingly competitive student culture, high school students often feel compelled to drop music programs—such as band, orchestra, and choir—assuming that it will help them focus on coursework and maintain both academic competitiveness and mental well-being. This study examines whether such assumptions are valid by evaluating the relationship between music participation, academic performance, and mental well-being. A survey of 646 students at Arcadia High School in Southern California was conducted between May 10 and June 3, 2024. Students completed three validated mental health instruments: Perceived Stress Questionnaire (PSQ), General Anxiety Disorder-7 (GAD-7), and Patient Health Questionnaire-9 (PHQ-9), assessing stress, anxiety, and depression levels. Data were also collected on each student's Grade-Point-Average (GPA), number of Advanced Placement (AP)/honors courses, and demographics. Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) were used to evaluate associations between music participation (current, past, none) and mental health or academic metrics. Of the students who completed the survey, 28% were currently involved in music programs, 17% participated in the past, and 55% never participated. Students currently involved in music programs reported significantly lower depression scores ($p=0.047$) and had nominally lower stress and anxiety scores although statistically insignificant. Academically, current music students had higher GPAs ($p<0.01$) and took more APs/honors courses than peers not involved in music. No evidence from our study suggested that involvement in music programs hinders academic or emotional success; rather, it is associated with improved academic outcomes and reduced depression. The belief that students must sacrifice music to excel is not supported by this study's findings.

1. Introduction

The relationships between music participation, academic performance, and mental health in students have long been a focus in educational research. In terms of the interplay between

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music participation and academic performance, while some studies suggest a link, findings remain largely inconsistent and inconclusive (Elpus, 2013; Foster & Jenkins, 2017; Guhn et al., 2020; Gustavson et al., 2021; Matei & Ginsborg, 2024). For instance, a large-scale analysis of over 100,000 students in British Columbia revealed that consistent participation in music was associated with significantly higher levels of academic achievement, equivalent to approximately one additional year of academic learning in favor of music students (Guhn et al., 2020). However, an Educational Longitudinal Study of 2002 based in the United States that examined over 15,000 students revealed that the academic advantage accredited to music participation became statistically insignificant once socioeconomic and other background factors were controlled (Elpus, 2013). As a result, the academic benefits of music education continue to be widely debated (Elpus, 2013; Foster & Jenkins, 2017; Guhn et al., 2020; Gustavson et al., 2021; Matei & Ginsborg, 2024). Similar ambiguity exists regarding the relationship between music participation and mental health. Some studies report that music participation can alleviate symptoms of anxiety and depression, ultimately improving students' overall well-being and quality of life (Cirelli et al., 2018; Lense et al., 2020; Theorell et al., 2014; Weinberg & Joseph, 2017; Zentner et al., 2010). Conversely, other studies highlight the mental health challenges faced by music students. Particularly for those in post-secondary education, heavy involvement in the extracurricular may come with emotional and academic pressures (Matei & Ginsborg, 2024). Thus, certain scholars argue that these results are likely correlational rather than causal (Foster & Jenkins, 2017; Gustavson et al., 2021; Sala & Gobet, 2017), cautioning against drawing over simplistic conclusions.

Considering these mixed findings, research that examines both the academic and psychological effects of music participation across different educational settings holds immense value. A research study involving 326 Chinese university students made strides in this direction by simultaneously examining academic performance and mental well-being. The results showed a positive correlation between music participation, improved psychological well-being, and higher academic achievement (Jiang, 2024). However, despite these contributions, most existing research either focuses on post-secondary populations (Jiang, 2024) or relies heavily on large-scale datasets that overlook concurrent mental health outcomes (Elpus, 2013; Guhn et al., 2020). Very few studies have addressed the holistic effects of music participation on high school students—a group undergoing significant cognitive and social development (Foster & Jenkins, 2017). One study conducted in Winnipeg, Manitoba, found a positive correlation between academic and mental health effects and music participation among 12th grade students (Burchill, 2021). However, by limiting its scope to seniors, the study failed to capture the potentially distinct experiences of students in other grade levels. Moreover, developmental differences across grade levels may influence how music impacts students, as academic pressures and levels of maturity vary across the years. These gaps underscore the need for research that examines the effects of music participation across the full spectrum of high school education.

In today's world, the high school environment grows increasingly more competitive. Both parents and students often prioritize high academic achievement through Advanced Placement (AP) and accelerated courses taken in large volumes. As a result, concerns about the place and value of music programs in students' schedules have become increasingly more common. Anecdotally, students express pressure, often coming from parents or peers, to drop music programs—particularly band—due to concerns about time commitment and its perceived interference with academic performance. Preconceived notions like "band is too stressful" or "this takes too much time" circulate among incoming freshmen and current students amidst course selection.

This prevailing belief that academic success must come at the expense of creative pursuits has contributed to a noticeable cultural shift within high schools. From 2014 to 2019, the Arcadia Unified School District (AUSD) in Southern California saw a drop of 251 students enrolled in music programs (CreateCA, 2024). At Arcadia High School (AHS), a large high- achieving public high school with a well-established music program in AUSD, the band program saw a decrease of roughly 15 members per year from 2010 to 2020. Once having a membership of approximately 400 members, the band now only has around 250. This drop of roughly 40% is dramatically higher than the change in overall student enrollment, a reflection of shifting priorities and the growing tension between academic rigor, mental health, and music participation.

This study seeks to determine the extent to which music participation is associated with academic achievement and mental health indicators among high school students across all grade levels. Using survey data from over 600 students at AHS, we examined students' participation in music programs, academic performance in relation with the number of APs/Honors courses taken and self-reported Grade Point Averages (GPA), and mental well-being assessed with instruments for stress, anxiety, and depression (Dhira et al., 2021; Kroenke et al., 2001; Levenstein, Prantera, Varvo, L., et al., 1993; Levenstein, Prantera, Varvo, Scribano, et al., 1993; Spitzer et al., 2006; Spitzer et al., 1999; Spitzer et al., n.d.). Participants in the survey were categorized by their music involvement status (currently involved, used to be involved, and never involved) and other demographics. By analyzing this comprehensive dataset, this study aims to provide new insight into whether music participation contributes to or alleviates academic and emotional challenges in high school students, and whether these effects vary with factors including course rigor, sex, race/ethnicity and grade level.

2. Methods

Our study employed a cross-sectional online survey to examine the relationship between music program participation, academic performance, and mental health among high school students. The research was conducted at AHS, a large public high school in the AUSD in Southern California. Data were collected from a total of 646 students.

2.1. The Survey and Data Collection

The survey was administered via Google Forms between May 10 and June 3, 2024. Participation in this survey was voluntary, and responses were collected anonymously.

To ensure a diverse sample across grade levels and different academic rigor, we collaborated with the English Department at Arcadia High School and invited all English teachers to post the survey in their Google Classrooms and offer class time for students to complete it. Outreach was also conducted to teachers across a range of course difficulties—such as AP Biology, English 10 Honors, and Spanish 1—to increase representation from students with varying academic schedules. Teachers of music courses—band, orchestra, and choir—were also contacted and asked to allocate class time for their students to participate. This helped ensure that students involved in music programs were adequately represented in the sample.

The survey began with a series of general questions asking about participants' sex, race, grade level, GPA during the first and second semester of the 2023-2024 academic year, number of APs/honors courses taken, and participation status in music programs. Additionally, we gave an open-ended question to past music participants regarding their reason for quitting. Following this, students completed specific questions taken directly from three validated self-report instruments: the Perceived Stress Questionnaire (PSQ) to assess stress levels, the Generalized

Anxiety Disorder-7 (GAD-7) to assess anxiety, and the Patient Health Questionnaire-9 (PHQ-9) to assess depression (Kroenke et al., 2001; Levenstein, Prantera, Varvo, Scribano, et al., 1993; Spitzer et al., 2006).

2.2. The Perceived Stress Questionnaire (PSQ)

The PSQ is a Likert scale questionnaire used in psychology that measures how much an individual perceives their life to be stressful in the past one or two years (Table S1). Developed by Levenstein and colleagues, the test has an internal consistency of 0.90 to 0.92 and a test-retest reliability of 0.82 (Levenstein, Prantera, Varvo, Scribano, et al., 1993) . The questionnaire consists of a series of 30 questions with answer choices of *usually, often, sometimes,* or *almost never* selected by participants on a scale of 1 (*almost never*) to 4 (*usually*) based on how applicable each statement is to their life. Reverse scoring was used on select few questions. "A PSQ index could be found by subtracting 30 from the raw score and dividing the result by 90, yielding a score between 0 and 1" (Levenstein, Prantera, Varvo, L., et al., 1993).

2.3. The Generalized Anxiety Disorder-7 (GAD-7)

The GAD-7 is another Likert scale questionnaire that screens for generalized anxiety disorder (GAD) and assesses the severity of anxiety symptoms over the last two weeks (Table S2). Developed by R.L. Spitzer and colleagues in 2006, the test has an overall Cronbach alpha score of 0.895 (Dhira et al., 2021). The questionnaire consists of 7 common anxiety symptoms with answer choices of *Not at all*, *Several days*, *More than half the days*, and *Nearly every day* on a scale from 0 (*Not at all*) to 3 (*Nearly every day*). A GAD-7 score is calculated by totaling up all points. A higher GAD-7 score corresponded to a higher level of anxiety.

In our study, besides assessing participants' anxiety symptoms over the past two weeks, we also assessed anxiety symptoms students experienced throughout the first semester of the 2023-2024 school year. Our primary analysis focused on the two weeks recall period and participants' current anxiety; however, we incorporated the exploratory analysis on students' anxiety during the first semester of the school year to compare possible changes.

2.4. The Patient Health Questionnaire-9 (PHQ-9)

The PHQ-9 is another Likert scale questionnaire that assesses the severity of depression symptoms in participants over the last two weeks (Table S3). Developed by Kroenke and colleagues in 1999, the PHQ-9 has a Cronbach alpha of 0.89 and a test-retest reliability of 0.84 (Kroenke et al., 2001). The PHQ-9 is structured with 9 questions addressing symptoms of depression, such as feeling down, having sleep problems, etc. Participants select from a scale from 0 (*Not at all*) to 3 (*Nearly every day*) based on how applicable each statement is. A total PHQ-9 score is calculated by totaling up all points. A higher PHQ-9 score correlates to a higher severity of depression and vice versa.

Similarly to the GAD-7, we assessed depression symptoms over the past two weeks and throughout the first semester of the 2023-2024 school year. Primarily analysis focused on the 2-week recall period and students' current depression; however, exploratory analysis on depression during the first semester was included to compare possible differences.

2.5. Categorization of Participants and Data

Students who completed the survey were categorized into three primary groups: those involved currently in music programs, those involved previously in music programs, and those not

involved in music programs. Current participants were those actively involved in band, orchestra, or choir during the 2023-2024 academic year. Previous participants were those who had been involved in a music program in prior years but were not currently participating. Non-participants were those who had not been involved in a music program at any time.

To differentiate between academic rigor levels, the number of APs or honors courses students took were grouped into three groups: 0 APs or honors, 1 to 2 APs or honors, and 3 or more APs or honors courses. The groups are comparable to low, medium, and high rigor levels, respectively. Average GPA, calculated by averaging students' reported GPAs from both semesters, was used in our analyses.

2.6. Statistical Analyses

The primary outcome variables in this study were students' mental health outcomes (assessed using the PSQ, the GAD-7, and the PHQ-9) and academic performance (measured by GPA). Covariates that were adjusted in the analysis of the association between music program participation (currently involved, previously involved, not involved) and the outcome variables included participants' course rigor (categorized by number of APs/honors courses taken: 0, 1-2, 3+), grade level (9^{th} through 12^{th} grade), and sex (male, female, other). Univariable and multivariable analyses were conducted using Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) to assess whether GPA, stress, anxiety, or depression scores differed significantly across music participation groups, course rigor levels, grade levels, or sex (Montgomery, 2001). Differences in estimated mean scores and their 95% confidence intervals (CI) are reported. All analyses were conducted using R (version 4.3.3) within RStudio (version 2024.04.2+764). All tests were two-sided, and statistical significance was defined as $p < 0.05$.

3. Results

Of the 646 students who completed the survey study, 331 (51.2%) were female and 292 (45.2%) were male (Table 1). 71.7% of participants were Asian, followed by Hispanic or Latino students (13.2%) and White students (7.6%). The proportion of students in each grade was 18.1% 9^{th} graders (freshmen), 33.6% 10^{th} graders (sophomores), 38.7% 11^{th} graders (juniors) and 9.6% 12^{th} graders (seniors). For music participation, 180 students (27.9%) were currently involved, 110 (17.0%) had participated in the past, and 356 (55.1%) had no participation. On average, students were taking 1.76 (standard deviation or SD=1.50) honors or AP courses during the school year. This average was 2.13 (SD=1.50) for music participants, a slight decrease to 1.77 (SD=1.50) for prior participants, and a further decrease to 1.58 (SD=1.50) for non-participants. Reported satisfaction with GPA varied across music participation statuses, with students involved in music programs reporting higher satisfaction.

Table 1. Characteristics of students who participated in the survey study

	Involved in Music Programs (N=180)	**Involved in the past (N=110)**	**Not Involved (N=356)**	**Overall (N=646)**
Sex				
Female	94 (52.2%)	55 (50.0%)	182 (51.1%)	331 (51.2%)
Male	78 (43.3%)	49 (44.5%)	165 (46.3%)	292 (45.2%)
Other/Unknown	8 (4.4%)	6 (5.5%)	9 (2.5%)	23 (3.6%)
Race				
Asian	155 (86.1%)	91 (82.7%)	217 (61.0%)	463 (71.7%)
White	6 (3.3%)	3 (2.7%)	40 (11.2%)	49 (7.6%)
Hispanic or Latino	10 (5.6%)	7 (6.4%)	68 (19.1%)	85 (13.2%)
Native American or Other Pacific Islander	0 (0%)	0 (0%)	1 (0.3%)	1 (0.2%)
More than one race	9 (5.0%)	6 (5.5%)	27 (7.6%)	42 (6.5%)
Other/Unknown	0 (0%)	3 (2.7%)	3 (0.8%)	6 (0.9%)
Grade				
Freshman	42 (23.3%)	20 (18.2%)	55 (15.4%)	117 (18.1%)
Sophomore	67 (37.2%)	41 (37.3%)	109 (30.6%)	217 (33.6%)
Junior	43 (23.9%)	42 (38.2%)	165 (46.3%)	250 (38.7%)
Senior	28 (15.6%)	7 (6.4%)	27 (7.6%)	62 (9.6%)
Satisfied with GPA Last Semester				
Very satisfied	64 (35.6%)	28 (25.5%)	94 (26.4%)	186 (28.8%)
Satisfied	36 (20.0%)	22 (20.0%)	64 (18.0%)	122 (18.9%)
Neutral	23 (12.8%)	28 (25.5%)	77 (21.6%)	128 (19.8%)
Dissatisfied	36 (20.0%)	15 (13.6%)	68 (19.1%)	119 (18.4%)
Very dissatisfied	21 (11.7%)	17 (15.5%)	53 (14.9%)	91 (14.1%)
Satisfied with GPA This Semester				
Very satisfied	50 (27.8%)	25 (22.7%)	67 (18.8%)	142 (22.0%)
Satisfied	36 (20.0%)	22 (20.0%)	61 (17.1%)	119 (18.4%)
Neutral	39 (21.7%)	30 (27.3%)	88 (24.7%)	157 (24.3%)
Dissatisfied	30 (16.7%)	18 (16.4%)	87 (24.4%)	135 (20.9%)
Very dissatisfied	25 (13.9%)	15 (13.6%)	53 (14.9%)	93 (14.4%)
How many honors/APs this school year				
Mean (SD)	2.13 (1.50)	1.77 (1.40)	1.58 (1.50)	1.76 (1.50)
Median [Min, Max]	2.00 [0, 6.00]	2.00 [0, 7.00]	1.00 [0, 7.00]	2.00 [0, 7.00]

3.1. PSQ Results

The mean PSQ index was 0.479 (SD=0.179), 0.501 (SD=0.204) and 0.498 (SD=0.188) among students currently involved in music, students involved in the past, and the non-participants, respectively (Table 2 and Table 3). In univariable analysis, although the mean PSQ index of current participants was nominally lower than past participants or non-participants, there was no statistically significant difference across the three groups. The estimated difference in mean PSQ index (95% CI) was 0.022 (-0.023, 0.067) for past music participants vs current participants, and was 0.019 (-0.015, 0.053) for non-participants vs current participants (p=0.484, Table 3 and Figure 1). There was also no statistically significant difference in mean PSQ index across students taking 0 APs/honors, 1-2 APs/honors, or more than 3 APs/honors courses (p = 0.776). Females had a significantly higher mean PSQ index of (0.528, SD=0.181) than males (0.449, SD=0.148, p<0.0001). The comparison between grade levels and mean PSQ index also showed a statistically significant difference (p=0.015) with freshmen reporting the lowest mean index of 0.450 and sophomores reporting the highest mean index of 0.518 (Table 3).

In multivariable analysis, after controlling for the other variables, involvement in music still had no statistically significant effect on stress levels (p=0.466, Table 3). The number of APs/honors courses taken also did not show a statistically significant association with stress levels (p=0.703). However, there remained statistically significant differences in stress scores across grade levels (p=0.017) and between sexes (p<0.001).

Table 2. Distribution of PSQ, GAD7 and PHQ scores among students currently involved in music programs, those involved in the past, and those not involved

	Involved in Music Programs (N=180)	**Involved in the past (N=110)**	**Not Involved (N=356)**	**Overall (N=646)**
PSQ Index				
Mean (SD)	0.479 (0.179)	0.501 (0.204)	0.498 (0.188)	0.493 (0.188)
Median [Min, Max]	0.467 [0.100, 0.911]	0.522 [0.0778, 0.978]	0.500 [0, 0.978]	0.494 [0, 0.978]
GAD7 Score (last 2 weeks)				
Mean (SD)	9.17 (5.63)	9.74 (5.99)	10.0 (5.85)	9.74 (5.82)
Median [Min, Max]	9.00 [0, 21.0]	10.0 [0, 21.0]	10.0 [0, 21.0]	9.00 [0, 21.0]
Missing	6 (3.3%)	1 (0.9%)	8 (2.2%)	15 (2.3%)
GAD7 Score (first semester)				
Mean (SD)	6.99 (4.54)	7.43 (5.77)	7.44 (5.38)	7.31 (5.23)
Median [Min, Max]	6.00 [0, 21.0]	7.00 [0, 21.0]	7.00 [0, 21.0]	7.00 [0, 21.0]
Missing	6 (3.3%)	1 (0.9%)	8 (2.2%)	15 (2.3%)
PHQ Score (last 2 weeks)				
Mean (SD)	6.79 (5.24)	8.06 (5.78)	7.99 (5.60)	7.67 (5.55)
Median [Min, Max]	6.00 [0, 21.0]	7.00 [0, 21.0]	7.00 [0, 21.0]	7.00 [0, 21.0]
Missing	5 (2.8%)	1 (0.9%)	8 (2.2%)	14 (2.2%)
PHQ Score (first semester)				
Mean (SD)	6.72 (5.17)	7.79 (5.52)	7.05 (5.25)	7.09 (5.28)
Median [Min, Max]	6.00 [0, 19.0]	7.00 [0, 21.0]	6.00 [0, 21.0]	6.00 [0, 21.0]
Missing	5 (2.8%)	1 (0.9%)	8 (2.2%)	14 (2.2%)

Table 3.Comparison of PSQ index by student characteristics

	Univariable			Multivariable	
Variables	**Mean (SD)**	**Difference in Mean (95% CI)**	**p-Value**	**Difference in Mean (95% CI)**	**p-Value**
Music Participation					
Current	0.479 (0.179)	Ref	0.484	Ref	0.466
Past	0.501 (0.204)	0.022 (-0.023, 0.067)		0.020 (-0.025, 0.064)	
None	0.498 (0.188)	0.019 (-0.015, 0.053)		0.019 (-0.016, 0.053)	
Course Rigor					
0 APs/Honors	0.485 (0.196)	Ref	0.776	Ref	0.703
1-2 APs/Honors	0.498 (0.188)	0.013 (-0.023, 0.049)		-0.001 (-0.038, 0.037)	
3+ APs/Honors	0.493 (0.182)	0.008 (-0.031, 0.046)		-0.011 (-0.053, 0.031)	
Grade					
Freshmen	0.450 (0.172)	Ref	0.015	Ref	0.017
Sophomores	0.518 (0.198)	0.068 (0.026, 0.111)		0.069 (0.024, 0.114)	
Juniors	0.495 (0.193)	0.046 (0.005, 0.087)		0.041 (-0.003, 0.086)	
Seniors	0.478 (0.146)	0.029 (-0.029, 0.086)		0.040 (-0.022, 0.101)	
Sex					
Female	0.528 (0.181)	Ref	<0.0001	Ref	<0.001
Male	0.449 (0.184)	-0.078 (-0.107, -0.049)		-0.078 (-0.107, -0.049)	
Other/Unknown	0.548 (0.233)	0.020 (-0.058, 0.098)		0.017 (-0.061, 0.095)	

Note. SD = Standard Deviation; 95% CI = 95% Confidence Interval

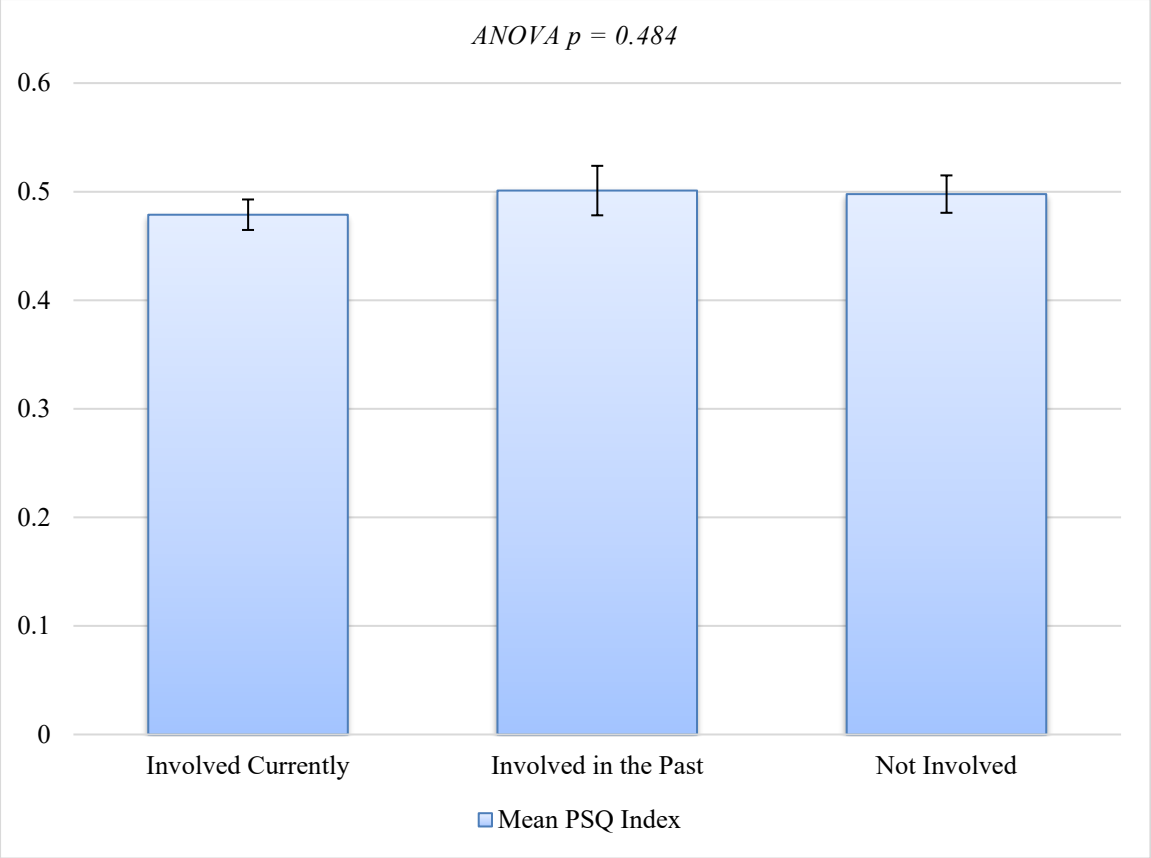

Figure 1. Relationship Between Music Participation and PSQ Index

3.2. GAD-7 Results

In the 2-week recall period, the mean GAD-7 score was 9.17 (SD=5.63), 9.74 (SD=5.99), and 10.0 (SD=5.85) among students currently involved in music, students involved in the past, and the non-participants, respectively (Table 2 and Table 4A). In univariable analysis, although the mean GAD-7 scores of current participants were nominally lower than past participants or non-participants, there was no statistically significant difference across the three groups. The estimated difference in mean GAD-7 score (95% CI) was 0.571 (-0.824, 1.97) for past music participants vs current participants, and was 0.856 (-0.204, 1.92) for non-participants vs current participants (p=0.285, Table 4A and Figure 2). There was also no statistically significant difference in GAD-7 scores across students taking 0 APs/honors, 1-2 APs/honors, or more than 3 APs/honors courses (p=0.329). Females had significantly higher mean GAD-7 scores (11.2, SD=5.46) than males (8.09, SD=5.68, p<0.0001). The comparison between grade levels and mean GAD-7 scores also showed a statistically significant difference (p=0.005) with freshmen reporting the lowest mean score of 8.25 (SD=5.42) and sophomores reporting the highest mean score of 10.4 (SD=5.89).

In multivariable analysis for the 2-week recall period, after controlling for the other variables, involvement in music still had no statistically significant effect on anxiety levels (p=0.257, Table 4A). The number of APs/honors courses taken also did not exhibit a statistically significant association with anxiety levels (p=0.178). However, there remained statistically significant differences in anxiety scores across grade levels (p=0.021) and between sexes (p<0.0001).

In the semester recall period, the mean GAD-7 score was 6.99 (SD=4.54), 7.43 (SD=5.77), and 7.44 (SD=5.38) among students currently involved in music, students involved in the past, and

the non-participants, respectively (Table 2 and Table 4B). The results regarding association between GAD-7 scores and music participation or other variables were largely similar to the 2-week recall period. On average, GAD-7 scores for the semester recall period were generally lower than for the 2-week recall period.

Table 4A. Comparison of GAD-7 scores (2-week recall period) by student characteristics

	Univariable			Multivariable	
Variables	**Mean (SD)**	**Difference in Mean (95% CI)**	**p-Value**	**Difference in Mean (95% CI)**	**p-Value**
Music Participation					
Current	9.17 (5.63)	Ref	0.285	Ref	0.257
Past	9.74 (5.99)	0.571 (-0.824, 1.97)		0.510 (-0.847, 1.87)	
None	10.0 (5.85)	0.856 (-0.204, 1.92)		0.889 (-0.180, 1.96)	
Course Rigor					
0 APs/Honors	9.19 (5.71)	Ref	0.329	Ref	0.178
1-2 APs/Honors	9.90 (5.88)	0.710 (-0.409, 1.83)		0.404 (-0.751, 1.56)	
3+ APs/Honors	10.0 (5.82)	0.836 (-0.351, 2.02)		0.453 (-0.853, 1.76)	
Grade					
Freshmen	8.25 (5.42)	Ref	0.005	Ref	0.021
Sophomores	10.4 (5.89)	2.20 (0.869, 3.53)		1.86 (0.448, 3.28)	
Juniors	10.1 (5.76)	1.81 (0.521, 3.10)		1.27 (-0.101, 2.65)	
Seniors	8.81 (6.02)	0.556 (-1.24, 2.35)		0.470 (-1.43, 2.37)	
Sex					
Female	11.2 (5.46)	Ref	<0.0001	Ref	<0.0001
Male	8.09 (5.68)	-3.09 (-3.98, -2.19)		-3.05 (-3.95, -2.16)	
Other/Unknown	10.3 (7.06)	-0.830 (-3.21, 1.55)		-0.785 (-3.17, 1.60)	

Note. SD = Standard Deviation; 95% CI = 95% Confidence Interval

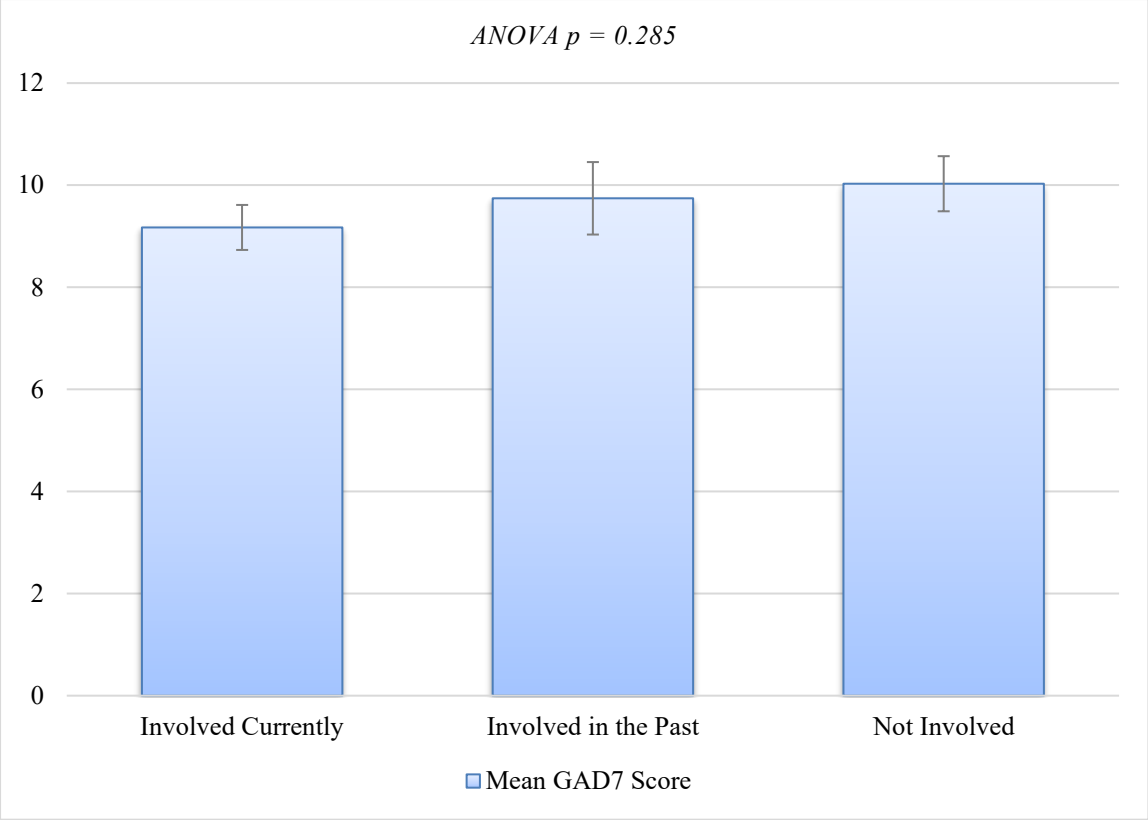

Figure 2. Relationship Between Music Participation and GAD-7 Score (2-week recall period)

Table 4B. Comparison of GAD-7 scores (semester recall period) by student characteristics

	Univariable			Multivariable	
Variables	**Mean (SD)**	**Difference in Mean (95% CI)**	**p-Value**	**Difference in Mean (95% CI)**	**p-Value**
Music Participation					
Current	6.99 (4.54)	Ref	0.632	Ref	0.618
Past	7.43 (5.77)	0.443 (-0.813, 1.70)		0.333 (-0.909, 1.58)	
None	7.44 (5.38)	0.448 (-0.506, 1.40)		0.295 (-0.684, 1.27)	
Course Rigor					
0 APs/Honors	7.22 (5.36)	Ref	0.962	Ref	0.910
1-2 APs/Honors	7.34 (5.25)	0.125 (-0.883, 1.13)		-0.190 (-1.25, 0.867)	
3+ APs/Honors	7.35 (5.12)	0.135 (-0.934, 1.20)		-0.389 (-1.58, 0.807)	
Grade					
Freshmen	6.15 (4.56)	Ref	0.046	Ref	0.047
Sophomores	7.46 (5.12)	1.30 (0.106, 2.50)		1.38 (0.081, 2.67)	
Juniors	7.84 (5.65)	1.64 (0.475, 2.80)		1.57 (0.315, 2.83)	
Seniors	6.40 (5.14)	0.848 (-0.772, 2.47)		1.15 (-0.582, 2.89)	

	Univariable			Multivariable	
Variables	**Mean (SD)**	**Difference in Mean (95% CI)**	**p-Value**	**Difference in Mean (95% CI)**	**p-Value**
Sex					
Female	8.31 (5.01)	Ref	<0.0001	Ref	<0.0001
Male	6.09 (5.08)	-2.22 (-3.04, -1.40)		-2.19 (-3.00, -1.37)	
Other/Unknown	8.70 (6.92)	0.387 (-1.78, 2.56)		0.276 (-1.90, 2.46)	

Note. SD = Standard Deviation; 95% CI = 95% Confidence Interval
Note: GAD-7 scores based on semester recall period are exploratory.

3.3. PHQ-9 Results

In the 2-week recall period, the mean PHQ-9 score was 6.79 (SD=5.24), 8.06 (SD=5.78), and 7.99 (SD=5.60) among students currently involved in music, students involved in the past, and the non-participants, respectively (Table 2, Table 5A). In univariable analysis, the mean PHQ-9 scores of current participants were statistically significantly lower than past participants and non-participants. The estimated difference in mean PHQ-9 score (95% CI) was 1.28 (-0.050, 2.60) for past music participants vs current participants, and was 1.20 (0.193, 2.21) for non-participants vs current participants (p=0.047, Table 5A and Figure 3). However, there was no statistically significant difference in PHQ-9 scores across students taking 0 APs/honors, 1-2 APs/honors, or more than 3 APs/honors courses (p=0.237). Females had significantly higher mean PHQ-9 scores (8.57, SD=5.69) than males (6.49, SD=5.02, p<0.0001). The comparison between grade levels and mean PHQ-9 scores did not show a statistically significant difference (p=0.060) with seniors reporting the nominally lowest mean score of 6.40 (SD=5.14) and sophomores reporting the nominally highest mean score of 8.23 (SD=5.63).

In multivariable analysis for the 2-week recall period, after controlling for other variables, involvement in music still had a statistically significant effect on depression levels (p=0.041, Table 5A). The number of APs/honors courses being taken still did not exhibit a statistically significant association with depression levels (p=0.377). However, grade level now had a statistically significant impact on depression levels (p=0.045). Sex still had a statistically significant effect on depression scores (p<0.0001).

In the semester recall period, the mean PHQ-9 score was 6.72 (SD=5.17), 7.79 (SD=5.52), and 7.05 (SD=5.25) among students currently involved in music, students involved in the past, and the non-participants, respectively (Table 2, Table 5B). The results of PHQ-9 scores in the semester recall period showed differing patterns to the 2-week recall period. Predominantly, PHQ-9 scores in the semester recall period weren't statistically significant for music participation status and were significant for grade level. On average, PHQ-9 scores for the semester recall period were generally lower than for the 2-week recall period.

Table 5A. Comparison of PHQ-9 (2-week recall period) by student characteristics

	Univariable			Multivariable	
Variables	**Mean (SD)**	**Difference in Mean (95% CI)**	**p-Value**	**Difference in Mean (95% CI)**	**p-Value**
Music Participation					
Current	6.79 (5.24)	Ref	0.047	Ref	0.041
Past	8.06 (5.78)	1.28 (-0.050, 2.60)		1.10 (-0.214, 2.41)	

	Univariable			Multivariable	
Variables	**Mean (SD)**	**Difference in Mean (95% CI)**	**p-Value**	**Difference in Mean (95% CI)**	**p-Value**
None	7.99 (5.60)	1.20 (0.193, 2.21)		1.04 (0.005, 2.07)	
Course Rigor					
0 APs/Honors	8.04 (5.93)	Ref	0.237	Ref	0.377
1-2 APs/Honors	7.83 (5.59)	-0.206 (-1.27, 0.861)		-0.444 (-1.56, 0.674)	
3+ APs/Honors	7.13 (5.13)	-0.910 (-2.04, 0.221)		-1.14 (-2.41, 0.119)	
Grade					
Freshmen	6.96 (5.27)	Ref	0.060	Ref	0.045
Sophomores	8.23 (5.63)	1.27 (-0.002, 2.54)		1.61 (0.236, 2.98)	
Juniors	7.84 (5.65)	0.885 (-0.350, 2.12)		0.956 (-0.375, 2.29)	
Seniors	6.40 (5.14)	-0.552 (-2.27, 1.17)		0.256 (-1.58, 2.09)	
Sex					
Female	8.57 (5.69)	Ref	<0.0001	Ref	<0.0001
Male	6.49 (5.02)	-2.08 (-2.95, -1.21)		-2.08 (-2.94, -1.21)	
Other/Unknown	9.65 (7.00)	1.08 (-1.23, 3.39)		1.03 (-1.28, 3.34)	

Note. SD = Standard Deviation; 95% CI = 95% Confidence Interval

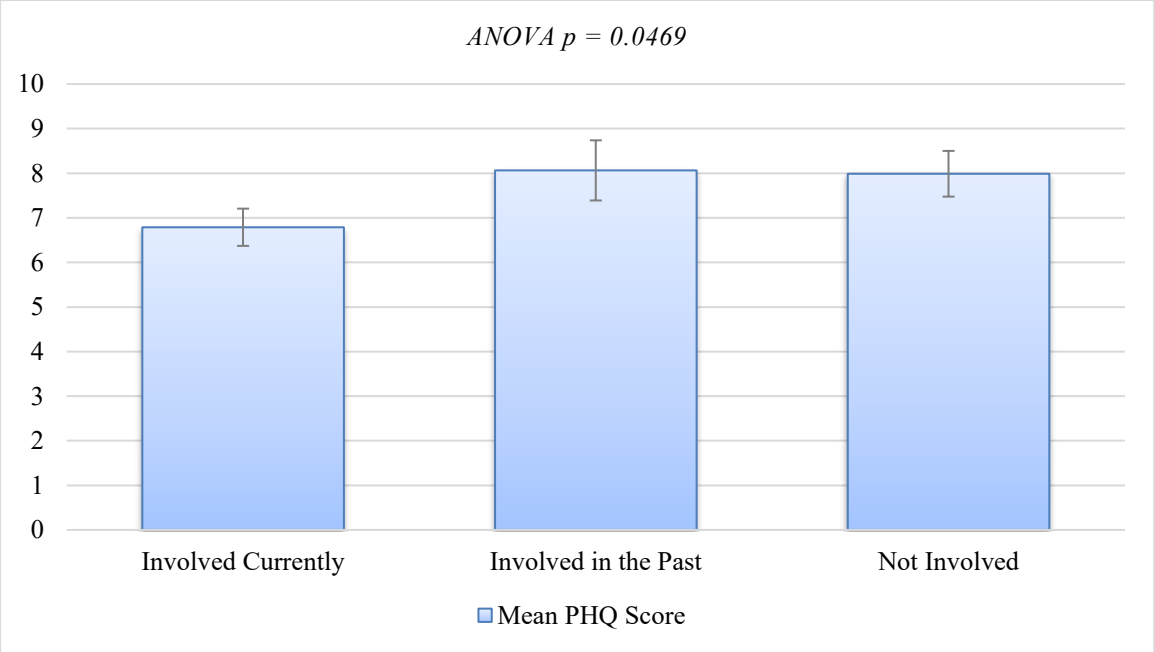

Figure 3. Relationship Between Music Participation and PHQ-9 Score (2-week recall period)

Table 5B. Comparison of PHQ-9 (semester recall period) by student characteristics

	Univariable			Multivariable	
Variables	**Mean (SD)**	**Difference in Mean (95% CI)**	**p-Value**	**Difference in Mean (95% CI)**	**p-Value**
Music Participation					
Current	6.72 (5.17)	Ref	0.249	Ref	0.226
Past	7.79 (5.52)	1.07 (-0.195, 2.33)		1.00 (-0.233, 2.24)	
None	7.05 (5.25)	0.335 (-0.625, 1.29)		0.256 (-0.717, 1.23)	
Course Rigor					
0 APs/Honors	6.86 (5.33)	Ref	0.790	Ref	0.748
1-2 APs/Honors	7.16 (5.52)	0.302 (-0.715, 1.32)		-0.171 (-1.22, 0.884)	
3+ APs/Honors	7.20 (4.92)	0.345 (-0.732, 1.42)		-0.429 (-1.62, 0.763)	
Grade					
Freshmen	5.61 (4.40)	Ref	0.012	Ref	0.010
Sophomores	7.32 (5.41)	1.71 (0.508, 2.92)		1.76 (0.468, 3.05)	
Juniors	7.51 (5.44)	1.90 (0.730, 3.07)		1.82 (0.566, 3.08)	
Seniors	7.29 (5.27)	1.68 (0.053, 3.31)		2.03 (0.298, 3.76)	
Sex					
Female	8.13 (5.40)	Ref	<0.0001	Ref	<0.0001
Male	5.71 (4.62)	-2.42 (-3.23, -1.60)		-2.40 (-3.21, -1.58)	
Other/Unknown	9.74 (6.89)	1.61 (-0.561, 3.78)		1.38 (-0.794, 3.55)	

Note. SD = Standard Deviation; 95% CI = 95% Confidence Interval
Note: PHQ-9 scores based on semester recall period are exploratory.

3.4. GPA

The mean GPA was 3.75 (SD=0.372), 3.64 (SD=0.436), and 3.53 (SD=0.554) among students currently involved in music, students involved in the past, and the non-participants, respectively (Table 6). In univariable analysis, the mean GPA of current participants was significantly higher than that of past participants and non-participants ($p<0.0001$, Table 6). Likewise, there was a statistically significant difference in mean GPA across students taking 0 APs/honors, 1-2 APs/honors, or more than 3 APs/honors courses ($p<0.0001$). Mean GPA across sexes did not have a significant difference ($p=0.365$) with females having an average GPA of 3.63 (SD=0.458) and males having an average GPA of 3.58 (SD=0.546). The comparison between grade levels and mean GPA showed a statistically significant difference ($p<0.001$) with freshmen having the lowest mean GPA of 3.56 (SD=0.669) and seniors having the highest mean GPA of 3.76 (SD=0.291).

In multivariable analysis, after controlling for the other variables, involvement in music still had a statistically significant effect on mean GPA ($p<0.0001$, Table 6). The number of APs/honors courses taken and grade level also continued to show statistically significant associations with GPA ($p<0.0001$, $p=0.001$). However, there was still not a statistically significant difference in GPA across sexes ($p=0.232$).

Table 6. Comparison of GPA (unweighted) by student characteristics

	Univariable			Multivariable	
Variables	**Mean (SD)**	**Difference in Mean (95% CI)**	**p-Value**	**Difference in Mean (95% CI)**	**p-Value**
Music Participation					
Current	3.75 (0.372)	Ref	<0.0001	Ref	<0.0001
Past	3.64 (0.436)	-0.108 (-0.224, 0.009)		-0.058 (-0.167, 0.051)	
None	3.53 (0.554)	-0.219 (-0.307, -0.131)		-0.105 (-0.190, -0.020)	
Course Rigor					
0 APs/Honors	3.31 (0.688)	Ref	<0.0001	Ref	<0.0001
1-2 APs/Honors	3.65 (0.381)	0.342 (0.255, 0.430)		0.357 (0.265, 0.448)	
3+ APs/Honors	3.81 (0.261)	0.499 (0.406, 0.592)		0.530 (0.427, 0.634)	
Grade					
Freshmen	3.56 (0.669)	Ref	<0.001	Ref	0.001
Sophomores	3.68 (0.376)	0.119 (0.008, 0.230)		-0.105 (-0.216, 0.007)	
Juniors	3.53 (0.524)	-0.032 (-0.141, 0.077)		-0.212 (-0.322, -0.103)	
Seniors	3.76 (0.291)	0.203 (0.050, 0.355)		-0.100 (-0.252, 0.052)	
Sex					
Female	3.63 (0.458)	Ref	0.365	Ref	0.232
Male	3.58 (0.546)	-0.055 (-0.134, 0.024)		-0.058 (-0.129, 0.013)	
Other/Unknown	3.65 (0.426)	0.014 (-0.202, 0.229)		0.035 (-0.162, 0.231)	

Note. SD = Standard Deviation; 95% CI = 95% Confidence Interval

4. Discussion

In the last few years, we have observed that many high school students have been increasingly opting out of music programs, not primarily due to a lack of interest, but due to the growing pressure to enroll in rigorous academic courses. When we asked past participants why they decided to leave their music program, common answers included time commitment issues or wanting to devote time to other classes. Additionally, it is known that rehearsals and performances are routine for music programs. They often demand significant time outside of regular school hours, causing students and parents to often assume that the additional commitment can lead to late nights and increased stress. They may also believe that the time investment would inadvertently contribute to feelings of overwhelming pressure, especially when combined with an already demanding academic workload. As a result, music programs face a decline in enrollment.

In this study, by conducting a survey using the established instruments PSQ, GAD-7, and PHQ-9, we found that the assumption that students enrolling in music programs on top of an already demanding academic workload would experience increased stress, anxiety, or depression is not supported. No evidence from our study suggested that involvement in music programs hinders emotional success, and this finding remains the same when we conducted sensitivity analysis among participants with higher self-reported GPA or among those with lower self-reported GPA. Our results showed that there was no significant association between music participation

and stress or anxiety levels. On the contrary, students currently involved in music programs reported the lowest stress and anxiety levels among the three groups of students (those currently involved, those involved in the past, and those not involved). Additionally, music participation was significantly associated with decreased depression levels.

The association between music participation and reduced stress, anxiety, or depression levels can be multifaceted. Music programs are both creative and active, which could potentially provide a unique form of stress and anxiety relief by shifting students' focus away from academic pressures and toward an enjoyable, goal-oriented task. Additionally, playing a musical instrument combines physical movement with auditory feedback, engaging the participant emotionally and stimulating relaxation pathways, helping to counteract anxiousness or nervousness (Toyoshima et al., 2011). A study on flute playing found that it increased heart rate variability (HRV), increased alpha and theta brain waves associated with calmness, and reduced beta waves that are linked to stress. These benefits are likely due to the slow and controlled breathing patterns involved in playing a wind instrument, which activates the body's parasympathetic nervous system. In other instruments and in singing, similar coordination between body movements and auditory feedback can yield comparable results (Miller & Goss, 2014). Furthermore, the structured routine of practices and performances could help create a feeling of confidence and resilience as students work through mastering a piece and showcase their hard work. Moreover, the group setting of music programs fosters emotional support that helps protect students against depression or burnout. Hence, it is possible that music programs can help create a positive and restorative environment that can improve students' mental health.

Our results also demonstrated that participating in music programs was significantly associated with a higher GPA, with students currently involved in music programs having the highest average GPA, followed by students involved in the past. Non-participants showed the lowest average GPA. While speculative and likely multifaceted, one possible explanation is that music education may help develop skills that can directly aid in academic success. Learning an instrument or participating in an ensemble requires discipline, time management, attention to detail, and extended periods of focus. These are all qualities that are valuable in the classroom. In addition, practicing music helps train memory, pattern recognition, and develop problem solving skills, all of which further improve performance in academics. Furthermore, the collaborative nature of music can help normalize teamwork and perseverance, subsequently encouraging consistent academic effort. It is possible that this combination of cognitive, behavioral, and motivational benefits can contribute to the higher academic achievement observed among music participants in high school.

In our study, students involved in music programs tended to take more APs/honors classes. The number of APs/honors courses were not associated with the stress, anxiety, or depression levels, but students taking more APs/honors classes showed a significantly higher average GPA. Although speculative, these findings can also be explained by the cognitive, behavioral, and motivational benefits from music participation, highlighting the possible positive impact of music participation both on students' academic performance and on their mental health.

Freshmen generally reported the lowest stress, anxiety, and depression levels among the four high school grades. The pressure, as reflected by stress, anxiety, and depression levels, increased in the sophomore year, was highest in the junior year, and seemed to cool off in the senior year. These results are consistent with our intuition about the intensity of coursework for each grade level. Consistent with previous research, our study also found that females self-reported higher levels of stress, anxiety, and depression levels than males (Misra & McKean, 2000). However, these differences in reported stress, anxiety, and depression may not necessarily indicate that females experience higher levels of psychological distress; rather,

women may be more likely to acknowledge and express it, while men may underreport or suppress it. Regarding race and ethnicity, our sample was predominantly Asian (approximately 75%), with smaller representation from other racial/ethnic groups. However, when we evaluated differences in stress, anxiety, and depression across racial/ethnic groups, we did not find any statistically significant effects. While broader representation would be ideal, race and ethnicity were not included as a primary factor in the results due to the lack of significant differences in this sample.

While the GAD-7 and PHQ-9 are conventionally validated for a 2-week recall period, we explored the usage of these two instruments in the semester recall period, asking students to answer the survey questions based on their experience in the first semester. We emphasize that this methodological adaptation is exploratory. Comparable research, such as Chilver et al. (2023), has shown that extending the recall period of similar mental-health scales (e.g. K6) from 7 to 30 days resulted in no substantive differences in scores at the group level (Chilver et al., 2023). By administering the GAD-7 and PHQ over a longer period, it allowed us to compare anxiety and depression levels across semesters where students in band, for example, may feel differing amounts of anxiety due to the band season. The results from the semester recall period in our study were largely similar to those from the 2-week recall period. However, the average GAD-7 and PHQ-9 scores were generally lower for the first semester recall period than the 2-week recall period. These differences could be attributed to the alleviation of negative feelings during the peak of the season in the first semester or possibly from recall bias due to faded memory. Given the differences observed in our results based on 2-week recall period vs semester recall period, we note that future use of extension of recall period for GAD-7 and PHQ-9 beyond the 2-week recall period needs to be done with caution.

Limitations of our study included that we only conducted the survey at a single site, AHS in Southern California. AHS is known to be a very competitive high school with a high average GPA, and students often are pressured to thrive academically. The self-reported GPA in our study could be prone to self-reporting bias. We also did not measure potential confounding factors such as family's social economic status, student's prior achievement, or parental education. In addition, our analyses did not adjust for multiple testing, and the results reported in the study need to be validated with an independent, larger study. Despite these limitations, our study is one of the first to assess the role of music education in improving students' mental health in the high school setting—an important stage of secondary education. Our research has the strength of evaluating the role of music classes in an environment of demanding academic load and hence, emphasizes the importance of promoting music programs in academically competitive high schools. Our future research will include high schools in various geographic areas, evaluate the effect of social economic status, assess reasons or motivations for joining music programs, and take into consideration genuine interest versus enrollment for other reasons when comparing mental health or academic performance between students.

5. Conclusions

This study assessed the association between music participation, academic performance, and mental well-being in a high school setting. In this survey study, students involved in music programs had significantly lower levels of depression and nominally lower stress and anxiety scores than students not involved in music programs. Music participation was also associated with higher GPAs. Our findings provide no evidence that participation in music programs hinders academic or emotional success; in fact, music participation is associated with stronger academic performance and reduced depression. These results challenge the belief that students must give up music in order to excel academically. Our study demonstrated a positive

correlation between music participation and students' mental health and academic performance, highlighting the importance of promoting music programs in secondary education. Our findings will need to be validated with a larger, independent study.

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Appendix

Supplement Table S1. The PSQ Scale

Item No.	PSQ Item	Reverse-Scoring
1	You feel rested.	Yes
2	You feel that too many demands are being made on you.	No
3	You are irritable or grouchy.	No
4	You have too many things to do.	No
5	You feel lonely or isolated.	No
6	You find yourself in situations of conflict.	No
7	You feel you're doing things you really like.	Yes
8	You feel you're in a hurry.	No
9	You feel safe and protected.	Yes
10	You have trouble relaxing.	No
11	You are under pressure from deadlines.	No
12	Your life is full of things that keep you interested.	Yes
13	You are afraid for the future.	No
14	You feel that things are going your way.	Yes
15	You feel tense.	No
16	You have enough time for yourself.	Yes
17	You feel overloaded with your work.	No
18	You have a lot of fun.	Yes
19	You feel lonely.	No
20	You feel you're in control of things.	Yes
21	You feel that difficulties are piling up so you can't overcome them.	No
22	You are in a good mood.	Yes
23	You have problems concentrating.	No
24	You enjoy your spare time.	Yes
25	You feel discouraged.	No
26	You enjoy yourself.	Yes
27	You feel like you're about to explode.	No
28	You feel you're doing things because you have to, not because you want to.	No
29	You feel you've enough time.	Yes
30	You feel criticized or judged.	No

Note. Reverse-scored items were adjusted prior to computing the PSQ Index. Table adapted from Levenstein et al. (1993).

Supplemental Table S2. The GAD-7 Scale

Item No.	GAD-7 Item

1	Feeling nervous, anxious, or on edge
2	Not being able to stop or control worrying
3	Worrying too much about different things
4	Trouble relaxing
5	Being so restless that it is hard to sit still
6	Becoming easily annoyed or irritable
7	Feeling afraid as if something awful might happen

Note. Each item is scored from 0 ('Not at all') to 3 ('Nearly every day'). Total scores range from 0 to 21. Table adapted from Spitzer et al. (2006).

Supplemental Table S3. The PHQ-9 Scale

Item No.	**PHQ-9 Item**
1	Little interest or pleasure in doing things
2	Feeling down, depressed, or hopeless
3	Trouble falling or staying asleep, or sleeping too much
4	Feeling tired or having little energy
5	Poor appetite or overeating
6	Feeling bad about yourself — or that you are a failure or have let yourself or your family down
7	Trouble concentrating on things, such as reading the newspaper or watching television
8	Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual
9	Thoughts that you would be better off dead, or of hurting yourself

Note: Each item is scored from 0 ('Not at all') to 3 ('Nearly every day'). Total scores range from 0 to 27. Table adapted from Kroenke et al. (2001).