The Association Between Music Education in High School and Academic and Mental Health Outcomes Among Grade 12 Students in Winnipeg, Manitoba from 2009/10-2017/18

by

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Abstract

Introduction: Educators contend that music programs benefit students, in terms of both academic achievement and mental wellness. Most studies assessing the relationship between music education and adolescent outcomes focus on academic achievement and have found mixed results. Although there is some evidence of the benefits of music programs to mental wellness, research looking at diagnoses of mental disorders related to music education is lacking, as is research within the Canadian context.

Objectives: This retrospective cohort study investigated the association between being enrolled in high school for-credit music courses and i) academic outcomes and ii) mental disorder diagnoses while adjusting for several health and social covariates. The potentially moderating effects of sex and income level were also investigated.

Methods: Administrative health, education, and social services data housed by the Manitoba Centre for Health Policy (MCHP) were linked together to examine the relationship between the number of music courses taken and grade 12 mathematics and language arts achievement test marks, on-time graduation rates, and diagnosis with a mental disorder (ADHD, substance use disorder, mood or anxiety disorder, or any of these three mental disorders) (n=31,487 students in Winnipeg high schools between 2009/10 to 2017/18). To examine the risk of diagnosis after exposure to music courses, students with a diagnosis prior to grade 9 were excluded from the appropriate analyses. Grade 12 achievement tests were analyzed using multiple linear regression, on-time graduation using logistic regression, and mental disorder diagnoses using survival analysis. All analyses adjusted for several student characteristics including sex, income level, residential mobility, income assistance, involvement with child protection services, and prior academic achievement.

Results: Taking any music courses was statistically significantly ($p<.05$) associated with higher marks on grade 12 mathematics (1-2 music courses mean mark increase 1.39 ± 0.39; 3-5 music courses 5.30 ± 0.50; 6+ music courses 9.21 ± 0.57) and language arts (1-2 music courses 1.79 ± 0.75; 3-5 music courses 5.07 ± 0.91; 6+ music courses 9.59 ± 0.97) achievement tests. The odds of graduating on time were also positively associated with taking music courses. This relationship was stronger for female students (1-2 music courses adjusted Odds Ratio (aOR) 1.49, 95% Confidence Interval (CI) 1.31-1.69; 3-5 music courses aOR 3.93, CI 3.11-4.97; 6+ music courses aOR 10.81, CI 6.31-18.54) than male students (1-2 music courses aOR 1.19, CI

1.06-1.33; 3-5 music courses aOR 2.35, CI, 1.90-2.90; 6+ music courses aOR 11.25, CI 6.91-18.33). Taking 3 or more music courses was associated with a decreased risk of being diagnosed with a substance use disorder (3-5 music courses adjusted Hazard Ratio (aHR) 0.71, CI 0.52-0.98; 6+ music courses aHR 0.32, CI 0.18-0.57). For ADHD diagnosis rates, the only statistically significant difference was for students taking 1-2 music courses compared with non-music students (aHR 0.80, CI 0.68-0.94). No association was found between music courses and mood or anxiety disorders. Moderating effects of sex and income level were found in some relationships between music courses and academic outcomes, but none were found in the relationships between music courses and mental disorders.

Conclusions: Taking music courses was associated with better academic outcomes for grade 12 achievement tests as well as on-time graduation rates. Findings were mixed regarding the statistical significance of the association with a mental disorder diagnosis – taking music courses was associated with a decreased risk of a substance use disorder or ADHD diagnoses, but there was no relationship with a diagnosis of a mood or anxiety disorder. The statistical significance of the relationship of sex and income level with these findings varied across academic and mental disorder outcomes. These results suggest promising benefits of music courses to academic and mental health outcomes and point to continued support of music courses in Manitoba schools. Sex and income levels should be considered when planning music courses, given the moderating effects of sex and income levels found in some relationships between music courses and academic outcomes. Further research should continue to consider the underlying factors of the relationship between music courses and student outcomes, especially those related to mental disorder diagnoses as there is a paucity of research in this area.

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Chapter 1: Introduction

Music programs in high school are linked to a wide range of benefits, but there remain gaps in our understanding of these benefits, including who may benefit. Music programs differ across schools and countries but schools in Manitoba typically offer courses in choir, wind band, guitar, jazz band, and vocal jazz.[1] The Manitoba government supports music programs in the school system for their intrinsic benefits to students and to provide the opportunity to obtain a comprehensive music education. Music is considered important by the Manitoba government not only for its intrinsic value, but also for its role in developing "creative, critical, and ethical thinking" skills that can be used and applied in a variety of contexts, contributing to multi-modal literacy, and the development of a students' personal identity.[2] The goal of these types of courses is to "support, nurture, and inspire the growth of every student as a musician and as an artful learner".[3]

While most of the available literature assessing the relationship between music education and later adolescent outcomes has focused on the relationship between music participation and academic outcomes or other measures of cognitive development,[4–15] there is evidence of benefits to mental wellness such as increased self-esteem, empathy, and a sense of belonging.[16–20] Research looking at diagnoses of specific mental disorders related to music education is limited, and the studies available have conflicting findings.[21–25] The emotional skills developed through music, such as positive self-perception, stronger feelings of belonging, more positive personal identity and self-concept, and improved self-esteem can be transferable to other areas of the students' lives.[17]

The goal of this study was to investigate the association between being enrolled in high school for-credit music courses and academic outcomes (grade 12 achievement tests results and graduation rates), and between school music courses and a diagnosis of one or more of the most prevalent mental disorders in adolescence: mood or anxiety disorders; Attention-Deficit Hyperactivity Disorder (ADHD); and substance use disorder. The cohort used for this study included all students attending a high school in Winnipeg during their grade 7 through 12 years and attending a high school offering for-credit music courses. The influence of health and social factors related to academic outcomes and mental disorder diagnoses were considered in addressing the relationship between music education and later outcomes.

This study fills a gap in the Canadian literature by using whole-population individual-level data to examine the relationship between high school music education and academic achievement, and diagnosis of a mental disorder in a large urban setting. This study is among the first of its kind in Canada and provides insights regarding the relationship between music education and later adolescent outcomes.

Chapter 2: Background Literature

2.1: Defining Music Education

Music education is quantified differently between studies. Some researchers included private music lessons or targeted programs[5,9,26] in their studies, while others looked at group lessons.[8,27,28] Even between the studies using administrative or population-level data, the definition of music education has varied. Fitzpatrick defined music education as participating in band, orchestra, or jazz band through the school.[14] Gouzouasis et al. and Guhn et al. defined music education similarly, but also included choir and music composition classes in their definition.[4,6] A province-wide report published in British Columbia included one hundred different courses in its definition.[15]

2.2: Demographic Differences Between Music and Non-Music Students

The literature on the benefits of music education on adolescent academic achievement and mental health often fails to account for the pre-existing differences between music and non-music students. Students who take music courses in high school are not representative of the general student population. Prior to entering high school, students who take music courses are already doing better academically than their peers.[7,14,29–33] Based on studies conducted in the United States, students who took music courses in high school were overwhelmingly female, white, and from affluent well-educated families compared to students who did not take music courses.[13,29–31] Affluent students were also more likely to take music courses for multiple years.[32] Interestingly, a study focused specifically on low-income grade 6-8 students in Miami, Florida found that students enrolled in music courses were primarily male,[33] while a study conducted by Kinney et al. found male and female students were just as likely to enroll in band but males were less likely to enroll in orchestra or choir.[34] Alegrado & Winsler also found greater music enrolment by non-black compared to black students, but that this difference was due to the fact that black students were more likely to attend schools not offering music courses.[33] Other researchers have found that, even when attending schools offering music programs, black students are less likely to enroll.[35] These differences between music and non-music students suggest systematic differences, including their lived experiences, rather than the influence of music courses, are driving the differences in academic outcomes. The present study accounts for some of these systematic differences between students.

Students who enrolled in school music courses were often engaged with music outside of school, such as private lessons or attending concerts.[30] This additional cost was likely prohibitive for lower-income families, so these students were less likely to be exposed to music early in childhood and therefore may be less interested in taking music courses later. A survey by Pendergast & Robinson reported that around 37% of students taking music courses in school also took music lessons outside of school, and 27% played or sang at their chosen religious centre.[36] Students who only played music outside of school cited a low interest in the types of ensembles offered at school to be a contributing factor for not enrolling in school music courses.[36]

Some educators posit that the difference in demographics between music and non-music students is rooted in how music is often taught in Canadian schools. That is, emphasis is placed on Western European music as the "highest form of musical experience" while excluding, deliberately or not, music from other cultures, leading to minority students feeling isolated in school music programs and less likely to enroll.[37] Specifically, this devaluation of non-Western music may be pushing these students away from school music courses.[38] Among students who did not participate in music courses in or outside of school, the most common reason for not participating was lack of interest followed by not having time for any other courses or extracurriculars.[36] Offering a broader range of music courses, or courses specifically tailored to student interest, may attract more students to music programs. There are factors other than cultural differences that may also influence a student's decision to enroll or continue in music programs, such as pressure from their peers,[39,40] or the higher prevalence of bullying toward music students compared with non-arts students.[41]

2.3: Music Education and Academic Outcomes

In the last few decades, the connection between music and increased intelligence or academic prowess has received increasing attention from researchers. Many of these studies centered around the Mozart Effect, a since debunked theory that listening to music by W.A. Mozart as infants would give children an intellectual 'head start' over their peers.[42–47] Other researchers who focused on the act of making music found that children who participated in music programs often received higher marks in core academic courses such as Math and English

Language Arts.[4,6,10,11,15,48] Although there are a variety of ways to measure music education, most studies presented in this section used school music classes as their measure of music education.[4,6,10–15,31,48,49]

The underlying mechanisms for these differences between music and academic outcomes is poorly understood.[50] Researchers who have studied active music engagement, such as music lessons or classes, and cognitive development, have suggested significant neurological differences between individuals who participate in music and those who do not. These differences may be related to visual-spatial reasoning,[51] neuroplasticity or adaptability,[52] brain changes favouring areas related to music abilities such as perfect pitch,[53] or interhemispheric communication.[54]

A recent meta-analysis of studies of musical training concluded that positive correlations between musical training and academic outcomes may be due to unmeasured confounding, rather than a transfer of learned music-related skills.[55] Researchers who did not control for potential systematic differences between students, such as socioeconomic status (SES) or previous academic standing, in their studies consistently found better academic outcomes among students taking music courses compared to those not.[6,10,11,15,48] In contrast, researchers who were able to control for other factors found mixed associations between music courses and academic outcomes. Southgate and Roscigno noted once they controlled for several environmental and student-level factors (such as SES, family structure, race, gender, prior academic achievement, and the number of books at home), they found no association between music course enrollment and academic outcomes among either Kindergarten and grade 1 or grade 10 students.[13]

Similar to Southgate and Roscigno's study, Elpus's 2013 study of high school seniors across the United States found that, after controlling for school-level fixed-effects, family income level, family structure, student race, grade 9 grade point average, and individualized education plan, there were no significant differences in Scholastic Aptitude Test (SAT) scores between students enrolled and not enrolled in music courses.[12] The model used by Elpus was better at accounting for the variation between music and non-music students than the model used by Southgate and Roscigno; the model used by Elpus could account for 74.5% of the variation in SAT scores.[12]

Research done by Fitzpatrick is an example of the rare studies done using population-level data to examine the association between music and academic outcomes.[14] Her observational study used data from a county in Ohio that served more than 62,000 students and 142 schools across SES. Of those students, 15,431 were in grade 9-12 during the study period. This study included 915 students enrolled in at least one instrumental music course, and stratified students by income based on their eligibility for subsidized school lunch programs.[14] In grade nine, low-income music students achieved higher marks than more affluent non-music students on standard tests of citizenship, math, science, and reading.[14] However, the statistical significance of these differences was not tested. Students from lower-income areas showed the greatest improvements to academic outcomes after enrollment in school music classes,[14] but this too was not statistically tested. These findings are supported by some other researchers,[56,57] but not by others.[58]

There has been very little published literature on the association between music education and graduation rates. Researchers who focused more broadly on extracurricular participation and graduation rates found that students who participated in extracurriculars were less likely to withdraw from high school,[59] especially those deemed most at risk.[60] The explanation these researchers provide is these students are more engaged in their studies and are surrounded by peers who value their strengths rather than focus on their weaknesses, thus encouraging them to stay in school and graduate.

Similar to the mixed association between music education and academic achievement, the benefits are not consistent across program quality or type. A study by Johnson and Memmott demonstrated that these benefits were related to the quality of the school music program, rather than participating in music courses alone.[11] Students who attended schools with higher quality music programs scored higher on achievement tests than students attending other schools. Another researcher found that schools whose musical ensembles received better grades in competition (an indicator of music program quality) also had better overall academic achievement.[49] These competition grades are often considered evidence of successful teaching practices, despite the validity of these grades being questioned, as judges may provide undeserved positive feedback and potentially inflated grades in order to encourage continued music program enrollment.[61] Additionally, Guhn et al. found that students enrolled in instrumental music courses have better academic achievement than students enrolled in other types of music courses.[4]

While researchers have identified sometimes conflicting associations between taking music and academic outcomes depending on how the analysis was conducted, there is agreement that taking music in school does not hamper a student's academic achievement. Rigorous whole-population research that considers the academic history of students and their social environment could provide insight as to some of the factors related to students choosing to take music courses and their later academic success and how broadening the availability of these courses could help support student achievement.

The literature also underscores the need to consider other factors when comparing music and non-music students. Female students have been shown to score better on measures of educational success than male students.[62] Individuals living in lower SES areas were more likely to have lower academic outcomes in grade 12 than their more affluent peers.[63,64] Better academic achievement in earlier grades was associated with both later enrollment in music courses[7,14,31] and better course outcomes in later grades.[65,66] Students' level of engagement in their own learning may have a positive association with later academic outcomes.[67,68] Factors in a student's home environment, such as residential mobility,[69–71] living in a family receiving employment and income assistance,[72] or having contact with child and family services (i.e. child protection services),[62] were negatively associated with academic outcomes.

2.4: Music Education and Mental Health Outcomes

Compared to the volume of research looking at academic and cognitive outcomes, there is limited research examining the association between music education and mental health among adolescents. In the context of these studies, mental health was conceptualized as both having attributes of positive health (mental wellness) and having a mental illness. Mental wellness includes aspects such as confidence and a sense of belonging. Mental illness includes showing symptoms of behavioural, emotional and mental disorders, or having a diagnosis of specific mental disorders. Among adolescents aged 13-19 years, ADHD, mood or anxiety disorders, and substance use disorders were the most commonly diagnosed mental disorders.[73]

Recent neurological research has posited that the ability of music to evoke emotions can be used to support individuals in achieving and maintaining positive mental health. Music is capable of triggering activity in neural systems related to emotion or pleasure and behavioural regulation,[74–77] supporting findings from studies on mental wellness that music has a positive effect on mental health.[76,78] Music education can provide a platform for expressing complex emotions, developing empathy, and being a safe place for students to take risks in the pursuit of learning new skills.[79] Music preference can serve as a reflection of an individual's mental state or emotional vulnerability.[80–83] Hospitalized individuals in Japan diagnosed with schizophrenia, for example, were less likely to identify 'minor' (typically considered sad in Western music) chords as sad compared with those without a diagnosis.[84] Listening to familiar music can also serve as a comforting 'surrogate' to fulfil an emotional need in the absence of close friends.[85,86]

A review done by Koelsch looking at the changes in neural activity of individuals participating in group music, such as school music courses, outlined some potential social functions of music, including fostering empathy, communication, cooperation, and a sense of belonging.[74] The researchers found that areas of the brain related to social interactions were active when individuals participated in group music making.[74] Savage et al. suggests that human musicality is "a coevolved system for social bonding"[87] where primitive music and culture had a feedback effect on biological evolution allowing each to become more complex as time passed. Some researchers have also found associations between active music engagement (such as through private lessons or school courses) and measures of mental wellness, including greater positive self-perception, stronger feelings of belonging, more positive personal identity and self-concept, and improved self-esteem.[16,17,19,20] In a study conducted in Poland, students attending music-focused schools were more emotionally aware and used different coping strategies under stress than students not attending these schools.[88]

Despite the positive association between music participation and mental health, research by Daykin et al. suggests that group music-making can lead to feelings of isolation and exclusion as group music engagement can serve to reinforce social divisions.[28] In the school context, these social divisions could be related to the skill level (real or perceived) of the student in relation to their peers. Students with lower abilities were more likely to feel excluded, or be actively excluded, based on ability,[89–91] as many schools offer invitational or auditioned music courses for highly skilled students. Part of a students' mental wellness includes a sense of belonging[16,17] and the exclusivity of these ensembles could undermine other benefits of being enrolled in a music course for students not included in the higher level ensembles. Students enrolled in music courses are also more likely to face bullying from their peers compared to students not taking arts-related courses.[41]

No studies were found that looked at the relationship between high school music education and receiving a diagnosis of a specific mental disorder. Despite this, there have been recent studies connecting artistic pursuits (music and otherwise) to changes in mental disorder symptoms or the risk of diagnoses. A Swedish study showed that residents who grew up in the country and ever enrolled in a performing arts (music, dance, or theatre and drama) post-secondary program were at 19% increased odds of being hospitalized with depression compared to students who enrolled in a law or jurisprudence program, after adjusting for familial factors.[24] The timing of this hospitalization (before, during, or after the post-secondary program) was not determined. A twins study conducted in Sweden concluded that, while the twin who played an instrument was more likely to self-report mental health challenges or receive a mental health diagnosis, this was largely attenuated by other environmental factors.[25]

Several researchers looked at learning music outside of music therapy as an intervention for ADHD and found a positive relationship with success in other areas or a reduction in the severity of symptoms.[21,22] Another study found that reading comprehension scores for students diagnosed with ADHD increased while listening to music while their peers without ADHD did not have any change in comprehension score or had decreased scores under the same circumstances.[23]

As described above, there is a link between participating in music and an improved sense of wellbeing. But in the school environment, the musical ability of students can be associated with feelings of exclusion and lead to increased bullying of music students.[28,41] Among young adults diagnosed with a mental disorder, the evidence regarding the association with taking music courses is conflicting.

In addressing the relationship between music education and mental disorders, other factors associated with mental disorders need to be considered. The relationship between sex and mental disorder diagnosis depends on the mental disorder, and can vary based on factors such as age and disorder definition. For diagnosis first made in adolescence, ADHD was equally diagnosed among males and females,[92–94] mood or anxiety disorders were more common among females,[73] and there was no significant sex difference for substance use among Manitoban youth.[73] Students living in lower SES areas were more likely to be diagnosed with a mental disorder.[63,73] Individuals diagnosed with a mental disorder were more likely than their peers to receive a subsequent diagnosis than individuals with no prior diagnosis of a mental disorder.[95–98]

Students assessed as more engaged in their learning were less likely to face later mental health challenges associated with anxiety, depressive symptoms, or problem substance use.[68,99] Environmental factors in a student's home life such as residential mobility,[69,100] living in a family receiving employment and income assistance,[73] or having contact with child and family services[73] were positively associated with being diagnosed with a mental disorder.

2.5: Canadian Context

The literature reviewed above is based primarily on studies conducted in the United States. The limited Canadian studies available present similar findings to those found in the United States relating to the association between music education and academic achievement.

Two small-scale studies in the province of Quebec found significantly better academic outcomes for students taking music courses or lessons compared to those not.[9,10] A study conducted in Toronto with 144 6-year-old children offered "standard" keyboard lessons, Kodaly technique voice lessons, drama lessons, or no arts lessons and compared IQ, pattern recognition, English and Math skills, and social skills before and after exposure. The researchers found no significant increases in several measures of academic achievement and parent-rated maladaptive social behaviour among students offered lessons over those who were not.[8] An additional study in the Greater Toronto Area looking at the relationship between personality and the duration of regular music playing found that those playing the longest scored highest on measures of "openness-to-experience" as a personality trait among both young adults and preteen aged children.[26] However, these individuals were also more likely to come from more affluent families.[26]

A large study in the province of British Columbia used administrative data from across the province, containing records from more than 180,000 eligible students over three academic years.[6] However, this study falls short of the one done by Fitzpatrick in the United States as no adjustments for other potential influential factors were made, nor were distinctions made between SES groups. Their results showed a significant positive correlation between a variety of music courses and grade 11 and 12 final marks in academic courses.[6] This study examined different music course types separately – band, choir, composition, and orchestra. Taking band in grade 11 was associated with higher achievement in all core courses, while other music course types did not demonstrate consistent improvement in all core courses.[6] Due to the lack of adjusting for potential confounders, the results must be interpreted with caution.

A follow up to the Gouzouasis et al. study using the same databases and more recent years that controlled for several confounders made similar conclusions,[4] strengthening the Canadian findings of music courses having a positive association with academic outcomes. In contrast to studies conducted in the United States, Guhn et al. found that after adjusting for previous academic achievement and socioeconomic factors, there remained a significant difference in grade 12 language arts exam scores between music and non-music students, with music students having better scores.[4] Higher marks in music courses were also associated with higher marks on the grade 12 language arts exam, as was the type of music courses taken.

Despite addressing some of the limitations of the original study, there were still several limitations to the Guhn et al. study that may reduce its relevance to the broader student population even within the province of BC. The primary limitation was the researchers' decision to include only six common music courses with other music courses as prerequisites, thus excluding students who chose to take non-traditional, uncommon, or courses without prerequisites (such as guitar or music appreciation/general music courses). Another factor that may have affected their findings was the decision to group students living in urban areas (i.e., with populations greater than 90,000 residents) with students living in rural areas, as this might have implications for access to services, the quality or variety of courses, or school resources to support course enrollment for low-income students. This in turn could affect the observed relationship between music courses and academic outcomes in areas they report as rural. The potential differences in music course enrollment between urban and rural students was not addressed, which could have an effect on the reported overall proportion of students taking music courses. The other major difference between their study and previous research which makes it difficult to directly compare the results was the grade levels included – Guhn et al. only included students in grade 10 to 12 during the study period, whereas most studies looked at younger students until grade 9 or 10. Any of these decisions could have contributed to their findings not aligning with those of research from the United States.

Three of these six Canadian studies looking at academic outcomes adjusted for social confounders;[4,9,26] the remaining studies noted this lack of adjustment as a limitation.[6,8,10] These social factors may be associated with the type of student attracted to music programs and thus contribute to the significance of findings. The limitations of the Canadian studies, specific populations or programs[9,10,26] and lack of adjusting for potential confounders,[6,8,10] prevent the results from being meaningfully extrapolated to the broader population.

One Canadian study addressed the connection between a targeted music program and student's mental wellness among low-income elementary school students in Montreal by conducting interviews and focus groups with students participating in this program. These researchers found that participating in this program gave students opportunities to "learn to cope with stress, be patient and respectful, confident, and made them feel proud".[19] These students also noted that they felt they belonged to the community and like they could bring something of interest to conversations with their families and peers. But contrary to this study, Schellenberg found no difference between music and non-music students in terms of social behaviour.[8]

These Canadian studies have similar results to those from other countries, in that they demonstrate a positive relationship between taking music and academic outcomes. These studies also align with others looking at mental wellness, in that being part of a music program was related to a sense of pride and community for music students. There have been no Canadian studies looking at music courses and a mental disorder diagnosis.

2.6: Framework

The framework presented by Bronfenbrenner was used to guide the study design and interpretation of the findings. This framework conceptualizes the environments an individual interacts with.[101] It speaks to the interactions between children, their family and social environments, their broader neighbourhood, and the influence of provincial, national, and global policies.[101] The first level of this framework, the microsystem, includes factors and relationships with a direct influence on the individual, such as their families, friends, or teachers. The second level, the mesosystem, includes how different relationships within the first level interact with each other to have a direct influence on the individual. An example would be a parent-teacher conference, with two separate microsystems (parent-child, teacher-child) interacting. Third is the exosystem, which includes factors in the individual's larger social environment, such as the school system, with an indirect influence. The macrosystem includes broader societal and cultural patterns such as gender roles and government policies. The final level has been termed the chronosystem and considers the compounding influence of changes to the person or their environment over time.[102] The framework provides a basis for understanding that a change in any part of the child's environment can affect a change for the child. This study will focus primarily on the relationship with music education between various microsystem factors over time. Although it is hypothesized that music education within schools is positively associated with the adolescent's academic and mental health outcomes, it is also recognised that individual and family factors play a role not only in these outcomes, but also in who enrols in music courses and that a myriad of factors influence students' outcomes. These factors range from sex and SES to history of mental disorders and student engagement in learning.

2.7: Music Education in Manitoba

Music education is offered in several forms to Manitoba high school students, with the focus being making music as a group. The most commonly offered courses in Manitoba are concert band, choir, jazz band, and guitar.[1] In recent years, as the Manitoba arts curriculum has been updated, a greater variety of music courses are being offered such as music technology, Indigenous music, and fiddling.[1] These types of courses are included under the umbrella term "music education" as there is no differentiation of subject content in the coding.[103]

The music curriculum in Manitoba offers some unique challenges and opportunities to students. Music programs offered to students in Manitoba are robust and varied,[1] and a survey found that school principals felt a moderate level of multicultural and Aboriginal programming was included in their classes.[104] A report focused specifically on Manitoba schools found that most school principals (70.5%) and divisional administration (79.3%) believed their staff to consider music just as important as other academic subjects.[104]

While there are ample music programs and other learning opportunities available to Manitoba students, the *Administration and Implementation Guide for Grades 9 to 12 Arts Education* recommends, "scheduling that ensures equitable access to arts education…so that students do not have to choose between [compulsory and arts courses]".[1] The presence of this recommendation suggests that scheduling conflicts remain a barrier for students wanting to enroll in music courses while also taking courses required for graduation or admission to University programs.

The recently re-designed Manitoba music course curriculum is designed to encourage continuous student growth using "recursive learning", that is, successive lessons build on previous knowledge or skills through guided and thoughtful repetition,[2] and to encourage students to actively engage in and guide their learning.[105,106] The Manitoba music course curriculum aims to be inclusive, continuously evolving, and to be welcoming to "diverse learners" by offering a range of learning experiences.[2] The draft statement from Manitoba Education and Training provides some of the implications of encouraging active participation in learning, such as the teacher's role as a facilitator of discussion and inquiry rather than simply passing on information.[105] This type of music instruction would likely attract students interested in inquiry and willing to engage in their learning, rather than be a passive recipient of information.

2.8: Limitations of Previous Studies

Many of the studies reviewed have one or more of several limitations. These limitations are primarily due to a lack of clarity in adjustment strategies such as confounding or moderating variables or composition of comparison groups. Other researchers chose to study small groups or specific populations, which reduces the generalizability of findings. In considering the Canadian context, many of the available studies were conducted in the United States.[11–14,21,31,41,48,58] Due to the differences in health and education systems, the generalizability of these studies to Canadian students may be limited.

Previous studies, both in Canada and abroad, investigating the association between music and academic outcomes used a variety of recruitment strategies. Some studies were designed as an intervention among vulnerable children using an "opt-in" system introducing potential bias based on the personality and values of the family,[9,23] while others were targeted toward a specific population,[5,10,11,27] or participants were specifically sought out for participation.[31,82] In other studies, the recruitment process was vague or not stated.[26] Several studies have also looked at specific populations, such as youth in the justice system[16,28] or students living in low income areas.[9,33] Five studies found used administrative data, only one of which looked at mental illness diagnoses.[4,6,14,15,24] The mental illnesses examined were only in the context of hospitalizations among post-secondary students and did not include high school courses.[24] The several studies conducted by Elpus and colleagues used the national surveys of high school students in the United States in lieu of music-focused surveys or administrative data.[12,29,30,41,107,108] This may have overlooked factors specific to the relationship between music courses and student outcomes, such as program quality or course variety, that other data might have available. Surveys are also vulnerable to recall bias and important contextual information for students may have been missed or forgotten.

There were similar issues with studies looking at the relationship between music and mental illness. There were two broad categories of these studies – those that examined mental illness through either registry or self-report data and those that looked at mental wellbeing more broadly. The two studies looking at the relationship between music participation and mental illness diagnosis were both conducted in Sweden with adults,[24,25] and so it is unknown whether the results would generalize to adolescents in the Canadian context. Studies looking more broadly at mental wellness usually used surveys or self-report of symptoms or challenges[18,19,25,88] but two of these studies had limited or lack of adjustment for potential confounders.[18,88] Merati et al.'s study examined a specific population thereby limiting its generalizability and used focus groups to determine thematic similarities between responses rather than attempt to determine symptoms or other challenges that were improved.[19] There were no Canadian studies looking at high school students who received a diagnosis of a mental disorder.

Previous research examining the relationship between music and student outcomes have not accounted for confounders, although several studies have identified factors related to music-associated benefits. Elpus identified confounding factors related to music-associated benefits including: income level, parental education, family structure, prior academic achievement, gender, ethnicity, and native language.[12] Other researchers identified moderating factors instead: income level,[31] family structure,[31] prior academic achievement,[31] gender,[31] ethnicity,[31] residential mobility,[31] and student engagement.[67] This thesis will fill the identified gaps and address some of the challenges in the existing literature.

Chapter 3: Data and Methods

3.1: Objectives

The objective of this study was to examine the association between the number of high school music courses taken, academic outcomes in grade 12, and mental disorders diagnosed from grade 9 to grade 12.

3.2: Research Questions and Hypotheses

1. What is the relationship between the number of high school music courses and grade 12 achievement tests scores?

    1. Hypothesis: The unadjusted analysis will demonstrate that students with music courses will have better grade 12 achievement test scores than students with no music courses.

1a. Does sex moderate the relationship between the number of high school music courses and grade 12 achievement tests scores?

1a. Hypothesis: The relationship between the number of high school music courses and grade 12 achievement test scores will vary by sex.

1b. Does income quintile moderate the relationship between the number of high school music courses and grade 12 achievement tests scores?

1b. Hypothesis: The relationship between the number of high school music courses and grade 12 achievement test scores will be stronger among low-income students compared with high-income students.

1c. Does the relationship between the number of high school music courses and grade 12 achievement test scores results change in terms of magnitude after adjusting for sex, SES, residential mobility, social services, previous diagnosis of a mental disorder, previous academic achievement, and student engagement?

1c. Hypothesis: Accounting for potential confounders will attenuate the relationship between the number of music courses and grade 12 test scores.

2. What is the relationship between the number of high school music courses and on-time graduation rates?

2. Hypothesis: The unadjusted analysis will demonstrate that students with music courses will be more likely to graduate on time than students with no music courses.

2a. Does sex moderate the relationship between the number of high school music courses and on-time graduation rates?

2a. Hypothesis: The relationship between the number of high school music courses and on-time graduation rates will vary by sex.

2b. Does income quintile moderate the relationship between the number of high school music courses and on-time graduation rates?

2b. Hypothesis: The relationship between the number of high school music courses and on-time graduation rates will be stronger among low-income students compared with high-income students.

2c. Does the relationship between the number of high school music courses and on-time graduation rates change in terms of magnitude after adjusting for sex, SES, residential mobility, social services, previous diagnosis of a mental disorder, previous academic achievement, and student engagement?

2c. Hypothesis: Accounting for potential confounders will attenuate the relationship between the number of music courses and on-time graduation rates.

3. What is the relationship between the number of high school music courses and the incidence of mental disorder diagnoses throughout grade 9 to 12?

3. Hypothesis: The unadjusted analysis will demonstrate that students with music courses will have lower mental disorder diagnosis rates than students with no music courses.

3a. Does sex moderate the relationship between the number of high school music courses and the incidence of mental disorder diagnoses?

3a. Hypothesis: The relationship between the number of high school music courses and mental disorder diagnosis incidence will vary by sex.

3b. Does income quintile moderate the relationship between the number of high school music courses and the incidence of mental disorder diagnoses?

3b. Hypothesis: The relationship between the number of music courses and mental disorder diagnosis incidence will be stronger among low-income students compared with high-income students.

3c. Does the relationship between the number of high school music courses and the incidence of mental disorder diagnoses change in terms of magnitude after adjusting sex, SES, residential mobility, social services, previous diagnosis of a mental disorder, previous academic achievement, and student engagement?

3c. Hypothesis: Including potential confounders will attenuate the relationship between number of music courses and incidence of mental disorder diagnoses.

3.3: Study Design, Setting

This is a retrospective cohort study that used health, education, and social services administrative data, and census data. The cohort consisted of students attending a school in Winnipeg, the capital city of the Canadian province of Manitoba. Only students who attended a high school offering music courses between the 2009/10 to 2016/17 school years in a Winnipeg school division were included in this study.

3.4: Participants

To be eligible for inclusion, students needed to have continuous Manitoba Health coverage from age 6 years until four years after grade 9 start, attended a Winnipeg high school between the 2009/10 to 2016/17 academic years from the beginning of grade 9 until four years after grade 9, and valid scores for grade 7 and 8 academic assessments. Students were not followed after June 30 of their on-time graduation year (four years after the start of grade 9). This process excluded students who were held back a year or who skipped ahead a year at any point.

The cohort was limited to students who attended a high school in Winnipeg in order to compare students with access to similar programs, who lived in a similar urban environment, and to account for unmeasured factors that may differ between urban and rural students. Students could have been living anywhere in the province, but must have been enrolled in a Winnipeg school from their grade 9 through grade 12 years. As such, this was not a provincial study, but rather focused on students who attended Winnipeg schools.

These selection criteria restrict the generalizability of results to students who have lived in the province for an extended period and attended a high school in Winnipeg. The results may not apply to rural areas or students who spent less time in the province.

3.5: Data Sources

The databases used for this study are housed in the Manitoba Population Research Data Repository (Repository) at the Manitoba Centre for Health Policy (MCHP). These data are administrative, that is, collected during routine interactions with provincially funded services available to residents. The data received by MCHP have been linked at the individual level and stripped of identifying information such as name and address and assigned a unique identifier. The data available for this study set a very broad definition for music education which includes instrumental music, choir, composition, and music technology classes.[1]

The following databases were used for this study:

- Enrollment, Marks, and Assessments to measure music course enrollment, grades 7 and 8 assessment results, achievement test scores in grade 12, and on-time graduation status;

- Manitoba Health Insurance Registry to determine students with Manitoba Health coverage and basic demographic information using their scrambled Personal Health Identification Number (PHIN);
- Medical Claims to identify mental disorder diagnoses through physician visits;
- Hospital Discharge Abstracts to identify mental disorder diagnoses and date of diagnosis;
- Drug Program Information Network to determine the use of mental disorder related prescription medications;
- Canada Census to determine the area-level income quintile of the student at grade 8 completion;
- Employment and Income Assistance (EIA) from the Social Allowances Management Information Network (SAMIN) database to determine students living in a family receiving EIA; and
- Child and Family Services Information System (CFSIS) to determine students who were in out-of-home care or whose families have received protection or support services from Child and Family Services (CFS).

3.6: Variables

Outcome variables

Educational outcomes in grade 12: Data for final marks for grade 12 achievement test scores (mathematics and language arts) and on-time high school graduation were used. On-time graduation indicates that the student fulfilled the requirements for graduation within four years of starting grade 9.

Mental disorder diagnosis through grade 9-12: The first diagnosis of any of three mental disorders – Mood or Anxiety Disorders, ADHD, and Substance Use Disorder were examined from grade 9 to June 30 of the student’s on-time graduation year. Only the first diagnosis of the mental disorder of interest (defined using the first instance of a diagnosis from the hospital discharge abstract, medical claims, and drug program information network databases) from January 1 onward of the student’s grade 9 year was considered for analysis to allow time for music course exposure. The diagnosis and prescription drug codes used are listed in Appendix A.

Exposure variable

High-School music course registration: Students were grouped into one of four categories of high school music education: none, 1-2, 3-5, or 6+ music courses. This information was available in the Enrollment, Marks, and Assessment database. All courses coded as music courses in the education database were considered part of music education. The codes to identify music courses are listed in Appendix A.

Covariates

Grade 7 and 8 academic assessments were available in the 2007/08 school year to measure academic status prior to high school music courses. All covariates except for a prior diagnosis of a mental disorder were measured during the student's grade 7 and 8 school years.

Student sex: This was identified as male or female using the Manitoba Health Insurance Registry.

Income Quintile: This was identified using neighbourhood-level data on average household income from the 2016 Canada Census. Income was divided into quintiles based on the average household income level with Quintile 1 the lowest average income and Quintile 5 with the highest average income. Each student was assigned to an income quintile based on their postal code of residence at completion of grade 8. Urban and rural quintiles were determined separately then combined into overall quintiles.

Residential mobility: Students were categorized according to how often they changed addresses during grade 7 or 8. This variable was defined based on students' postal code of residence from the Manitoba Health Insurance Registry.

Receipt of Employment or Income Assistance (EIA): This is financial support for families and individuals with no other way to support themselves, and includes housing costs and employment assistance.[109]

Contact with Child and Family Services: Child and Family Services (CFS) offer several support and protection programs to children and their families to prevent children from entering foster care.

In the care of Child and Family Services: Children are taken into care when it is deemed unsafe for them to remain with their family.

Mental disorder diagnosis prior to grade 9: These children have been diagnosed with any of ADHD, a mood or anxiety disorder, or a substance use disorder prior to January 1 of their grade 9 year as defined using the hospital discharge abstract, medical claims, and drug program information network databases. Diagnosis criteria are listed in Appendix A.

Grade 7 mathematics assessment: The established definition of this variable was the assessments from Manitoba Education. Starting in the 2007/08 school year, all grade 7 students were assessed for mathematics competency. These assessments were grouped as ‘Meeting or Approaching’ expectations in all competencies and ‘Not Meeting’ expectations. There were five competencies assessed: orders fractions; orders decimal numbers; understands that a given number may be represented in a variety of ways; uses number patterns to solve mathematical problems; and uses a variety of strategies to calculate and explain a mental mathematics problem.[110]

Grade 7 Student Engagement: The established definition of this variable was the grade 7 student engagement competencies from Manitoba Education. Starting in the 2007/08 school year, all grade 7 students were assessed for engagement. Students were grouped as ‘Established or Developing’ expectations in all competencies and ‘Emerging, Inconsistent, or Out of Scope’. There were five competencies assessed: demonstrates an interest in his/her learning; engages in self-assessment; aware of learning goals as a unit of study and/or personal learning goals; participates in lessons; and accepts responsibility for assignments.[110]

Grade 8 student academic assessments: The established definition of this variable was the grade 8 reading and writing competencies from Manitoba Education. Starting in the 2007/08 school year, all grade 8 students were assessed for reading and writing competency. Grade 8 assessments were grouped as ‘Meeting or Approaching’ expectations in all assessment categories and ‘Not Meeting’ expectations. There were six competencies assessed: understands key ideas and messages in a variety of texts; interprets a variety of texts; responds critically to a variety of texts; generates, selects and organizes ideas to support the reader’s understanding; chooses language (word choices and sentence patterns) to make an impact on the reader; and uses conventions (spelling, grammar, and/or punctuation) and resources to edit and proofread to make meaning clear.[110]

3.7: Approvals

Approval for this project was received from the Health Information Privacy Committee, the University of Manitoba Health Research Ethics Board, Manitoba Education, and Manitoba Families. The data used in this study were de-identified by Manitoba Health, so personal identifiers were removed and there is a low risk for individuals to be identified. Although six-digit postal codes were required to link census data to other database records, results are not presented at the postal code or school division level. There was no direct access to the study population and no attempt was made to identify specific individuals.

3.8: Statistical Methods

Prior to any statistical comparisons of music and non-music students, the demographics of Winnipeg high school students enrolled and not enrolled in music courses were examined for existing systematic differences. Chi-squared tests were used to determine whether there were statistically significant differences in the characteristics of students across music groups. For the outcome demographics, t-tests and ANOVA were used to compare final marks on grade 12 achievement test scores. Differences were considered significant at $p<.05$.

The first research question used linear regression to examine the relationship between the number of high school music courses taken and grade 12 achievement test scores. Marks were recorded as a continuous score from 0% to 100%. Linear regression was designed to compare continuous outcome values between groups.

The second research question used logistic regression to compare whether or not a student graduated on time between music student groups. Logistic regression was designed to compare dichotomous categorical outcomes between groups.

To examine the relationship between the number of high school music courses taken and mental disorder diagnoses, survival analysis was used. This type of analysis was chosen as a mental disorder can be diagnosed at any time from grade 9 to 12, and it was designed to take the temporal relationship into consideration when determining the risk of an outcome occurring.

To further examine the relationships between the number of high school music courses taken and the academic outcomes and mental disorders, interaction terms for the number of courses taken by sex and number of courses taken by income quintile were tested in separate models. Interaction terms were used to determine if sex or income quintile moderate the relationship between music courses and student outcomes, especially if there might be an opposite association that would make the overall association not significant.

The relationship between taking high school music courses and later outcomes was analyzed based on the number of music courses a student took as well as a dichotomous measure of music enrollment. Analyzing the relationship by the number of music courses taken provided more detail about the relationship between music course enrollment and student outcomes than simply a dichotomous response. The dichotomous analysis was conducted in case the relationship was different than when broken into music groups. The conclusions from these analyses were similar and are presented in Appendix B.

Chapter 4: Results

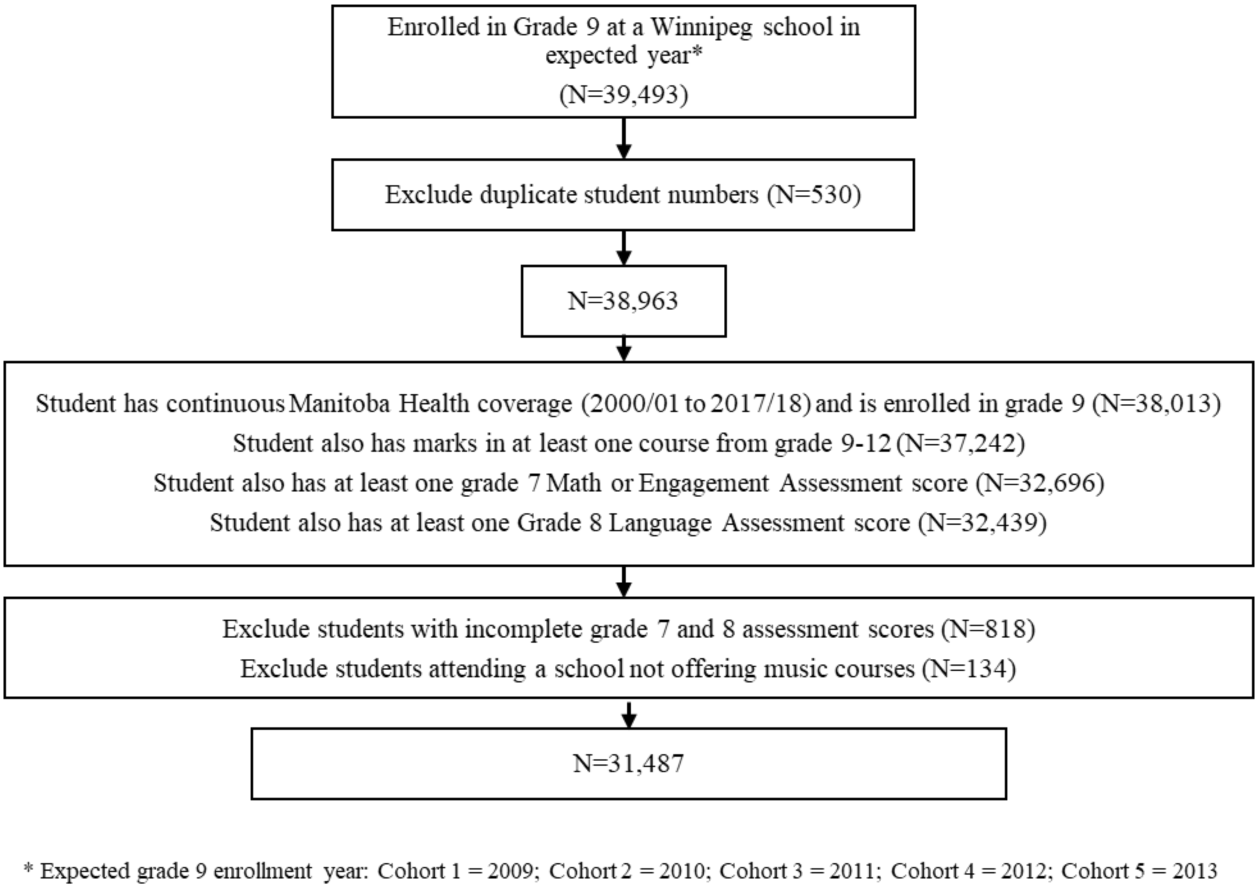
4.1: Descriptive Information

4.1.1: Cohort Formation

As shown in Figure 1, there were 39,493 students enrolled in grade 9 in Winnipeg schools during the expected year for their cohort. Among these students, there were 38,013 students with continuous health coverage between age 6 and grade 12. Excluding students without final marks in at least one high school course (771), without complete assessments in grade 7 and 8 (5,621), and who attended schools not offering music courses (134) resulted in a final study cohort of 31,487.

Most high schools in Winnipeg offered music courses. Four schools had fewer than five students who had taken a music course for credit. These low numbers prevented meaningful comparison, and therefore school-level demographics are not shown. Students attending these schools were excluded from further analysis, and are not included in the student-level tables.

Figure 1: Student Cohort Formation Flowchart



As the focus of this study was to examine the incidence of mental disorder diagnosis after being exposed to music courses, students with a diagnosis of ADHD, mood or anxiety disorders, or substance use disorder prior to grade 9 were excluded from the appropriate analyses. This provided reasonable assurance that Grade 9 students began the study period without the diagnosed mental disorder under examination.

4.1.2: Baseline Student Characteristics

Characteristics of students included in this study are shown in Table 1. 12,363 students, or 39.3%, were enrolled in at least one music course between grade 9 to 12. Of students enrolled in at least one music course, 53.3% enrolled in 1-2 music courses, 27.4% enrolled in 3-5 music courses, and 19.3% enrolled in 6+ music courses. Music course enrollment varied across grade 7 start years.

Table 1 shows the differences prior to high school between students enrolled and not enrolled in music courses in high school. For all variables, there were statistically significant differences across music groups (p<.05) with the exception of substance use disorders. In general, students who enrolled in music courses were more often female or more likely to have positive outcomes than students who enrolled in no music courses even before the start of high school.

The tables in Appendix B1 compare the baseline characteristics of students who took any music courses and no music courses, and show similar trends.

Table 1: Baseline Characteristics of Students Enrolled and Not Enrolled during Grade 9-12 by Number of Music Courses, 2000/01-2016/17

Variable	No Music Courses N=19,124	1-2 Music Courses N=6,589	3-5 Music Courses N=3,393	6+ Music Courses N=2,381
	N (%)	N (%)	N (%)	N (%)
Grade 7 start year*				
2007	3,953 (20.7)	1,410 (21.4)	694 (20.5)	472 (19.8)
2008	3,839 (20.1)	1,424 (21.6)	753 (22.2)	462 (19.4)
2009	3,828 (20.0)	1,226 (18.6)	608 (17.9)	440 (18.5)
2010	3,686 (19.3)	1,314 (19.9)	655 (19.3)	455 (19.1)
2011	3,818 (20.0)	1,215 (18.4)	683 (20.1)	552 (23.2)
Sex*				
Male	10,663 (55.8)	3,120 (47.4)	1,428 (42.1)	1,133 (47.6)
Female	8,461 (44.2)	3,469 (52.7)	1,965 (57.9)	1,248 (52.4)
Income Quintile in Grade 8*				
Income not Found and Q1 (Lowest)	3,668 (19.2)	1,338 (20.3)	422 (12.4)	212 (8.9)
Q2	3,478 (18.2)	1,255 (19.1)	570 (16.8)	341 (14.3)
Q3	3,662 (19.2)	1,220 (18.5)	660 (19.5)	437 (18.4)
Q4	4,204 (22.0)	1,332 (20.2)	817 (24.1)	582 (24.4)
Q5 (Highest)	4,112 (21.5)	1,444 (21.9)	924 (27.2)	809 (34.0)
Residential mobility*				
No moves in grade 7 and 8	14,731 (77.0)	5,208 (79.0)	2,782 (82.0)	2,059 (86.5)
One move in grade 7 and 8	3,622 (18.9)	1,172 (17.8)	514 (15.2)	288 (12.1)
Two moves in grade 7 and 8	771 (4.0)	209 (3.2)	97 (2.9)	34 (1.4)
Living in a Family Receiving Employment and Income Assistance in Grade 7 or 8*				
Yes	3,089 (16.2)	829 (12.6)	227 (6.7)	64 (2.7)
No	16,035 (83.9)	5,760 (87.4)	3,166 (93.3)	2,317 (97.3)
Student's Family had Contact with Child and Family Services in Grade 7 or 8*				
Yes	2,419 (12.7)	567 (8.6)	161 (4.8)	58 (2.4)
No	16,705 (87.4)	6,022 (91.4)	3,232 (95.3)	2,323 (97.6)
Student was in the Care of Child and Family Services in Grade 7 or 8*				
Yes	688 (3.6)	141 (2.1)	32 (0.9)	6 (0.3)
No	18,436 (96.4)	6,448 (97.9)	3,361 (99.1)	2,375 (99.8)

* Student characteristics are significantly different across music groups (p<.05)

Table 1: Continued

Variable	No Music Courses N=19,124	1-2 Music Courses N=6,589	3-5 Music Courses N=3,393	6+ Music Courses N=2,381
ADHD Diagnosis prior to Grade 9*				
Yes	2,276 (11.9)	590 (9.0)	230 (6.8)	140 (5.9)
No	16,848 (88.1)	5,999 (91.1)	3,163 (93.2)	2,241 (94.1)
Mood or Anxiety Disorder Diagnosis prior to Grade 9*				
Yes	1,433 (7.5)	440 (6.7)	184 (5.4)	135 (5.7)
No	17,691 (92.5)	6,149 (93.3)	3,209 (94.6)	2,246 (94.3)
Substance Use Disorder Diagnosis prior to Grade 9				
Yes	49 (0.3)	s	s	s
No	19,075 (99.7)	s	s	s
Any Diagnosis of ADHD, Mood or Anxiety disorders, or Substance Use Disorder Prior to Grade 9*				
Yes	3,341 (17.5)	949 (14.4)	384 (11.3)	250 (10.5)
No	15,783 (82.5)	5,640 (85.6)	3,009 (88.7)	2,131 (89.5)
Meeting or Approaching Expectations in Grade 7 Numeracy Skills*				
Yes	13,302 (69.6)	4,909 (74.5)	2,781 (82.0)	2,121 (89.1)
No	5,822 (30.4)	1,680 (25.5)	612 (18.0)	260 (10.9)
Established or Developing Skills in Grade 7 Student Engagement*				
Yes	11,677 (61.1)	4,411 (66.9)	2,616 (77.1)	1,942 (81.6)
No	7,447 (38.9)	2,178 (33.1)	777 (22.9)	439 (18.4)
Meeting or Approaching Expectations in Grade 8 Reading and Writing Skills*				
Yes	15,222 (79.6)	5,627 (85.4)	3,134 (92.4)	2,273 (95.5)
No	3,902 (20.4)	962 (14.6)	259 (7.6)	108 (4.5)

* Student characteristics are significantly different across music groups ($p<.05$)

Note: Percents may not add to 100% due to rounding.

s indicates suppression due to small numbers

Table 2 shows the percentage of education and mental disorder outcomes among each of the music student groups.

For all variables, there was a statistically significant differences across music groups ($p<.05$). In general, a higher percent of students who enrolled in 6+ music courses had better grade 12 outcomes than students with no music courses and a lower percent were diagnosed with a mental disorder. For example, among students who wrote their grade 12 tests, there was about a ten percentage-point difference between students with no music courses and those with 6+ music courses.

Table 2: Percentage of Education and Mental Disorder Outcomes for Students by Number of Music Courses, Students in grade 9-12 attending a high school from 2009/10-2016/17

Variable	No Music Courses N=19,124	1-2 Music Courses N=6,589	3-5 Music Courses N=3,393	6+ Music Courses N=2,381
	N (%)	N (%)	N (%)	N (%)
Educational Achievement				
Wrote Grade 12 Mathematics Achievement Test*	16,014 (83.7)	5,901 (89.6)	3,300 (97.3)	2,371 (99.6)
Average Final Mark in Grade 12 Mathematics Achievement Test (%)*	58.2	59.3	63.7	68.0
Wrote Grade 12 Language Arts Achievement Test*	16,004 (83.7)	5,897 (89.5)	3,298 (97.2)	2,371 (99.6)
Average Final Mark in Grade 12 Language Arts Achievement Test (%)*	67.6	69.0	73.2	76.7
Graduated On Time*	14,375 (75.2)	5,426 (82.4)	3,177 (93.6)	2,349 (98.7)
Mental Disorder diagnosis from grade 9-12				
ADHD (N=28,251)*	N=16,848 636 (3.8)	N=5,999 191 (3.2)	N=3,163 97 (3.1)	N=2,241 67 (3.0)
Mood or Anxiety Disorders (N=29,295)*	N=17,691 4,461 (25.2)	N=6,149 1,518 (24.7)	N=3,209 725 (22.6)	N=2,246 508 (22.6)
Substance Use Disorder (N=31,415)*	N=19,075 693 (3.6)	N=6,570 149 (2.3)	N=3,391 42 (1.2)	N=2,379 12 (0.5)
Any Mental Disorder** (N=26,563)*	N=15,783 4,231 (26.8)	N=5,640 1,455 (25.8)	N=3,009 716 (23.8)	N=2,131 496 (23.3)

* Student outcomes are significantly different across music groups ($p<.05$)

** Diagnosis with any of: ADHD, Mood and Anxiety Disorders, or Substance Use Disorder

Note: Count and percent of mental disorder diagnosis from grade 9-12 based on the number of students who were not diagnosed with the specified mental disorder prior to grade 9. As students can be diagnosed with more than one mental disorder, 'Any Mental Disorder' will not reflect the sum.

4.2: Mathematics Achievement Test

4.2.1: Unadjusted Model

The coefficient in the first row of Table 3 represents the average Mathematics Achievement Test score if a student has the reference value for all of the adjustment variables. The variables in the subsequent rows indicate how much the average test score was expected to change if the student fulfills the requirements for that category. For example, the average Mathematics Achievement Test score for students with 4 music courses was: 49.27 (the starting point) + 8.54 (for being in the 3-5 music course group) = 57.81.

Students with music courses were more likely to have a higher average test score than students with no music courses.

Table 3: Unadjusted Relationship Between Number of High School Music Courses and Grade 12 Mathematics Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	49.27 (0.22)	<.0001
1-2 Music Courses (Ref=None)	2.31 (0.42)	<.0001
3-5 Music Courses (Ref=None)	8.54 (0.53)	<.0001
6+ Music Courses (Ref=None)	14.48 (0.61)	<.0001

SE = Standard error

4.2.2: Models Examining the Effects of Sex and Its Interaction with Music Courses

The interaction between sex and number of music courses was tested (Table 4) and found to be not statistically significant, and therefore the model was re-run without the interaction term.

Table 4: Interaction Between Number of High School Music Courses and Sex for Grade 12 Mathematics Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Degrees of	Mean Squares	F Value	p-Value
Number of Music Courses	3	102,971.5	133.7	<.0001
Sex	1	4,109.5	5.3	0.0209
Number of Music Courses*Sex	3	1,797.5	2.3	0.0718

When adjusted by sex (Table 5), students with music courses were more likely to have a higher average score than students with no music courses. In addition, female students on average had a higher score than male students.

Table 5: Sex-Adjusted Relationship Between Number of High School Music Courses and Grade 12 Mathematics Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	48.59 (0.27)	<.0001
1-2 Music Courses (Ref=None)	2.18 (0.42)	<.0001
3-5 Music Courses (Ref=None)	8.34 (0.53)	<.0001
6+ Music Courses (Ref=None)	14.37 (0.61)	<.0001
Sex (Ref=Male)	1.51 (0.34)	<.0001

SE = Standard error

Note: The interaction between ever taking music courses and sex was not significant, and therefore not included in the analysis.

4.2.3: Models Examining the Effects of Income Quintile and Its Interaction with Music Courses

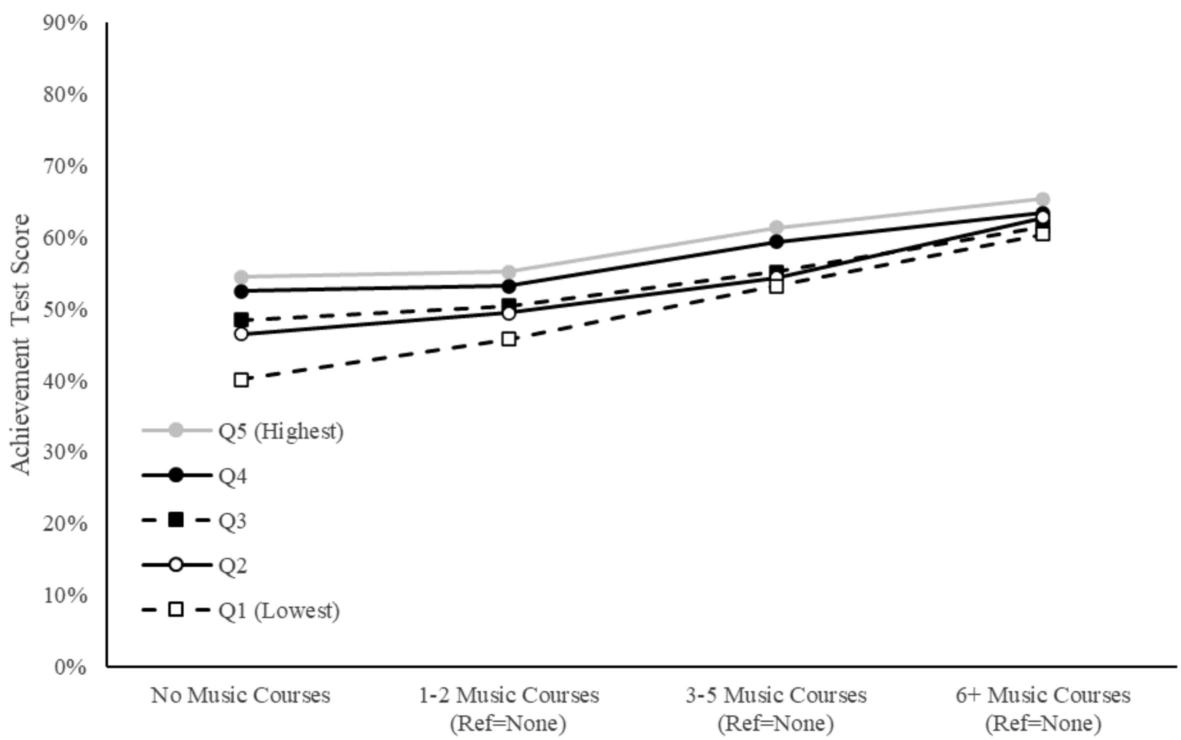
There was a statistically significant interaction between the number of music courses and income quintile (Table 6).

Table 6: Interaction Between Number of High School Music Courses and Income Quintile for Grade 12 Mathematics Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Degrees of Freedon	Mean Squares	F Value	p-Value
Number of Music Courses	3	162,126.3	215.4	<.0001
Income Quintile	4	48,615.5	64.6	<.0001
Number of Music Courses*Income Quintile	12	2,456.9	3.3	<.0001

Figure 2 shows that the relationship between music courses and Mathematics Achievement Test scores was most pronounced among students in lower income quintiles. Among students in the lowest income quintile, students with 6+ music courses scored 20.3 percentage points higher on average than students with no music courses in the same income quintile. In contrast, students living in the highest income quintile with 6+ music courses scored 10.9 percentage points higher on average than students with no music courses.

Figure 2: Relationship Between Number of High School Music Courses and Grade 12 Mathematics Achievement Test Scores by Income Quintile, 2012/13-2016/17



4.2.4: Fully Adjusted Model

When adjusted for all covariates (Table 7), the number of music courses a student took remained statistically significantly associated with the average Mathematics Achievement Test score, but at a smaller magnitude than the unadjusted relationship. The analyses conducted with music courses as a dichotomous variable yielded similar results (Appendix B2). The interaction between the number of music courses and income quintile was tested and found to be no longer statistically significant ($F = 0.97$, p = ns). Therefore, it was not included in the final analysis.

As shown in Table 7, students with music courses scored higher on average than students with no music courses. In the full model, all covariates were statistically significant at $p<.05$ except for moving two or more times in grade 7 or 8 and a prior substance use disorder diagnosis. Due to the small number of students diagnosed with a substance use disorder prior to grade 9, there was not sufficient statistical power to draw conclusions about this relationship.

Despite most covariates being statistically significantly associated with the Mathematics Achievement Test score, the full model could only account for about 16% of the variation in test scores (adjusted R^2=0.159). This suggests there are other important covariates that the available data could not account for such as teacher effectiveness, family structure, parent's education, or the home environment.

Table 7: Adjusted Relationship Between Number of High School Music Courses and Grade 12 Mathematics Achievement Test Scores, Final Model, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	34.07 (0.63)	<.0001
1-2 Music Courses (Ref=None)	1.39 (0.39)	0.0004
3-5 Music Courses (Ref=None)	5.30 (0.50)	<.0001
6+ Music Courses (Ref=None)	9.21 (0.57)	<.0001
Sex (Ref=Male)	-0.85 (0.32)	0.0078
Quintile 1 (Ref=Quintile 5)	-5.18 (0.54)	<.0001
Quintile 2 (Ref=Quintile 5)	-4.02 (0.49)	<.0001
Quintile 3 (Ref=Quintile 5)	-3.96 (0.47)	<.0001
Quintile 4 (Ref=Quintile 5)	-1.69 (0.45)	0.0001
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	-8.86 (0.61)	<.0001
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	-6.99 (0.72)	<.0001
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	-7.80 (1.46)	<.0001
1 move in Grade 7 and 8 (Ref=No Moves)	-1.08 (0.42)	0.0106
2 moves in Grade 7 and 8 (Ref=No Moves)	-1.77 (0.96)	0.0651
ADHD Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	-6.81 (0.58)	<.0001
Mood and Anxiety Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	-1.60 (0.65)	0.0132
Substance Use Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	3.05 (4.19)	0.4665
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	6.82 (0.37)	<.0001
Meeting or Approaching Expectations in Grade 7 Numeracy Skills (Ref=Not Meeting or Approaching)	8.35 (0.41)	<.0001
Meeting or Approaching Expectations in Grade 8 Reading and Writing Skills (Ref=Not Meeting or Aproaching)	11.63 (0.52)	<.0001

SE = Standard error

Note: The interaction between ever taking music courses and sex or income quintile was not significant, and therefore not included in the analysis.

4.3: Language Arts Achievement Test

4.3.1: Unadjusted Model

Students with music courses were more likely to have a higher average Language Arts Achievement Test score than students with no music courses.

Table 8: Unadjusted Relationship Between Number of High School Music Courses and Grade 12 Language Arts Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	59.67 (0.20)	<.0001
1-2 Music Courses (Ref=None)	3.11 (0.38)	<.0001
3-5 Music Courses (Ref=None)	10.19 (0.48)	<.0001
6+ Music Courses (Ref=None)	15.53 (0.55)	<.0001

SE = Standard error

4.3.2: Models Examining the Effects of Sex and Its Interaction with Music Courses

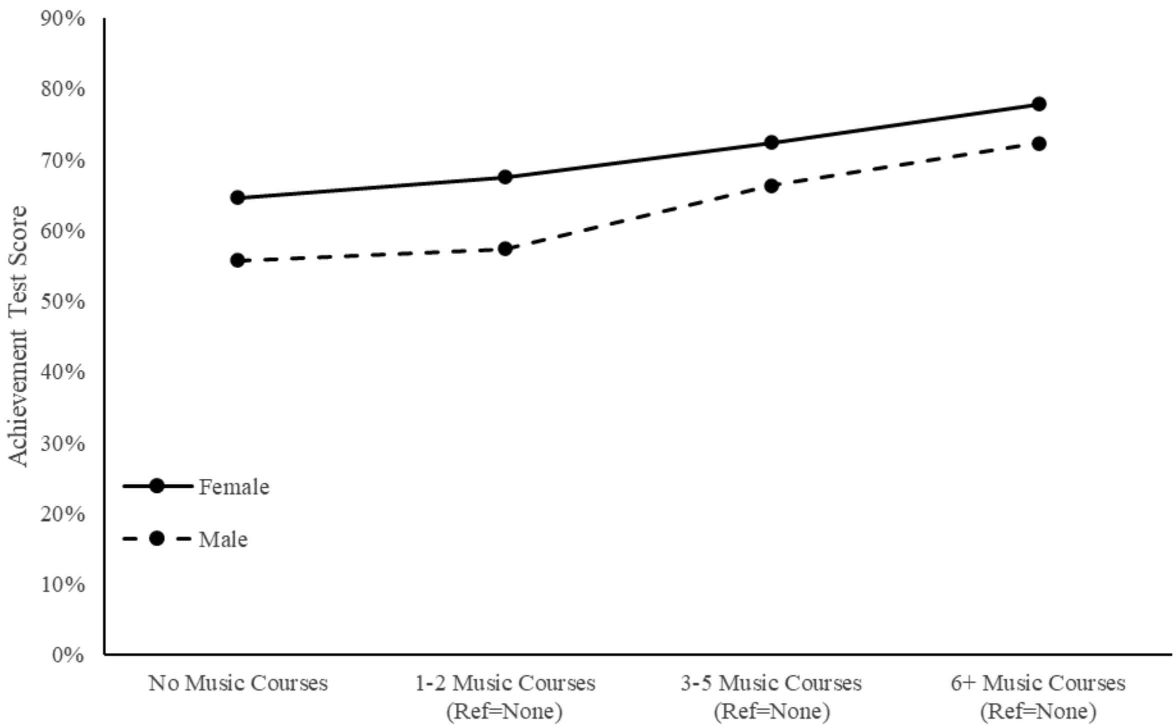
There was a statistically significant interaction between the number of music courses and sex (Table 9).

Table 9: Interaction Between Number of High School Music Courses and Sex for Grade 12 Language Arts Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Degrees of Freedon	Mean Squares	F Value	p-Value
Number of Music Courses	3	124,133.1	205.8	<.0001
Sex	1	241,586.7	400.5	<.0001
Number of Music Courses*Sex	3	4,886.4	8.1	<.0001

As shown in Figure 3, the relationship between music courses and Language Arts Achievement Test scores was different for males and females. Male students with 6+ music courses scored 16.6 percentage points higher on average than those with no music courses. In contrast, female students with 6+ music courses scored 13.3 percentage points higher than those with no music courses.

Figure 3: Relationship Between Number of High School Music Courses and Grade 12 Language Arts Achievement Test Scores by Sex, 2012/13-2016/17



4.3.3: Models Examining the Effects of Income Quintile and Its Interaction with Music Courses

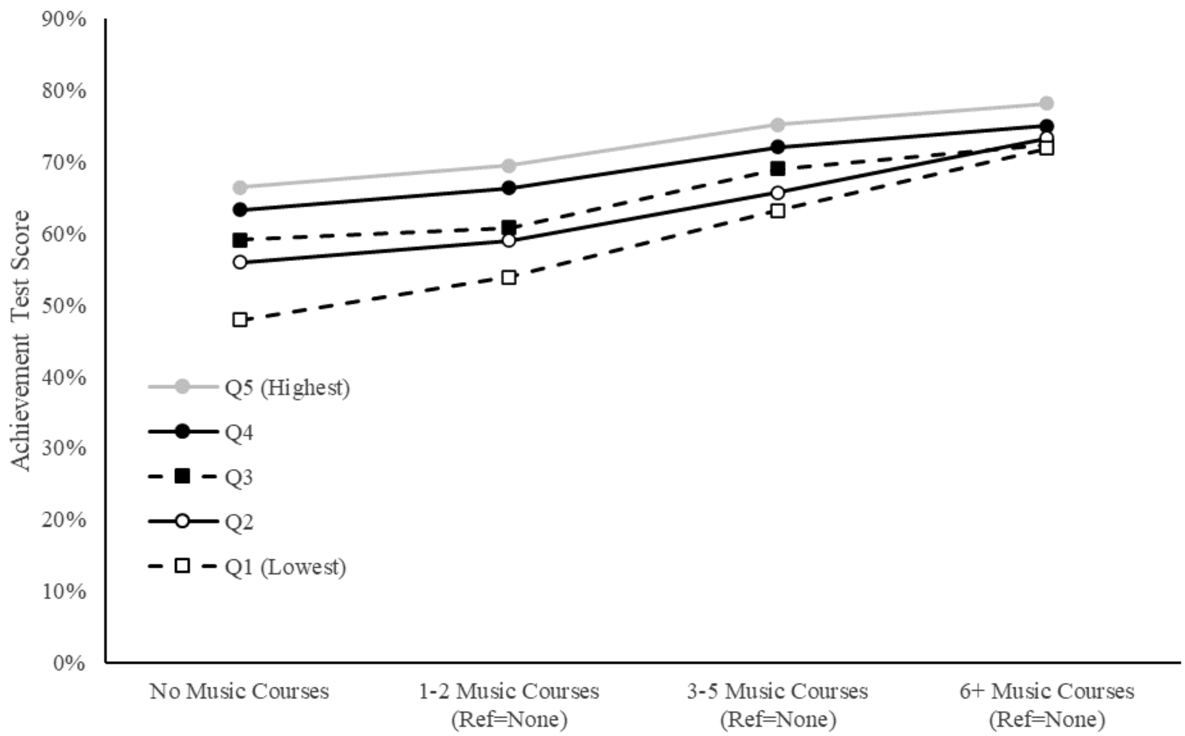
There was a statistically significant interaction between the number of music courses and income quintile (Table 10).

Table 10: Interaction Between Number of High School Music Courses and Income Quintile for Grade 12 Language Arts Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Degrees of Freedon	Mean Squares	F Value	p-Value
Number of Music Courses	3	203,694.4	345.1	<.0001
Income Quintile	4	79,448.5	134.6	<.0001
Number of Music Courses*Income Quintile	12	3,786.1	6.4	<.0001

Figure 4 shows the relationship between music courses and Language Arts Achievement Test scores was most pronounced among students in lower income quintiles. Among students in the lowest income quintile, students with 6+ music courses scored 24.0 percentage points higher on average than students with no music courses in the same income quintile. In contrast, students living in the highest income quintile with 6+ music courses scored 11.7 percentage points higher on average than students with no music courses.

Figure 4: Relationship Between Number of High School Music Courses and Grade 12 Language Arts Achievement Test Scores by Income Quintile, 2012/13-2016/17



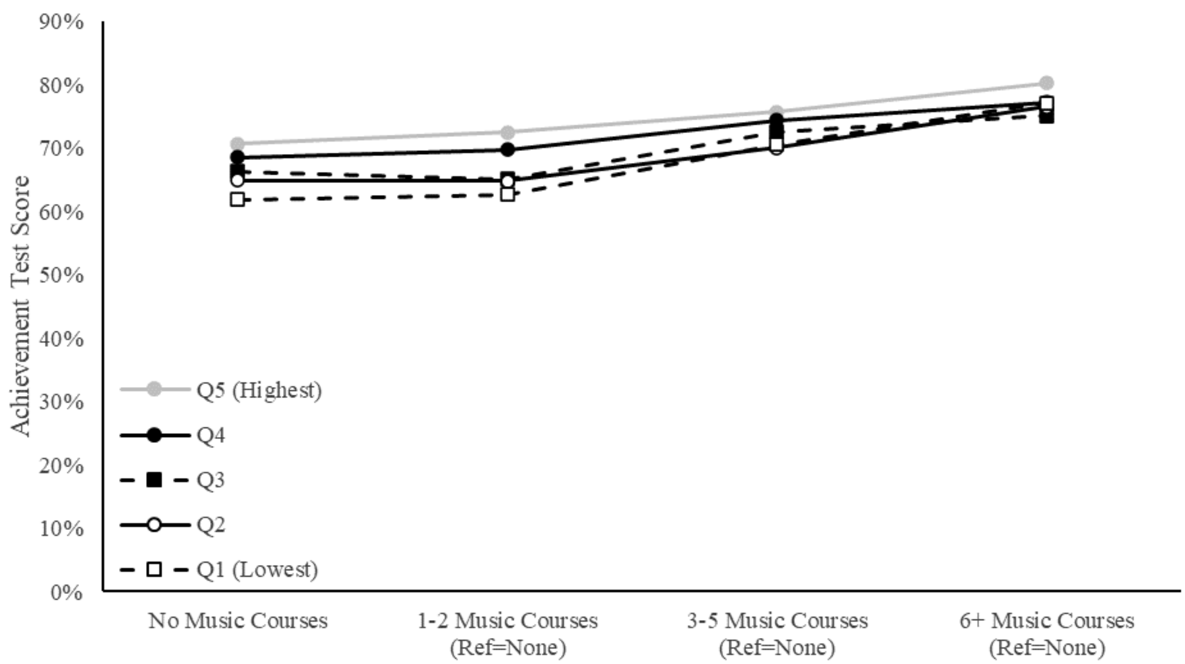
4.3.4: Fully Adjusted Model

When adjusted for all covariates, there was a statistically significant interaction between the number of music courses and sex ($F = 6.09$, $p < .001$), and between the number of music courses and income quintile ($F = 3.01$, $p < .001$). See Appendix Table 14 in Appendix B3 for the significance of specific covariates. Therefore, both interaction terms were included in the final analysis and denote that the relationship between the number of music courses a student took and the average Language Arts Achievement Test score varied by both sex and income. The analyses conducted with music courses as a dichotomous variable yielded similar results (Appendix B3).

The graphs showing the adjusted relationship between music courses and Language Arts Achievement Test scores represent the differences by income quintile between male (Figure 5) and female (Figure 6) students who were: not receiving EIA, had not had contact with CFS, were not in care of CFS, had not moved in grade 7 or 8, had no prior diagnosis of a mental disorder, had established or developing student engagement, and were meeting or approaching expectations in both grade 7 and grade 8 academic assessments. See Appendix Table 14 in Appendix B3 for the significance of specific covariates. Male students had a more pronounced increase in test scores associated with the number of music courses than female students. Students in the lowest income quintile had a more pronounced increase in test scores than higher income students. Female students scored consistently higher than male students.

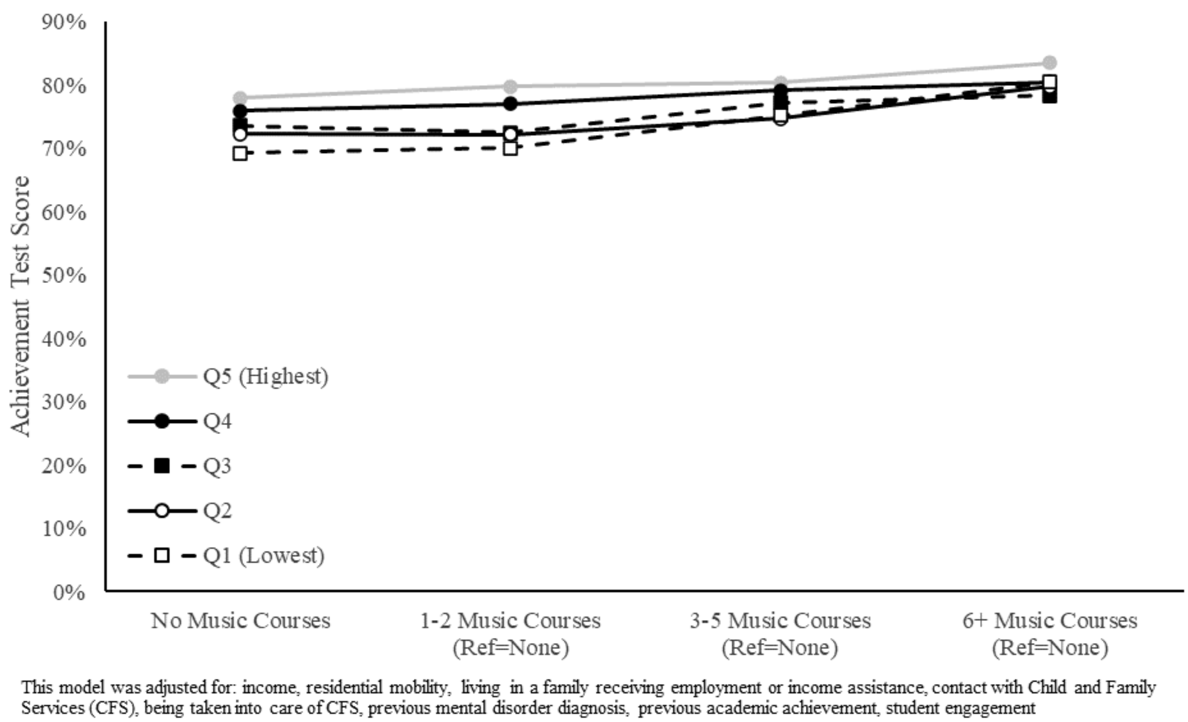
Even though most covariates were statistically significantly associated with Language Arts Achievement Test score, the full model could only account for about 30% of the variation in test scores (adjusted R^2=0.296). This suggests there are other important covariates that the available data could not account for such as teacher effectiveness, family structure, parent's education, or the home environment.

Figure 5: Adjusted Relationship Between Number of High School Music Courses and Grade 12 Language Arts Achievement Test Scores Among Male Students by Income Quintile, Final Model, 2012/13-2016/17



This model was adjusted for: income, residential mobility, living in a family receiving employment or income assistance, contact with Child and Family Services (CFS), being taken into care of CFS, previous mental disorder diagnosis, previous academic achievement, student engagement

Figure 6: Adjusted Relationship Between Number of High School Music Courses and Grade 12 Language Arts Achievement Test Scores Among Female Students by Income Quintile, Final Model, 2012/13-2016/17



4.4: On-Time Graduation Rates

4.4.1: Unadjusted Model

Students who took music courses had statistically significantly increased odds of graduating on time compared with students who did not take music courses. The odds of graduating on time were 54% greater for students who took 1-2 music courses compared with those who took no music courses. Students who took 6+ music courses had 24 times greater odds of graduating on time.

Table 11: Unadjusted Relationship Between Number of High School Music Courses and On-Time Graduation, 2012/13-2016/17

Adjustment Variables	Odds Ratio	95% Confidence Interval	p-Value
1-2 Music Courses (Ref=None)	1.54	1.44-1.66	<.0001
3-5 Music Courses (Ref=None)	4.86	4.22-5.60	<.0001
6+ Music Courses (Ref=None)	24.24	17.08-34.41	<.0001

4.4.2: Models Examining the Effects of Sex and Its Interaction with Music Courses

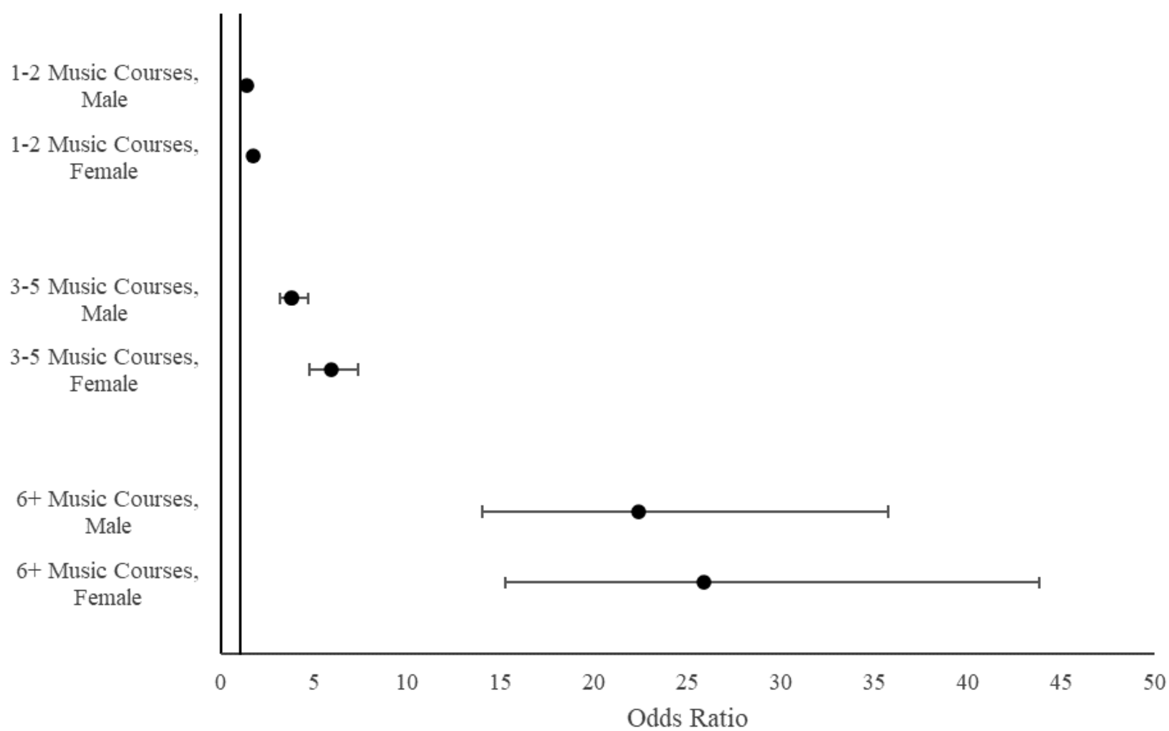
There was a statistically significant interaction between the number of music courses and sex (Table 12).

Table 12: Interaction Between Number of High School Music Courses and Sex for On-Time Graduation, 2012/13-2016/17

Adjustement Variables	Chi-Square	p-value
Number of Music Courses	374.1	<.0001
Sex	17.4	<.0001
Number of Music Courses*Sex	16.7	0.0008

The odds of graduating on time related to the number of music courses a student took were more pronounced among female students than male (Figure 7), but this difference was only statistically significant for students taking 3-5 music courses.

Figure 7: Relationship Between Number of Music Courses and On-Time High School Graduation by Sex, 2012/13-2016/17



4.4.3: Models Examining the Effects of Income Quintile and Its Interaction with Music Courses

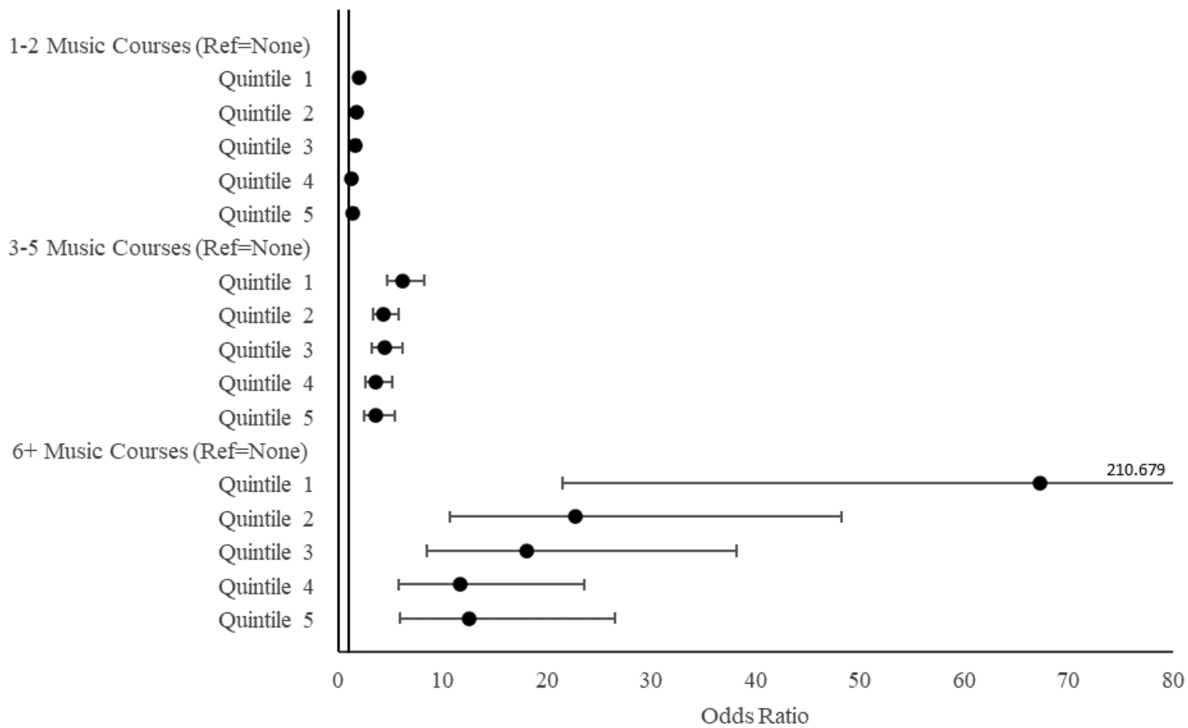
There was a statistically significant interaction between the number of music courses and income quintile (Table 13).

Table 13: Interaction Between Number of High School Music Courses and Income Quintile for On-Time Graduation, 2012/13-2016/17

Adjustement Variables	Chi-Square	p-value
Number of Music Courses	688.3	<.0001
Income Quintile	102.9	<.0001
Number of Music Courses*Income Quintile	31.5	0.0016

Figure 8 shows that the number of music courses a student took was statistically significantly associated with the odds of graduating on time when modified by income quintile. This relationship was most pronounced among lower income students.

Figure 8: Relationship Between Number of Music Courses and On-Time High School Graduation by Income Quintile, 2012/13-2016/17



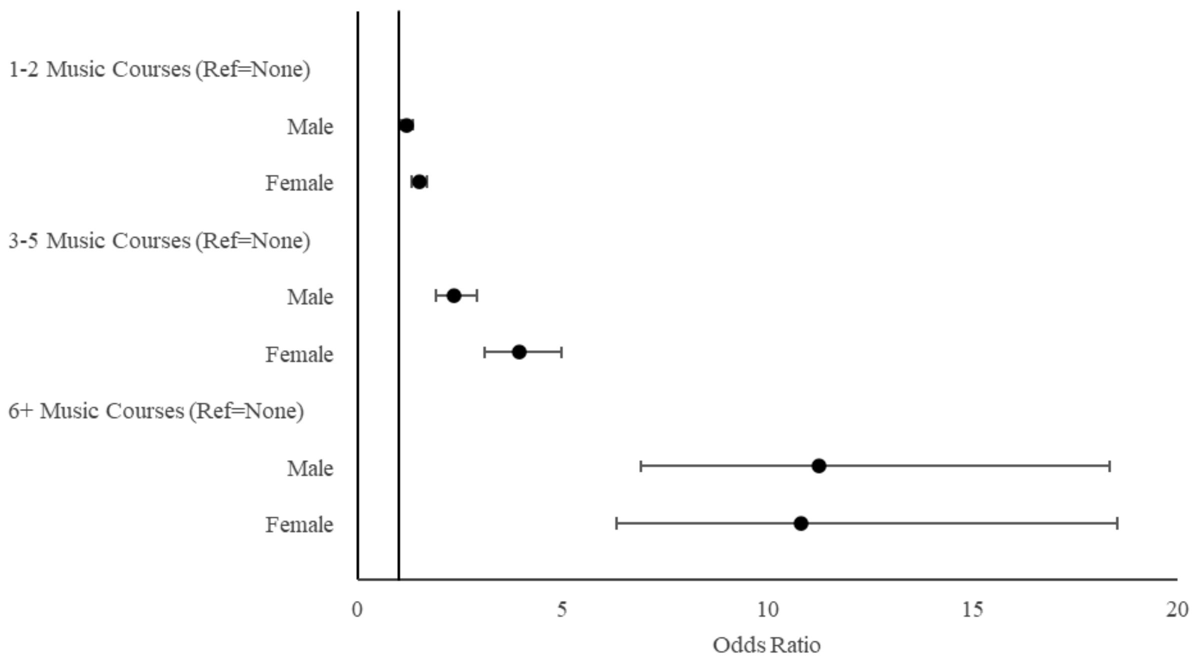
4.4.4: Fully Adjusted Model

When adjusted for all covariates, there was a statistically significant interaction between the number of music courses a student took and sex, therefore, this interaction term was included in the final analysis and denotes that the relationship between the number of music courses a student took and the on-time graduation rate varied by sex. The interaction between income quintile and number of music courses was tested and found to be no longer statistically significant (X^2(12, N=31,487) =14.01, *p*=ns). Therefore, it was not included in the final analysis.

The analyses conducted with music courses as a dichotomous variable yielded similar results (Appendix B4).

As shown in Figure 9, the number of music courses a student took had a more pronounced relationship with on-time graduation among female students than male, but this difference was only statistically significant for students taking 3-5 music courses. All covariates were statistically significant at $p<.05$ except having a prior substance use disorder diagnosis. See Appendix Table 18 in Appendix B4 for the significance of specific covariates. Due to the small number of students diagnosed with a substance use disorder prior to grade 9, there was not sufficient statistical power to draw conclusions about this relationship.

Figure 9: Adjusted Relationship Between Number of Music Courses and On-Time High School Graduation, Final Model, 2012/13-2016/17



This model was adjusted for: income, residential mobility, living in a family receiving employment or income assistance, contact with Child and Family Services (CFS), being taken into care of CFS, previous mental disorder diagnosis, previous academic achievement, student engagement

4.5: Attention-Deficit Hyperactivity Disorder (ADHD)

There were 3,236 students with a diagnosis of ADHD between age 6 and January 1 of their grade 9 school year who were excluded from this analysis in order to better determine the relationship between music course enrollment and the first diagnosis of ADHD. This resulted in a cohort of 28,251 students used for this outcome measure. There were 991 students diagnosed with ADHD from grade 9 to 12.

4.5.1: Unadjusted Model

Students who took 1-2 music courses were at decreased risk of being diagnosed with ADHD compared with students who did not take music courses. Taking 3 or more music courses was not associated with the risk of ADHD diagnosis.

Table 14: Unadjusted Relationship Between Number of Music Courses and Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.78	0.66-0.92	0.0029
3-5 Music Courses (Ref=None)	0.92	0.74-1.14	0.4473
6+ Music Courses (Ref=None)	0.91	0.70-1.16	0.4365

4.5.2: Models Examining the Effects of Sex and Its Interaction with Music Courses

The interaction between sex and number of music courses was tested (Table 15) and found to be not statistically significant, and therefore the model was re-run without the interaction term.

Table 15: Interaction Between Number of Music Courses and Sex for Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Number of Music Courses	8.3	0.0409
Sex	0.0	0.9678
Number of Music Courses*Sex	4.5	0.2087

When adjusted by sex (Table 16), students with 1-2 music courses remained at decreased risk of ADHD diagnosis compared with students who did not take music courses, while students taking 3 or more music courses were not. Sex was not statistically significantly associated with ADHD diagnosis.

Table 16: Sex-Adjusted Relationship Between Number of Music Courses and Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.78	0.66-0.92	0.0030
3-5 Music Courses (Ref=None)	0.92	0.74-1.14	0.4503
6+ Music Courses (Ref=None)	0.91	0.70-1.17	0.4406
Sex (Ref=Male)	1.00	0.88-1.13	0.9330

Note: The interaction between number of music courses and sex was not significant, and therefore not included in the analysis.

4.5.3: Models Examining the Effects of Income Quintile and Its Interaction with Music Courses

The interaction between income quintile and number of music courses was tested (Table 17) and found to be not statistically significant, and therefore the model was re-run without the interaction term.

Table 17: Interaction Between Number of Music Courses and Income Quintile for Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Number of Music Courses	1.2	0.7424
Income Quintile	4.1	0.3970
Number of Music Courses*Income Quintile	2.9	0.9963

As shown in Table 18, when adjusted for income quintile, students with 1-2 music courses were at decreased risk of diagnosis compared with students who did not take music courses, while students taking 3 or more music courses were not. Income quintile was not statistically significantly associated with ADHD diagnosis.

Table 18: Income-Adjusted Relationship Between Number of Music Courses and Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.78	0.66-0.92	0.0026
3-5 Music Courses (Ref=None)	0.92	0.74-1.14	0.4582
6+ Music Courses (Ref=None)	0.91	0.71-1.18	0.4770
Quintile 1 (Ref=Quintile 5)	1.05	0.86-1.28	0.6608
Quintile 2 (Ref=Quintile 5)	1.07	0.88-1.29	0.5232
Quintile 3 (Ref=Quintile 5)	0.86	0.71-1.04	0.1278
Quintile 4 (Ref=Quintile 5)	1.00	0.83-1.20	0.9994

Note: The interaction between number of music courses and income quintile was not significant, and therefore not included in the analysis.

4.5.4: Fully Adjusted Model

When adjusted for all covariates (Table 19), the number of music courses a student took was statistically significantly associated with the risk of being diagnosed with ADHD, similar to the unadjusted risk. These analyses were also conducted with music courses as a dichotomous variable (any music compared with no music), where there was an overall statistically significant association between taking music courses and ADHD diagnosis. Given the similarity of these results, they are not shown here but are included in Appendix B5.

As shown in Table 19, students with 1-2 music courses were at statistically significantly decreased risk of diagnosis with ADHD compared with students who did not take music courses, while students taking 3 or more music courses were not. In the full model, only these covariates were statistically significantly associated with an ADHD diagnosis: being in the care of CFS, receiving a previous diagnosis with a mood or anxiety disorder, and having established or developing skills in student engagement. However, due to the small number of students diagnosed with a substance use disorder prior to grade 9, there was not sufficient statistical power to draw conclusions about this relationship.

Table 19: Adjusted Relationship Between Number of Music Courses and Risk of ADHD Diagnosis Throughout High School, Final Model, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.80	0.68-0.94	0.0082
3-5 Music Courses (Ref=None)	0.99	0.80-1.23	0.9136
6+ Music Courses (Ref=None)	0.97	0.75-1.25	0.7958
Sex (Ref=Male)	0.99	0.87-1.12	0.8254
Quintile 1 (Ref=Quintile 5)	0.93	0.75-1.16	0.5342
Quintile 2 (Ref=Quintile 5)	1.00	0.82-1.22	0.9764
Quintile 3 (Ref=Quintile 5)	0.84	0.69-1.02	0.0762
Quintile 4 (Ref=Quintile 5)	0.99	0.83-1.20	0.9470
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	1.06	0.87-1.29	0.5719
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	1.08	0.86-1.36	0.5175
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	1.54	1.11-2.13	0.0100
1 move in Grade 7 and 8 (Ref=No Moves)	1.12	0.95-1.32	0.1938
2 moves in Grade 7 and 8 (Ref=No Moves)	0.84	0.59-1.21	0.3537
Mood or Anxiety Disorder Diagnosis Anytime Prior to Grade 9 (Ref=No Prior Diagnosis)	1.24	1.03-1.49	0.0213
Substance Use Disorder Diagnosis Anytime Prior to Grade 9 (Ref=No Prior Diagnosis)	1.96	0.80-4.81	0.1406
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	0.85	0.74-0.97	0.0142

Note: The interactions between number of music courses and sex or income quintile were not significant, and therefore not included in the analysis.

4.6: Mood or Anxiety Disorders

There were 2,192 students with a diagnosis of mood or anxiety disorders between age 6 and January 1 of their grade 9 school year who were excluded from this analysis in order to better determine the relationship between music course enrollment and the first diagnosis. This resulted in a cohort of 29,295 students used for this outcome measure. There were 7,212 students diagnosed with mood or anxiety disorders from grade 9 to 12.

4.6.1: Unadjusted Model

The number of music courses a student took was not statistically significantly associated with the risk of a student being diagnosed with a mood or anxiety disorder.

Table 20: Unadjusted Relationship Between Number of Music Courses and Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	1.02	0.96-1.08	0.5962
3-5 Music Courses (Ref=None)	0.99	0.91-1.07	0.7090
6+ Music Courses (Ref=None)	0.96	0.88-1.05	0.3833

4.6.2: Models Examining the Effects of Sex and Its Interaction with Music Courses

The interaction between sex and number of music courses was tested (Table 21) and found to be not statistically significant, and therefore the model was re-run without the interaction term.

Table 21: Interaction Between Number of Music Courses and Sex for Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Number of Music Courses	3.5	0.3206
Sex	95.9	<.0001
Number of Music Courses*Sex	3.7	0.2998

As shown in Table 22, when adjusted by sex, the number of music courses a student took was not statistically significantly associated with the risk of a student being diagnosed with a mood or anxiety disorder. However, student sex was statistically significantly associated with a mood or anxiety disorder – female students were more likely to be diagnosed than male students.

Table 22: Sex-Adjusted Relationship Between Number of Music Courses and Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.99	0.93-1.05	0.6610
3-5 Music Courses (Ref=None)	0.95	0.88-1.03	0.1827
6+ Music Courses (Ref=None)	0.93	0.85-1.02	0.1358
Sex (Ref=Male)	1.33	1.26-1.39	<.0001

Note: The interaction between number of music courses and sex was not significant, and therefore not included in the analysis.

4.6.3: Models Examining the Effects of Income Quintile and Its Interaction with Music Courses

The interaction between income quintile and number of music courses was tested (Table 23) and found to be not statistically significant, and therefore the model was re-run without the interaction term.

Table 23: Interaction Between Number of Music Courses and Income Quintile for Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Number of Music Courses	1.2	0.7527
Income Quintile	4.6	0.3356
Number of Music Courses*Income Quintile	9.7	0.6460

As shown in Table 24, when adjusted by income quintile, the number of music courses a student took was not associated with the risk of a student being diagnosed with a mood or anxiety disorder. Income quintile was also not statistically significantly associated with a mood or anxiety disorder diagnosis.

Table 24: Income-Adjusted Relationship Between Number of Music Courses and Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	1.02	0.96-1.08	0.6024
3-5 Music Courses (Ref=None)	0.99	0.91-1.07	0.7844
6+ Music Courses (Ref=None)	0.97	0.88-1.06	0.4654
Quintile 1 (Ref=Quintile 5)	1.05	0.98-1.13	0.1862
Quintile 2 (Ref=Quintile 5)	1.07	0.99-1.15	0.0845
Quintile 3 (Ref=Quintile 5)	1.04	0.96-1.11	0.3555
Quintile 4 (Ref=Quintile 5)	1.06	0.99-1.13	0.1135

Note: The interaction between number of music courses and income quintile was not significant, and therefore not included in the analysis.

4.6.4: Fully Adjusted Model

When adjusted for all covariates (Table 25), the number of music courses a student took was not associated with the risk of a student being diagnosed with a mood or anxiety disorder, similar to the unadjusted risk. The analyses conducted with music courses as a dichotomous variable yielded similar results (Appendix B6).

As shown in Table 25, student sex was statistically significantly associated with a mood or anxiety disorder – female students were more likely to be diagnosed than male students. Other statistically significant covariates were: being in contact or care of CFS, a previous diagnosis with ADHD, and student engagement. All other covariates were not statistically significant. However, due to the small number of students diagnosed with a substance use disorder prior to grade 9, there was not sufficient statistical power to draw conclusions about this relationship.

Table 25: Adjusted Relationship Between Number of Music Courses and the Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, Final Model, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	1.01	0.95-1.07	0.8734
3-5 Music Courses (Ref=None)	0.98	0.91-1.07	0.6989
6+ Music Courses (Ref=None)	0.98	0.90-1.08	0.7071
Sex (Ref=Male)	1.37	1.31-1.45	<.0001
Quintile 1 (Ref=Quintile 5)	0.97	0.90-1.05	0.5090
Quintile 2 (Ref=Quintile 5)	1.03	0.96-1.11	0.3870
Quintile 3 (Ref=Quintile 5)	1.02	0.95-1.10	0.6157
Quintile 4 (Ref=Quintile 5)	1.06	0.99-1.13	0.1148
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	0.98	0.91-1.05	0.5340
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	1.13	1.04-1.22	0.0036
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	1.22	1.07-1.39	0.0023
1 move in Grade 7 and 8 (Ref=No Moves)	1.01	0.95-1.08	0.6760
2 moves in Grade 7 and 8 (Ref=No Moves)	0.98	0.87-1.11	0.7340
ADHD Diagnosis Prior Anytime to Grade 9 (Ref=No Prior Diagnosis)	1.18	1.09-1.27	<.0001
Substance Use Disorder Diagnosis Anytime Prior ro Grade 9 (Ref=No Prior Diagnosis)	0.89	0.58-1.37	0.6086
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	0.88	0.84-0.93	<.0001

Note: The interactions between number of music courses and sex or income quintile were not significant, and therefore not included in the analysis.

4.7: Substance Use Disorder

There were 72 Students with a diagnosis of a substance use disorder between age 6 and January 1 of their grade 9 school year who were excluded from this analysis in order to better determine the relationship between music enrollment and the first diagnosis. This resulted in a cohort of 31,415 students used for this outcome measure. There were 896 students diagnosed with a substance use disorder from grade 9 to 12.

4.7.1: Unadjusted Model

As shown in Table 26, the number of music courses a student took was statistically significantly associated with the risk of a student being diagnosed with a substance use disorder. Students who took any number of music courses were at statistically significantly decreased risk of receiving a substance use disorder diagnosis compared with students who did not take music courses.

Table 26: Unadjusted Relationship Between Number of Music Courses and Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.79	0.66-0.94	0.0082
3-5 Music Courses (Ref=None)	0.56	0.41-0.77	0.0003
6+ Music Courses (Ref=None)	0.25	0.14-0.43	<.0001

4.7.2: Models Examining the Effects of Sex and Its Interaction with Music Courses

The interaction between sex and number of music courses was tested (Table 27) and found to be not statistically significant, and therefore the model was re-run without the interaction term.

Table 27: Interaction Between Number of Music Courses and Sex for Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Number of Music Courses	15.8	0.0012
Sex	0.1	0.7233
Number of Music Courses*Sex	4.0	0.2574

When adjusted by sex (Table 28), students who took any number of music courses were at decreased risk of receiving a substance use disorder diagnosis compared with students who did not take music courses. Sex was not statistically significantly associated with a substance use disorder diagnosis.

Table 28: Sex-Adjusted Relationship Between Number of Music Courses and Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.79	0.66-0.95	0.0097
3-5 Music Courses (Ref=None)	0.56	0.41-0.77	0.0003
6+ Music Courses (Ref=None)	0.25	0.14-0.44	<.0001
Sex (Ref=Male)	0.94	0.83-1.08	0.3818

Note: The interaction between number of music courses and sex was not significant, and therefore not included in the analysis.

4.7.3: Models Examining the Effects of Income Quintile and Its Interaction with Music Courses

The interaction between income quintile and number of music courses was tested (Table 29) and found to be not statistically significant, and therefore the model was re-run without the interaction term.

Table 29: Interaction Between Number of Music Courses and Income Quintile for Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Number of Music Courses	6.8	0.0773
Income Quintile	40.3	<.0001
Number of Music Courses*Income Quintile	16.2	0.1820

When adjusted for income quintile (Table 30), students who took any number of music courses were at statistically significantly decreased risk of receiving a substance use disorder diagnosis compared with students who did not take music courses. Students living in lower income quintiles were statistically significantly more likely to be diagnosed with a substance use disorder than students living in the highest income quintile.

Table 30: Income-Adjusted Relationship Between Number of Music Courses and Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.76	0.64-0.91	0.0029
3-5 Music Courses (Ref=None)	0.59	0.43-0.81	0.0011
6+ Music Courses (Ref=None)	0.26	0.15-0.47	<.0001
Quintile 1 (Ref=Quintile 5)	1.83	1.49-2.26	<.0001
Quintile 2 (Ref=Quintile 5)	1.51	1.21-1.89	0.0003
Quintile 3 (Ref=Quintile 5)	1.28	1.01-1.61	0.0374
Quintile 4 (Ref=Quintile 5)	1.32	1.05-1.65	0.0176

Note: The interaction between number of music courses and income quintile was not significant, and therefore not included in the analysis.

4.7.4: Fully Adjusted Model

After adjusting for covariates (Table 31), the number of music courses a student took remained statistically significantly associated with the risk of being diagnosed with a substance use disorder. The analyses conducted with music courses as a dichotomous variable yielded similar results (Appendix B7).

As shown in Table 31, students with 3 or more music courses were at statistically significantly decreased risk of diagnosis with a substance use disorder compared to students who did not take music courses, while taking 1-2 music courses no longer had a statistically significant association with a substance use disorder diagnosis. In the full model, all covariates were statistically significant at $p<.05$ except for living in income quintiles 1-3 or in a family receiving EIA and moving addresses during grade 7 and 8.

Table 31: Adjusted Relationship Between Number of Music Courses and Risk of Substance Use Disorder Diagnosis Throughout High School, Final Model, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.86	0.72-1.03	0.1067
3-5 Music Courses (Ref=None)	0.71	0.52-0.98	0.0374
6+ Music Courses (Ref=None)	0.32	0.18-0.57	<.0001
Sex (Ref=Male)	0.87	0.75-1.00	0.0472
Quintile 1 (Ref=Quintile 5)	1.25	1.00-1.57	0.0503
Quintile 2 (Ref=Quintile 5)	1.26	1.00-1.58	0.0518
Quintile 3 (Ref=Quintile 5)	1.18	0.93-1.49	0.1708
Quintile 4 (Ref=Quintile 5)	1.28	1.02-1.61	0.0352
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	1.18	0.99-1.41	0.0592
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	1.81	1.52-2.16	<.0001
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	1.37	1.10-1.72	0.0058
1 move in Grade 7 and 8 (Ref=No Moves)	1.08	0.92-1.27	0.3319
2 moves in Grade 7 and 8 (Ref=No Moves)	1.25	0.93-1.69	0.1462
Mood or Anxiety Disorder Diagnosis Anytime Prior to Grade 9 (Ref=No Prior Diagnosis)	1.23	1.00-1.50	0.0471
ADHD Disorder Diagnosis Anytime Prior to Grade 9 (Ref=No Prior Diagnosis)	1.21	1.02-1.44	0.0273
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	0.74	0.64-0.86	<.0001

Note: The interactions between number of music courses and sex or income quintile were not significant, and therefore not included in the analysis.

4.8: Any Mental Disorder

There were 4,924 students with a diagnosis of ADHD, a mood or anxiety disorder, or a substance use disorder between age 6 and January 1 of their grade 9 school year who were excluded from this analysis in order to better determine the relationship between music enrollment and the first diagnosis. This resulted in a cohort of 26,563 students used for this outcome measure. Only the first diagnosis of any disorder from January 1 onward was considered in this analysis. There were 6,898 students diagnosed with any disorder from grade 9 to 12.

4.8.1: Unadjusted Model

The number of music courses a student took was statistically significantly associated with the risk of a student being diagnosed with any mental disorder. Receiving credit for 3 or more music courses was associated with a decreased risk of being diagnosed with any mental disorder.

Table 32: Unadjusted Relationship Between Number of Music Courses and Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.96	0.91-1.02	0.2066
3-5 Music Courses (Ref=None)	0.89	0.82-0.96	0.0032
6+ Music Courses (Ref=None)	0.87	0.79-0.95	0.0029

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder

4.8.2: Models Examining the Effects of Sex and Its Interaction with Music Courses

The interaction between sex and number of music courses was tested (Table 33) and found to be not statistically significant, and therefore the model was re-run without the interaction term.

Table 33: Interaction Between Number of Music Courses and Sex for Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Chi-Square	p-value
Number of Music Courses	13.0	0.0046
Sex	303.9	<.0001
Number of Music Courses*Sex	0.3	0.9551

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder

After adjusting by sex, the number of music courses a student took was statistically significantly associated with a decreased risk of a student being diagnosed with any mental disorder (Table 34). Student sex was also statistically significantly associated with a mental disorder – female students were more likely to be diagnosed than male students.

Table 34: Sex-Adjusted Relationship Between Number of Music Courses and Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.92	0.87-0.98	0.0078
3-5 Music Courses (Ref=None)	0.83	0.77-0.90	<.0001
6+ Music Courses (Ref=None)	0.83	0.76-0.92	0.0001
Sex (Ref=Male)	1.73	1.65-1.82	<.0001

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder

Note: The interaction between number of music courses and sex was not significant, and therefore not included in the analysis.

4.8.3: Models Examining the Effects of Income Quintile and Its Interaction with Music Courses

The interaction between income quintile and number of music courses was tested (Table 35) and found to be not statistically significant, and therefore the model was re-run without the interaction term.

Table 35: Interaction Between Number of Music Courses and Income Quintile for Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustement Variables	Chi-Square	p-value
Number of Music Courses	0.9	0.8222
Income Quintile	10.1	0.0387
Number of Music Courses*Income Quintile	10.8	0.5430

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder

When adjusted by income quintile (Table 36), the number of music courses a student took was statistically significantly associated with the risk of a student being diagnosed with any mental disorder. Receiving credit for 3 or more music courses was associated with a statistically significantly decreased risk of diagnosis. Income quintile was not statistically significantly associated with any mental disorder diagnosis.

Table 36: Income-Adjusted Relationship Between Number of Music Courses and Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.96	0.91-1.02	0.1908
3-5 Music Courses (Ref=None)	0.89	0.82-0.97	0.0046
6+ Music Courses (Ref=None)	0.88	0.80-0.96	0.0053
Quintile 1 (Ref=Quintile 5)	1.07	0.99-1.15	0.1000
Quintile 2 (Ref=Quintile 5)	1.05	0.98-1.14	0.1607
Quintile 3 (Ref=Quintile 5)	1.02	0.95-1.10	0.6386
Quintile 4 (Ref=Quintile 5)	1.00	0.93-1.07	0.9462

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder
Note: The interactions between number of music courses and income quintile were not significant, and therefore not included in the analysis.

4.8.4: Fully Adjusted Model

When adjusted for all covariates (Table 37), the number of music courses a student took was statistically significantly associated with the incidence of a student being diagnosed with any mental disorder. The analyses conducted with music courses as a dichotomous variable yielded similar results (Appendix B8).

As shown in Table 37, students who took 3 or more music courses were at statistically significantly decreased risk of being diagnosed with any mental disorder compared with students who did not take music courses, while student who took 1-2 music courses were not. In the final model, all covariates were statistically significant except for living in all but the lowest income quintile and moving addresses in grade 7 and 8.

Table 37: Adjusted Relationship Between Number of Music Courses and Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None)	0.95	0.90-1.01	0.1133
3-5 Music Courses (Ref=None)	0.89	0.82-0.96	0.0031
6+ Music Courses (Ref=None)	0.91	0.83-1.00	0.0427
Sex (Ref=Male)	1.75	1.66-1.84	<.0001
Quintile 1 (Ref=Quintile 5)	0.90	0.83-0.97	0.0087
Quintile 2 (Ref=Quintile 5)	0.98	0.91-1.06	0.5954
Quintile 3 (Ref=Quintile 5)	0.98	0.91-1.06	0.5840
Quintile 4 (Ref=Quintile 5)	0.99	0.93-1.07	0.8526
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	1.10	1.02-1.19	0.0175
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	1.36	1.25-1.48	<.0001
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	1.32	1.15-1.51	<.0001
1 move in Grade 7 and 8 (Ref=No Moves)	1.01	0.95-1.07	0.8640
2 moves in Grade 7 and 8 (Ref=No Moves)	1.01	0.89-1.15	0.8789
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	0.82	0.78-0.86	<.0001

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder

Note: The interactions between number of music courses and sex or income quintile were not significant, and therefore not included in the analysis.

Chapter 5: Discussion

5.1: Discussion

While the intent of offering music courses to students is not to affect outcomes in other areas, it is important to understand the relationship between taking music courses and both academic and mental health outcomes in order to support adolescent success and wellbeing. The present study is one of the few to use population-level data to examine the relationship with academic outcomes, and the first study in Canada to use these data to examine the relationship with adolescent mental health outcomes.

Even prior to the start of high school, there were observable demographic differences between the students who took and did not take school music courses as well as between students who took few music courses or many. Overall, the results of this study support the hypotheses that receiving school credit for music courses is related to better academic outcomes and a lower risk of being diagnosed with a mental disorder. Specifically, students who took school music courses were more likely to score higher on grade 12 achievement tests and to graduate on time, and less likely to be diagnosed with ADHD or a substance use disorder. These findings are discussed in greater detail below.

5.1.1: Demographic Outcomes

About 39% of students enrolled in grade 9-12 in Winnipeg received credit for at least one music course. This is considerably higher than the percent (13.7%) of grade 10 to 12 students taking at least one of the six music courses included by Guhn et al. in their study conducted in British Columbia.[4] Their decision to include only specific music courses with prerequisites and not determine the enrollment proportion separately for urban and rural students are possible explanations for the large difference in music participation between Guhn et al.'s study and this thesis. A report conducted by the Student Transitions Project using data gathered by the provincial ministry of education in British Columbia suggested the rate of students taking any music course (21%) was also lower than what was found in the current study for Winnipeg.[15] Studies conducted in the United States found that between 21% and 37% of grade 12 students received credit for at least one music course depending on data collection method.[12,29,30,107] Music course enrollment was higher when using transcript data (between 34% to 37%[12,107]) compared to survey data (about 21% to 24%[29,30]), possibly due to attrition from the survey population, recall bias, or the specific music courses considered in the survey. The differences between studies may also be due to variation in course availability or quality between study locations, differentiation between urban and rural students, or which music courses were included in the analysis.

Previous studies have shown differences between students who chose to enroll in music programs in high school and those who did not.[7,14,29–32] These findings align with the results of this thesis. Music students were more likely to be female, with girls comprising 44.2% of the students with no music courses but making up 52.4% of students with 6 or more music courses. Although this study and others[4,15,30] have demonstrated that high school music students are more likely to be female, Kinney's study demonstrated that the decision to enroll in high school music courses depends on the specific course – males were just as likely to enroll and persist in band as females, but were less likely to enroll in orchestral or choral courses.[34] This may be because elements of the microsystem such as relationships with their friends[39,40] may be influencing the demographics of music courses. The lack of differentiation by course in the data used for the present study precluded further study of this relationship.

Music students were also more likely to be from an affluent area. Students with no music courses tended to be relatively equally spread among the income quintiles, while students with 6 or more music courses were much more likely to be from the highest (34.0%) than the lowest (8.9%) income quintile. This demonstrates the influence of a student's larger social environment (the exosystem) on their choice or ability to enroll in music courses. Elpus and Abril came to a similar conclusion regarding the differences in enrollment between high and low income music students in the United States using a national student survey.[29,30] However, a study from Guhn et al. using population-level data suggested there was no difference in median income between music and non-music students living in British Columbia.[4] The specific music courses included in their study may explain the lack of difference between income levels, and expanding the definition of a music course may have yielded different results.

The findings of this study confirm previous research regarding pre-existing differences between music and non-music students.[7,14,29–32] The present study found that prior to grade 9, students who took music courses in high school were more likely to be approaching or meeting grade-level expectations for student engagement and numeracy in grade 7 and for reading and writing in grade 8, suggesting they were academically stronger and more engaged than students who did not enrol in high school music courses. Additionally, students who enrolled in high school music courses were less likely to be in families receiving income assistance, have contact with child and family services, or be diagnosed with a mental disorder. These findings demonstrate the importance of adjusting for pre-existing differences between music and non-music students when examining differences in outcomes between these groups of students.

5.1.2: Academic Outcomes

The findings of this study suggest enrollment in music courses was positively associated with academic outcomes independent of student differences based on prior academic achievement, income level, or other demographic factors. Specifically, students who took any number of music courses received higher marks on grade 12 achievement tests and had higher odds of graduating on time than students who did not take music courses, even after accounting for factors such as socioeconomic status and prior academic achievement that are associated with both music course enrolment and academic achievement. As previous studies using administrative data have shown, there was a positive association between taking music courses in high school and grade 12 test scores.[4,14] However, the underlying mechanisms for this relationship are poorly understood.[50] Previous neurological research has pointed to differences between music and non-music students on the neurological level,[51–54] while a recent meta-analysis suggests this relationship is due to unmeasured confounding rather than a direct effect of taking music courses.[55]

There was a positive association between the number of music courses a student took and grade 12 mathematics achievement test marks, and this positive association remained even after adjusting for several potentially confounding factors. The amount of variance in math test scores that could be accounted for by the factors included in the fully adjusted model was about 16%. Although this value is considered moderately high,[111] there are several additional factors that could potentially improve this model such as the quality of music education, teacher effectiveness, family structure, parent's education, or the home environment. These factors could not be examined in the current study. It is possible that taking them into consideration would reduce the magnitude of the relationship found between music course enrollment and grade 12 math test scores. With respect to moderating variables, although it appeared from the unadjusted models that lower income students experienced greater benefit from taking music courses, when other factors were adjusted for, this relationship was no longer statistically significant.

Furthermore, the relationship between music course participation and math test scores did not differ by sex.

As with mathematics achievement test scores, there was a positive association between the number of music courses a student took and grade 12 language arts achievement test scores which remained even after adjusting for several potentially confounding factors. The amount of variance in language arts test scores that could be accounted for by the factors included in the fully adjusted model was about 30%. Although this value is considered high,[111] as noted above, there are factors that could not be examined using the data available for the study that could attenuate the observed relationship. With respect to moderating variables, lower income and male students showed a more pronounced increase in test scores associated with the number of music courses. However, higher income and female students scored consistently higher. This suggests access to school music programs is particularly important for male students and those living in lower income areas.

On-time graduation was positively associated with the number of music courses a student took even after adjusting for several potentially confounding factors. With respect to moderating variables, although it appeared from the unadjusted models that lower income students had a more pronounced increase in the odds of graduating on time, as did female students, when other factors were adjusted for, only student sex remained statistically significant. To this end, the relationship between the number of music courses and graduation was more pronounced among female students. However, lower income students in general had lower odds of graduating than their higher income peers.

5.1.3: Mental Disorder Outcomes

While there have not been previous studies examining the relationship between high school music education and later mental disorder diagnoses, the results of the present study still have similarities to previous conclusions that suggest taking music courses is associated with better mental health. The results of this study demonstrate that students who took 3 or more music courses were statistically significantly less likely overall to be diagnosed with a mental disorder than their peers who did not take music courses. However, the number of music courses a student took and the specific disorder they were diagnosed with is important to consider when describing this relationship. Taking only 1-2 music courses was associated with lower rates of ADHD diagnoses, there was no difference in diagnosis rates of mood or anxiety disorders, and taking 3 or more music courses was associated with a lower rate of diagnosis with a substance use disorder. This aligns with a previous study that found taking part in any school activity is also associated with a lower rate of illicit drug use.[112] The following discussion examines the results of each mental disorder separately.

Taking 1-2 music courses was associated with a decreased likelihood of being diagnosed with ADHD, but no association was found for students taking additional music courses even after adjusting for several potentially confounding factors. This suggests that taking some music courses could be protective against a diagnosis, while taking more music courses is not related to the risk of diagnosis. This result is unexpected and challenging to explain. Most outcomes examined in this study indicated that more music courses were associated with better outcomes. This counterintuitive result may be due to the relatively small number of students diagnosed with ADHD during their high school years. When the analysis was conducted using a dichotomous variable for music (no music courses vs 1 or more music courses), music courses were associated with a lower ADHD rate.

Another explanation for this unexpected finding may be related to the age of the students, given that those with early onset ADHD were excluded from the analyses. Much of the current literature around ADHD focuses on treatment and outcomes for individuals diagnosed in childhood – one of the diagnosis conditions is for several symptoms to be present prior to age 12.[113] As this thesis focuses on high-school age students, it is important to recognize potential differences between childhood and adolescent diagnosis patterns. Although many individuals with ADHD are diagnosed as children, there is increasing evidence of adolescents or young adults who meet all the diagnosis conditions except the age of onset.[92–94,114–116] Among these individuals, many did not meet diagnostic criteria when they were younger, and there was no clear gender difference in diagnosis rate.[92–94] Other researchers suggest the difference in diagnosis pattern among adults may be primarily due to false positives related to comorbid challenges or previously undetected symptoms, rather than an accurate reflection of late-onset symptoms.[114–116]

It is also possible that students with undiagnosed ADHD are drawn to music as a coping mechanism to manage their symptoms, and their participation may prevent exacerbation of these symptoms into a clinical diagnosis. Hansen reported, among a small group of students, that the need for prolonged, intense attention to learn music fits well within the hyper-focus that some individuals with ADHD experience.[117] However, this explanation does not explain why taking three or more music courses was not associated with a lower risk of being diagnosed with ADHD. The association between music courses and ADHD requires further study.

The association between the number of music courses a student took and diagnosis with ADHD was not moderated by either sex or income quintile. This suggests the relationship between music courses and diagnosis rate in high school did not depend on sex or income. Neither sex nor income quintile were statistically significantly associated with an ADHD diagnosis when examined along with other factors. Previous studies have found mixed results. One study showed about 42% of individuals with late-onset ADHD were from a lower social class[93] but others found that the average income of young adults newly diagnosed with ADHD was not statistically significantly different than those with none or childhood diagnosis.[92,94] The findings of the present study do align with other research demonstrating late-onset ADHD diagnosis is split evenly between males and females.[92–94]

Students with any number of music courses were equally likely to be diagnosed with a mood or anxiety disorder as students with no music courses. This lack of evidence of relationship between music courses and these mental disorders persists even after several potentially confounding factors were adjusted for. This does not mean taking music courses has no value to students – there are established mental wellness benefits to students, such as improved self-esteem, confidence, or sense of belonging to a community[16,17,19,20] that the available data could not measure. Regarding the moderating variables, the relationship between the number of music courses and diagnosis did not vary by either sex or income. That said, student sex was statistically significantly associated with a diagnosis, with females having 1.37 times increased odds of receiving a diagnosis than males, but income quintile was not.

The most notable findings were found in examining music courses and substance use disorder. After adjusting for several potentially confounding factors, taking 3 or more music courses was associated with a statistically significantly decreased likelihood of receiving a substance use disorder diagnosis. Students taking 1-2 music courses were equally likely to be diagnosed as students who did not take music courses. It appears the benefits of taking music courses are not consistent across the number of music courses, suggesting that more music courses are required to reduce the risk of substance use disorders. However, students using substances to the point of receiving a diagnosis could also be less likely to enroll in multiple music courses or this relationship may be due to the relatively small number of students diagnosed with substance use during their high school years. When the analysis was conducted using a dichotomous variable for music, music courses were associated with a lower substance use rate. Conversely, it is possible that music provided students with a healthy coping mechanism because it involves a sense of community and provides some emotional support, and therefore the student is not drawn to over-using substances. At many high schools, some music courses are offered outside of the regular school day, and engaging in these courses could take up time that students may otherwise spend engaging in problem substance use. Taking music courses has also been linked to improved self esteem, confidence, and a sense of belonging.[16,17,19,20] Mulder et al. found that students often had similar self-reported substance use behaviour and music preferences as their friends, thus reinforcing existing patterns.[118]

Whatever the mechanism at play in explaining the relationship between music courses and lower rates of substance use disorders, it appears that more than one or two courses are required to reach this possible protective effect. However, the reasons for this relationship cannot be drawn from the available data. This association was moderated by neither sex nor income quintile, suggesting the relationship between music courses and diagnosis did not vary based on these factors. When considered along with other factors, female students were less likely than male students to be diagnosed with a substance use disorder.

Taking 3 or more music courses was associated with a statistically significantly decreased likelihood of receiving any diagnosis of a mental disorder (a combination of ADHD, mood or anxiety disorders, or substance use disorder). As discussed above, the most notable finding was related to substance use disorders. No association was found between music courses and mood or anxiety disorders and the association between music courses and ADHD is difficult to understand given the relatively few students diagnosed in adolescence. It remains that the association between music courses and substance use disorders is promising and worthy of further study. It would be valuable to examine the association between music courses and mental health using different measures of mental health and to explore reasons for this association using qualitative methods.

5.2: Implications

The results of this study demonstrate a consistent positive relationship between taking music courses and improved academic outcomes, regardless of a students' background. The results also show that students who took 3 or more music courses were statistically significantly less likely to be diagnosed with a substance use disorder than their peers who did not take music courses. The relationship between music courses and ADHD was less clear and none was found between music courses and mood or anxiety disorders. These findings suggest the current provincial support of school music programs is well-founded. However, surveys of teachers and school administrators suggest that additional support, both financial and otherwise, would allow them to better support their students in their music education.[104,106] Given the positive relationship between school music courses and academic achievement and inverse relationship with substance use disorder diagnosis, the opportunity to better support students musically would likely serve to further improve academic and mental health outcomes.

Although the percent of students enrolled in music courses in high school was found to be higher than other studies, the difference in enrollment rates between high and low-income students shows there may still be enrollment barriers. Based on the findings of this study and others, encouraging students to take music courses could potentially contribute to better academic performance[4,14] and fewer mental health challenges for more students.[17,19,20] This in turn could lead to fewer school resources needed for addressing these challenges, allowing them to be redirected to better address other challenges. In removing enrollment barriers, more students would have access to an existing program shown to be associated with improved academic and mental health outcomes. This could not only help build a better-educated work force, it could also encourage resilience in individuals, allowing them to better manage and care for their mental health leading to fewer missed days of work due to mental illness. Previous research suggests adolescents who engage in music making are likely to continue making music as they age, and also experience better mental health.[119]

Given the positive or neutral relationship between taking music courses and academic or mental disorder outcomes, and similar subsequent studies bearing out these results, there could be reasonable evidence for administrators to consider making music courses a mandatory credit for graduation. In light of not all students taking music, and some groups of students being less likely to enroll in music courses, more can be done to encourage these groups to enroll and decrease enrollment barriers. School administration can support greater music course enrollment in several ways. They can help reduce barriers to enrollment, such as scheduling constraints, by providing options before or after the regular school day, or offering the same course more often during the school cycle. This would allow a greater number of students to enroll in music courses and allow teachers to more easily customize lessons and musical choices based on the students' needs due to smaller class sizes. Providing musical instruments to students at low or no cost to their families would help reduce the financial enrollment barrier of renting or purchasing instruments. As students often engage with music differently in and out of school,[36] providing diverse courses (such as Indigenous drumming, rock band, or song writing) that bridge this gap in interest could encourage greater music course enrollment.

Although the variety and quality of music courses could not be measured using the available data, previous research suggests there may be a segment of the student population not taking music because the music they like or is culturally important to them is not reflected in the classroom or the teaching style does not connect with them.[37,38] In many schools, enrolling in additional performance-based music electives (such as jazz ensembles) requires students to also be part of a concert ensemble, which some students may feel is exclusionary. Offering courses and prerequisites more tailored to the music preferences of the students, and in some cases the technical skills required, may attract a greater number of students to music programs.

The relationship between music courses and substance use disorder diagnosis is a novel finding, and it is important to understand how these two factors may be related. This could have important implications for preventing addiction for adolescents and reducing diagnoses of other mental disorders later in life. For example, a review by Costello and Maughan found that adolescents with a substance use disorder were at risk for additional mental disorders in adulthood.[120] Brownlie et al. came to a similar conclusion, in that adolescents with substance use disorders often have psychiatric comorbidities.[121] Preventing or reducing addiction among adolescents could help reduce the rate or severity of other mental disorders. Future research focused specifically on adolescents with substance use disorders could also help clarify the direction of this relationship.

Continued support of music programs in schools is based on the intrinsic benefit of music to students and allowing students to explore facets of their identity that exist outside of the core academic courses. The rationale for providing music education to Manitoba students is to help support them in understanding their environment and allowing them to flourish within the context of growing as a musician.[124] However, given the suggested benefits of music to high school students both academically and to their mental health, music programs should continue to be supported in at least their current capacity and barriers to participating should be minimized as much as possible.

5.3: Strengths and Limitations

5.3.1: Strengths

This study has several strengths, primarily that the population-wide data in the Repository allowed for studying an entire population of Winnipeg high school students and adjusting for social, health, and academic factors that may have been associated with academic achievement or mental disorder diagnosis. The large number of students included in this study (N=31,487) allowed for regression analysis with multiple covariates while avoiding overfitting the models and other pitfalls associated with small sample sizes and a relatively large number of covariates. The inclusion of social factors and prior mental health in the regression models contributed to the existing body of research by accounting for additional challenges students may have been facing. Research of this scale using a retrospective cohort design has not previously been done using administrative data and the range of covariates available for this study.

This study added to the limited number of studies addressing these relationships in the Canadian context. There have been several previous studies conducted in the United States, but differences in the health care and education systems prevented meaningful extrapolation to the Canadian context.

Administrative data overcome some of the limitations of other data collection methods, such as recall bias when completing surveys or selection bias when participation is voluntary. The data were collected during routine interactions with population-level services, and therefore coded and collected consistently. The regular updates of continuously collected data held in the Repository means they can be used to follow individuals through time with limited attrition.[125] The Repository has linkable comprehensive de-identified data on over 99% of individuals who have had contact with many of the population-level services available in Manitoba (e.g. education, health, social services).[125] This linkability allowed for research across sectors and more complete understanding of factors related to health and social outcomes.

5.3.2: Limitations

Despite the many strengths of this research, there were also several limitations. The generalizability affects how broad a population the results can be applied to. Including only students attending a Winnipeg school, the associations found in this study may not be accurate among students living in smaller cities or in rural areas. There are established differences between urban and rural students in Manitoba such as access to health or social resources[63] that may influence the relationship between music courses and later outcomes. The music courses offered at rural schools may differ from urban schools in both quality and variety.

There are also biases inherent to administrative data. Only those diagnosed by a physician were entered in the medical claims and hospital databases[125] and services provided by non-medical professionals (e.g. psychologists) are not captured.[73] Therefore, students with mental disorders who received care from non-medical professionals and those who have not sought help were not included as having a mental disorder. This results in mental disorders being underreported in the data, and may serve to decrease the magnitude or significance of the relationship between taking music courses and receiving a diagnosis. Adolescents with more severe mental disorders are likely disproportionately represented in the administrative data, given their symptoms were brought to the attention of their caregivers and/or they sought treatment.[73]

The education data in the Repository does not include specific course information for students prior to grade 9, and so previous music course participation could not be considered in analyses. Complete information on out-of-school music training is also lacking. The Repository does not contain information for non-school-credit music and does not capture the students' home or social environment in this capacity. Furthermore, administrative data do not provide any information about the quality of music instruction, which may have influenced the findings.

Students who engage exclusively in out-of-school music programs were considered non-music students in the current study as students need to request school credit for these skills. This is not done reliably, and some schools may place limitations on the types of music considered for credit. This may have contributed to biasing the results toward the null. The relationship between taking music courses and academic or mental disorder outcomes would likely have been stronger if out-of-school music courses were controlled for. Students who took music courses outside of school may have been positively influenced by taking these courses and may have contributed to increasing the academic scores and graduation rates and decreasing rates of diagnosed mental disorders in "no music courses" group. This could have narrowed the differences between the music course and no music courses group.

The decision to include only those students who followed the expected timeline through school excluded students who were held back (those likely experiencing the most challenges academically) or moved ahead a grade (those likely to be excelling academically), and may have led to the associations being underestimated. The findings of this study may not be applicable to these students.

To assess the relationship between music education and academic outcomes and mental disorder diagnoses in grade 12, students needed to have data from age 6 through their grade 12 school years. This excluded any students who moved to the province after age 6, or who moved away prior to the end of their grade 12 school year. This has several implications for the findings of this study. First, it reduced the number of eligible students and reduced the generalizability to students who have lived in the province for most of their life and attended a high school in Winnipeg. Second, students moving to a new province have experienced a dramatic change in their social and community connections which may have influenced the diagnosis of a mental disorder. Related, students coming into the province in their teen years may be immigrant or refugee students who have a greater likelihood of facing academic and mental health challenges.[126]

This was an observational study because the administrative data were not collected as part of a controlled experiment. Therefore, we could only observe associations and could not draw any causal conclusions. The study design and available data did not allow for determination of whether enrollment in music courses actually prevented substance use disorders or resulted in better academic achievement.

While all high schools in Winnipeg offer a music program to their students in some capacity, the full variety of courses may not be captured in the Repository and therefore some music courses may have been missed. Differences between schools where this does and does not occur may introduce bias to the results. It is difficult to determine what these school-level differences might be, such as school size or administrative differences, and how they could influence results. In addition to this, the complexity of the education data made it infeasible to determine the potential interactions between other elective courses (both arts and non-arts) and music courses on student outcomes.

5.4: Areas for Further Study

Based on the limitations of using administrative data, there are several avenues that could be explored to add context and better explain some of the differences in outcomes that were found in this study. One of the biggest limitations of the administrative data used in this study is they cannot be used to examine the underlying reasons for the results, such as extra-curricular music participation, students' home environment, or program quality. Surveys, case studies, or focus groups including questions about student's self-described mental health, involvement in the arts outside of school, how they feel about their home environment, and how they perceive the music program quality could be used to better understand the differences between music and non-music students. Also lacking in the administrative data, which could also be collected through other means, is the variety of music courses students took.

Asking students what they would like to see included in (or what is missing from) music courses, or the types of music courses they would like to participate in, could help increase interest in enrolling in music courses. This could help researchers and school administrators better understand the musical needs and preferences of their students and better tailor the courses offered.

Understanding why students unlikely to take music courses (such as the small number of students in the care of child and family services enrolled in 6 or more music courses in high school) chose to or otherwise had the support or resources to persist in music courses could provide some insights on how best to structure music programs to encourage these students to continue in music programs. This may also shed light on other factors that differ between these students and their peers that facilitate or create challenges for participation, such as social pressures or expectations, familial support, or systemic or structural factors.

There are also several questions as yet unanswered about the relationship between taking music courses and receiving a specific mental disorder diagnosis, especially considering the inconsistent relationship across diagnoses, that present promising opportunities for future exploration. Given that one of the limitations of administrative data is information is only available for those who sought treatment, surveys including questions related to symptoms and other types of help-seeking behaviour (like talking to a school counsellor, psychologist, or even a trusted friend) could help provide a more nuanced understanding of the relationship between music courses and mental health. Other study designs such as focus groups or case studies could yield insights about these students as well. These methods could also elucidate whether taking music courses serves a protective purpose, or if students at risk of developing a mental disorder are less likely to enroll in music courses in the first place or have higher attrition rates from these courses. Given the relationship for students diagnosed with ADHD is difficult to explain using the available data, exploring the role of music in these students' lives could shed light on why taking few music courses seems to be associated with lower incidence but this does not extend to taking more music courses. The significant positive association between music courses and substance use disorders suggests a promising area for others to explore further.

The universal disruption to school scheduling due to the COVID-19 pandemic provides a valuable opportunity to understand the impact of music education on the outcomes of high school students both now and several years into the future. This would be specifically important in the context of mental disorder diagnoses due to the known connection between music education and mental wellness through a sense of belonging and community.[16,17,19,20] In addition, students having the opportunity to learn from home, rather than come into a building every day, may have provided some relief from bullying in the classroom (more commonly directed toward music students than other non-arts students[41]) which could lead to easing the mental health challenges these students face. Investigating this change could help clarify whether the observed benefits of music courses are related to the act of making music or are more closely tied to the community in the music classroom.

5.5: Conclusions

Taking music courses was associated with better academic outcomes for grade 12 achievement tests as well as on-time graduation rates. Findings were mixed regarding the association with a mental disorder diagnosis. For students diagnosed with ADHD, only taking 1-2 music courses was associated with a statistically significant decrease in diagnosis rate compared with students not taking music courses. There was no difference in mood or anxiety disorder diagnosis rates between music and non-music students. Students taking 3 or more music courses had lower rates of being diagnosed with a substance use disorder than students with no music courses.

The results suggest promising benefits of music courses to academic and mental health outcomes and point to continued support of music courses in Manitoba schools. School administration can encourage greater enrollment in music courses by removing scheduling and financial barriers for students. Further research should continue to consider the underlying factors of the relationship between music courses and student outcomes, especially those related to mental disorder diagnoses as there is a lack of information in this area.

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Appendices

Appendix A: Indicator Definitions

Appendix Table 1: Indicator Definitions

Indicator	Definition
High School Music Enrollment	Grade 9 students with at least one of these course codes: • 2009/10 and 2010/11 academic years: 3941 (jazz band), 3953 (band), 3954 (choir), 3955 (guitar), 3956 (strings/orchestra), 3961 (vocal jazz), 3960 (International Baccalaureate Music, Higher Level), 3957 (International Baccalaureate Music, Standard Level), 3959 (Advanced Placement Music), 9993 (school-initiated general music), 9946 (school-initiated choral music), 9948 (school-initiated music ensemble), 8954 (student-initiated general music), or 8948 (student-initiated music ensemble); • 2011/12 and 2012/13 academic years: 3941, 3953, 3954, 3955, 3956, 3961, 3960, 3957, or 3959; • 2013/14 academic year: 0115 (general music), 3941, 3953, 3954, 3955, 3956, 3961, 3960, 3957, or 3959. Grade 10 to 12 students with at least one of these course codes: • 2010/11 academic year: 3941, 3953, 3954, 3955, 3956, 3961, 3960, 3957, 3959, 9993, 9946, 9948, 8954, or 8948; • 2011/12 and 2012/13 academic years: 3941, 3953, 3954, 3955, 3956, 3961, 3960, 3957, or 3959; • 2013/14 academic year: 0115, 3941, 3953, 3954, 3955, 3956, 3961, 3960, 3957, or 3959; • 2014/15 to 2016/17 academic years: 0115, 0258, 0259, 0260, 0261, 0262, 0263, 0264, 0265, 0266, 0267, 0268, 0269, 0270, 0271, 0272, 0273, 3960, 3957, or 3959.

	Course codes used during the 2014/15 school year and later were not tied to specific courses. The most common courses were concert band, concert choir, or guitar. Course credits could also include jazz band, vocal jazz, music composition, among others.
Mental Disorders	Adolescent mental disorders were measured from January 1 of the students' grade 9 year through their on-time graduation year.
Attention-Deficit Hyperactivity Disorder (ADHD)	• 1+ hospitalizations with diagnosis of hyperkinetic syndrome (ICD-10 F90; ICD-9 314), or • 1+ physician claims with diagnosis of hyperkinetic syndrome (ICD-9 314), or • 2+ Rx for ADHD drugs without a diagnosis in the in the previous/following 6 months of: o conduct disorder (ICD-9: 312; ICD-10: F63, F91, F92) o disturbance of emotions (ICD-9: 313; ICD-10: F93, F94) o cataplexy/narcolepsy (ICD-9: 347; ICD-10: G47), or
Mood or Anxiety	• 1+ hospitalizations with diagnosis codes: ICD-9 296, 300, 309, 311; ICD-10 F31-F34, F40-F43, F53; or • 2+ physician visits with a diagnosis code: ICD-9 296, 300, 309, 311.
Substance Use Disorder	• One or more hospitalization with a diagnosis for alcohol or drug psychoses, alcohol or drug dependence, or nondependent abuse of drugs: o ICD-10-CA codes F10-F19, F55, Z50, or ICD-9-CM: 291, 292, 303, 304, 305; • one or more physician visits with a diagnosis for alcohol or drug psychoses, alcohol or drug dependence, or nondependent abuse of drugs: o ICD-9-CM codes 291 (alcoholic psychoses), 292 (drug psychoses), 303 (alcohol dependence), 304 (drug dependence), or 305 (nondependent abuse of drugs).

Any mental disorder	A diagnosis of any of the following mental disorder indicators: • ADHD • Mood or Anxiety Disorders • Substance Use Disorder
Income Quintile	Determined using the student's postal code of residence in their grade 8 school year. Income at the census dissemination-area level was determined using responses from the 2016 census.
Grade 12 Mathematics and Language Arts Achievement Tests	Test results in mathematics and language arts, and final marks from these tests.
Grade 7 Mathematics Assessment	Teacher assessment of mathematical skills for students in Grade 7 of publicly funded schools in Manitoba. The five mathematic competencies were assessed halfway through the school year as meeting, approaching, not meeting, or out of range: 1. orders fractions; 2. orders decimal numbers; 3. understands that a given number may be represented in a variety of ways; 4. uses number patterns to solve mathematical problems; and 5. uses a variety of strategies to calculate and explain a mental mathematics problem.
Grade 7 Student Engagement	Teacher assessment of engagement for students in Grade 7 of publicly funded schools in Manitoba. The five measures of engagement were assessed halfway through the school year as established, developing, emerging, inconsistent, or out of scope: 1. demonstrates an interest in his/her learning; 2. engages in self-assessment; 3. aware of learning goals as a unit of study and/or personal learning goals;

	4. participates in lessons; and 5. accepts responsibility for assignments.
Grade 8 Writing assessment	Teacher assessment of reading comprehension and writing of informal texts for students of publicly funded schools in Manitoba. The six competencies were assessed in the first term of the school year meeting, approaching, not meeting, or out of range: 1. understands key ideas and messages in a variety of texts; 2. interprets a variety of texts; 3. responds critically to a variety of texts; 4. generates, selects and organizes ideas to support the reader's understanding; 5. chooses language (word choices and sentence patterns) to make an impact on the reader; and 6. uses conventions (spelling, grammar, and/or punctuation) and resources to edit and proofread to make meaning clear.
High School Completion	High school completion included individuals who: 1. were identified as graduates in the "year-end status" variable; or 2. earned at least 30 high school credits; or 3. earned at least six Grade 12 credits during high school.
Residential Mobility	Number of moves to a different 6-digit postal code during the student's grade 7 and 8 school years.
Employment and Income Assistance	A family was receiving Employment and Income Assistance (EIA) during the child's grade 7 or 8 school year. All children living within a family unit that was receiving EIA were identified.
Children in Care	Children in out-of-home care during their grade 7 or 8 school year. A child who was in out-of-home care: Children in care are children who have been removed from the care of their original families because of a situation where authorities have deemed their family unable or unfit to look after them properly. In some cases, children were voluntarily placed into care by their parents or guardians. Children can be placed in out-of-home care for a variety of reasons

	including abuse and neglect, illness, death of a parent, addiction issues or conflict in their family, disability, or emotional problems.
Any contact with Child and Family Services	Children who had contact with child and family services such as receiving protection or voluntary family services during their grade 7 or 8 school year.

Appendix B: Results for Ever Took a Music Course in High School

This appendix includes results for the dichotomous comparison of students who ever took music courses versus no music courses.

Appendix B1: Student Characteristics Based on Ever Took a Music Course in High School

Appendix Table 2 shows the differences prior to high school between students enrolled and not enrolled in music courses in high school. A higher percent of students who ever received credit for any music courses were female, from the highest income areas, had not moved in grade 7 and 8, had not used social services, had not been diagnosed with ADHD or mood or anxiety disorders, and were meeting or approaching grade level expectations in grade 7 and 8. Students who accessed social services had a higher prevalence of being enrolled in no music courses. Students with any music courses had a lower prevalence being diagnosed with a mental disorder prior to grade 9 except for a substance use disorder. A higher percent of students with any music courses were meeting or approaching grade-level expectations in grade 7 and 8 than students with no music courses. Students enrolled in any music courses also had a higher prevalence of having Established or Developing student engagement in grade 7. In general, students with any music courses were more often female or had better outcomes than students who did not enroll in music courses in high school.

Appendix Table 2: Baseline Characteristics of Students Enrolled and Not Enrolled during Grade 9-12 by Ever Took a Music Course, 2000/01-2016/17

Variable	Overall N=31,487	No Music Courses N=19,124	1+ Music Courses N=12,363
	N (%)	N (%)	N (%)
Grade 7 start year*			
2007	6,529 (20.7)	3,953 (20.7)	2,576 (20.8)
2008	6,478 (20.6)	3,839 (20.1)	2,639 (21.4)
2009	6,102 (19.4)	3,828 (20.0)	2,274 (18.4)
2010	6,110 (19.4)	3,686 (19.3)	2,424 (19.6)
2011	6,268 (19.9)	3,818 (20.0)	2,450 (19.8)
Sex*			
Male	16,344 (51.9)	10,663 (55.8)	5,681 (46.0)
Female	15,143 (48.1)	8,461 (44.2)	6,682 (54.1)
Income Quintile in Grade 8*			
Income not Found and Q1 (Lowest)	5,640 (17.9)	3,668 (19.2)	1,972 (16.0)
Q2	5,644 (17.9)	3,478 (18.2)	2,166 (17.5)
Q3	5,979 (19.0)	3,662 (19.2)	2,317 (18.7)
Q4	6,935 (22.0)	4,204 (22.0)	2,731 (22.1)
Q5 (Highest)	7,289 (23.2)	4,112 (21.5)	3,177 (25.7)
Residential mobility*			
No moves in grade 7 and 8	24,780 (78.7)	14,731 (77.0)	10,049 (81.3)
One move in grade 7 and 8	5,596 (17.8)	3,622 (18.9)	1,974 (16.0)
Two moves in grade 7 and 8	1,111 (3.5)	771 (4.0)	340 (2.8)
Living in a Family Receiving Employment and Income Assistance in Grade 7 or 8*			
Yes	4,209 (13.4)	3,089 (16.2)	1,120 (9.1)
No	27,278 (86.6)	16,035 (83.9)	11,243 (90.9)
Student's Family had Contact with Child and Family Services in Grade 7 or 8*			
Yes	3,205 (10.2)	2,419 (12.7)	786 (6.4)
No	28,282 (89.8)	16,705 (87.4)	11,577 (93.6)
Student was in the Care of Child and Family Services in Grade 7 or 8*			
Yes	867 (2.8)	688 (3.6)	179 (1.5)
No	30,620 (2.8)	18,436 (96.4)	12,184 (98.6)

* Student characteristics are significantly different across music groups (p<.05)

Appendix Table 2: Continued

Variable	Overall N=31,487	No Music Courses N=19,124	1+ Music Courses N=12,363
	N (%)	N (%)	N (%)
ADHD Diagnosis prior to grade 9*			
Yes	3,236 (10.3)	2,276 (11.9)	960 (7.8)
No	28,251 (89.7)	16,848 (88.1)	11,403 (92.2)
Mood or Anxiety Disorder Diagnosis prior to grade 9*			
Yes	2,192 (7.0)	1,433 (7.5)	759 (6.1)
No	29,295 (93.0)	17,691 (92.5)	11,604 (93.9)
Substance Use Disorder Diagnosis prior to grade 9			
Yes	72 (0.2)	49 (0.3)	23 (0.2)
No	31,415 (99.8)	19,075 (99.7)	12,340 (99.8)
Any Diagnosis of ADHD, Mood or Anxiety disorders, or Substance Use Disorder Prior to Grade 9*			
Yes	4,924 (15.6)	3,341 (17.5)	1,583 (12.8)
No	26,563 (84.4)	15,783 (82.5)	10,780 (87.2)
Meeting or Approaching Expectations in Grade 7 Numeracy Skills*			
Yes	23,113 (73.4)	13,302 (69.6)	9,811 (79.4)
No	8,374 (26.6)	5,822 (30.4)	2,552 (20.6)
Established or Developing Skills in Grade 7 Student Engagement*			
Yes	20,646 (65.6)	11,677 (61.1)	8,969 (72.6)
No	10,841 (34.4)	7,447 (38.9)	3,394 (27.5)
Meeting or Approaching Expectations in Grade 8 Reading and Writing Skills*			
Yes	26,256 (83.4)	15,222 (79.6)	11,034 (89.3)
No	5,231 (16.6)	3,902 (20.4)	1,329 (10.8)

* Student characteristics are significantly different across music groups (p<.05)

Note: Percents may not add to 100% due to rounding.

The percent of students diagnosed with a mental disorder during high school was consistently higher among students with no music courses than students with any music courses. A higher percent of students with any music courses graduated on time and wrote their grade 12 achievement tests than students without.

Appendix Table 3: Percentage of Education and Mental Disorder Outcomes for Students by Ever Took Music Courses, Students in Grade 9-12 Attending a High School from 2009/10-2016/17

Variable	Overall N=31,487	No Music Courses N=19,124	1+ Music Courses N=12,363
	N (%)	N (%)	N (%)
Educational Achievement			
Wrote Grade 12 Mathematics Achievement Test*	27,586 (87.6)	16,014 (83.7)	11,572 (93.6)
Average Final Mark in Grade 12 Mathematics Achievement Test (%)*	60.0	58.2	62.5
Wrote Grade 12 Language Arts Achievement Test*	27,570 (87.6)	16,004 (83.7)	11,566 (93.6)
Average Final Mark in Grade 12 Language Arts Achievement Test (%)*	69.4	67.6	71.9
Graduated On Time*	25,327 (80.4)	14,375 (75.2)	10,952 (88.6)
Mental Disorder diagnosis from grade 9-12			
ADHD (N=28,251)*	991 (3.5)	N=16,848 636 (3.8)	N=11,403 355 (3.1)
Mood or Anxiety Disorders (N=29,295)*	7,212 (24.6)	N=17,691 4,461 (25.2)	N=11,604 2,751 (23.7)
Substance Use Disorder (N=31,415)*	896 (2.9)	N=19,075 693 (3.6)	N=12,340 203 (1.7)
Any Mental Disorder** (N=26,563)*	6,898 (26.0)	N=15,783 4,231 (26.8)	N=10,780 2,667 (24.7)

* Student outcomes are significantly different across music groups (p<.05)

** Diagnosis with any of: ADHD, Mood and Anxiety Disorders, or Substance Use Disorder

Note: Count and percent of mental disorder diagnosis from grade 9-12 based on the number of students who were not diagnosed with the specified mental disorder prior to grade 9. As students can be diagnosed with more than one mental disorder, 'Any Mental Disorder' will not reflect the sum.

Appendix B2: Mathematics Achievement Test

Appendix Table 4: Unadjusted Relationship Between Ever Taking Music Courses and Grade 12 Mathematics Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	49.27 (0.22)	<.0001
Ever Took a Music Course (Ref=None)	6.58 (0.34)	<.0001

SE = Standard error

Appendix Table 5: Interaction Between Ever Taking Music Courses and Sex for Grade 12 Mathematics Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Degrees of Freedon	Mean Squares	F Value	p-Value
Ever Took a Music Course	1	143,294.2	183.8	<.0001
Sex	1	10,976.0	14.1	0.0002
Ever Took a Music Course*Sex	1	176.0	0.2	0.6347

Appendix Table 6: Sex-Adjusted Relationship Between Ever Taking Music Courses and Grade 12 Mathematics Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	48.58 (0.27)	<.0001
Ever Took a Music Course (Ref=None)	6.43 (0.34)	<.0001
Sex (Ref=Male)	1.53 (0.34)	<.0001

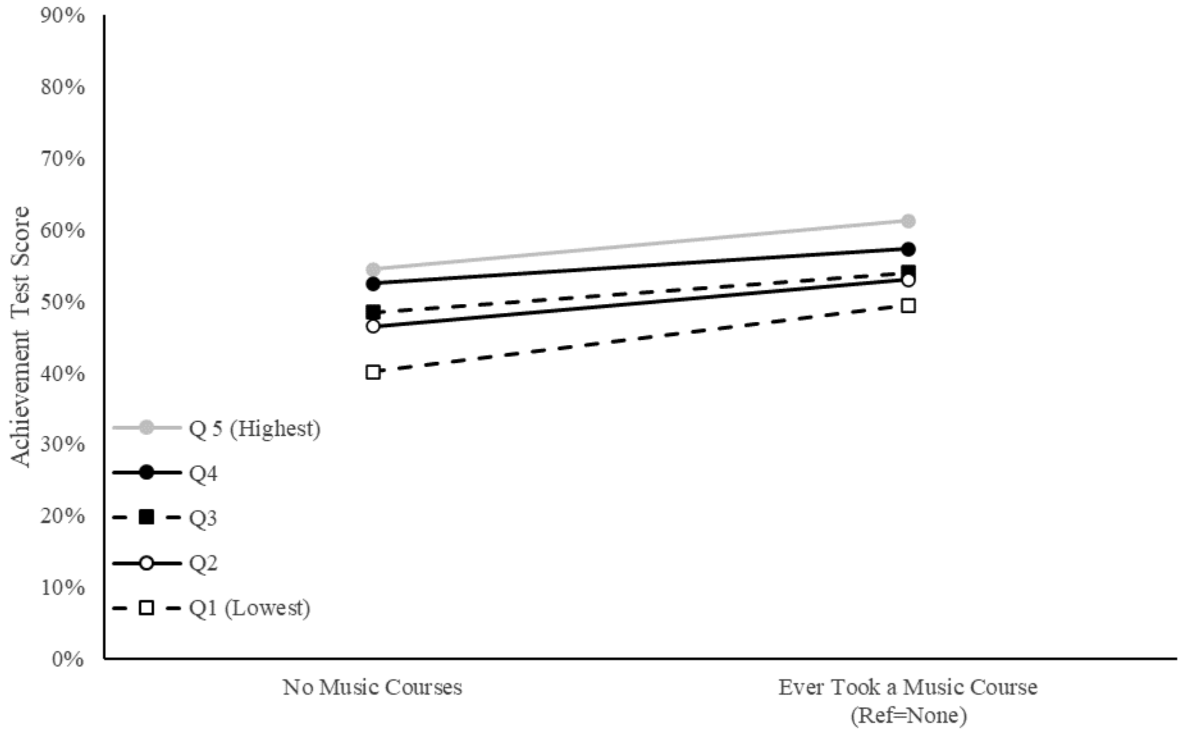
SE = Standard error

Note: The interaction between ever taking music courses and sex was not significant, and therefore not included in the analysis.

Appendix Table 7: Interaction Between Ever Taking Music Courses and Income Quintile for Grade 12 Mathematics Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Degrees of Freedon	Mean Squares	F Value	p-Value
Ever Took a Music Course	1	281,878.4	370.7	<.0001
Income Quintile	4	92,144.4	121.2	<.0001
Ever Took a Music Course*Income Quintile	4	3,305.8	4.4	0.0016

Appendix Figure 1: Relationship Between Ever Taking Music Courses and Grade 12 Mathematics Achievement Test Scores by Income Quintile, 2012/13-2016/17



Appendix Table 8: Adjusted Relationship Between Ever Taking Music Courses and Grade 12 Mathematics Achievement Test Scores, Final Model, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	33.91 (0.63)	<.0001
Ever Took a Music Course (Ref=None)	4.06 (0.32)	<.0001
Sex (Ref=Male)	-0.88 (0.32)	0.0062
Quintile 1 (Ref=Quintile 5)	-5.57 (0.54)	<.0001
Quintile 2 (Ref=Quintile 5)	-4.28 (0.50)	<.0001
Quintile 3 (Ref=Quintile 5)	-4.14 (0.47)	<.0001
Quintile 4 (Ref=Quintile 5)	-1.79 (0.45)	<.0001
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	-9.00 (0.62)	<.0001
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	-7.05 (0.73)	<.0001
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	-7.89 (1.47)	<.0001
1 move in Grade 7 and 8 (Ref=No Moves)	-1.18 (0.42)	0.0052
2 moves in Grade 7 and 8 (Ref=No Moves)	-1.84 (0.96)	0.0563
ADHD Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	-6.84 (0.58)	<.0001
Mood and Anxiety Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	-1.62 (0.65)	0.0127
Substance Use Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	2.60 (4.20)	0.5366
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	6.99 (0.37)	<.0001
Meeting or Approaching Expectations in Grade 7 Numeracy Skills (Ref=Not Meeting or Approaching)	8.55 (0.41)	<.0001
Meeting or Approaching Expectations in Grade 8 Reading and Writing Skills (Ref=Not Meeting or Aproaching)	11.77 (0.52)	<.0001

SE = Standard error

Note: The interaction between ever taking music courses and sex or income quintile was not significant, and therefore not included in the analysis.

Appendix B3: Language Arts Achievement Test

Appendix Table 9: Unadjusted Relationship Between Ever Taking Music Courses and Grade 12 Language Arts Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	59.67 (0.20)	<.0001
Ever Took a Music Course (Ref=None)	7.68 (0.31)	<.0001

SE = Standard error

Appendix Table 10: Interaction Between Ever Taking Music Courses and Sex for Grade 12 Language Arts Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Degrees of Freedon	Mean Squares	F Value	p-Value
Ever Took a Music Course	1	171,900.6	279.9	<.0001
Sex	1	311,643.4	507.5	<.0001
Ever Took a Music Course*Sex	1	986.8	1.6	0.2049

Appendix Table 11: Sex-Adjusted Relationship Between Ever Taking Music Courses and Grade 12 Language Arts Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	55.84 (0.24)	<.0001
Ever Took a Music Course (Ref=None)	6.84 (0.30)	<.0001
Sex (Ref=Male)	8.55 (0.30)	<.0001

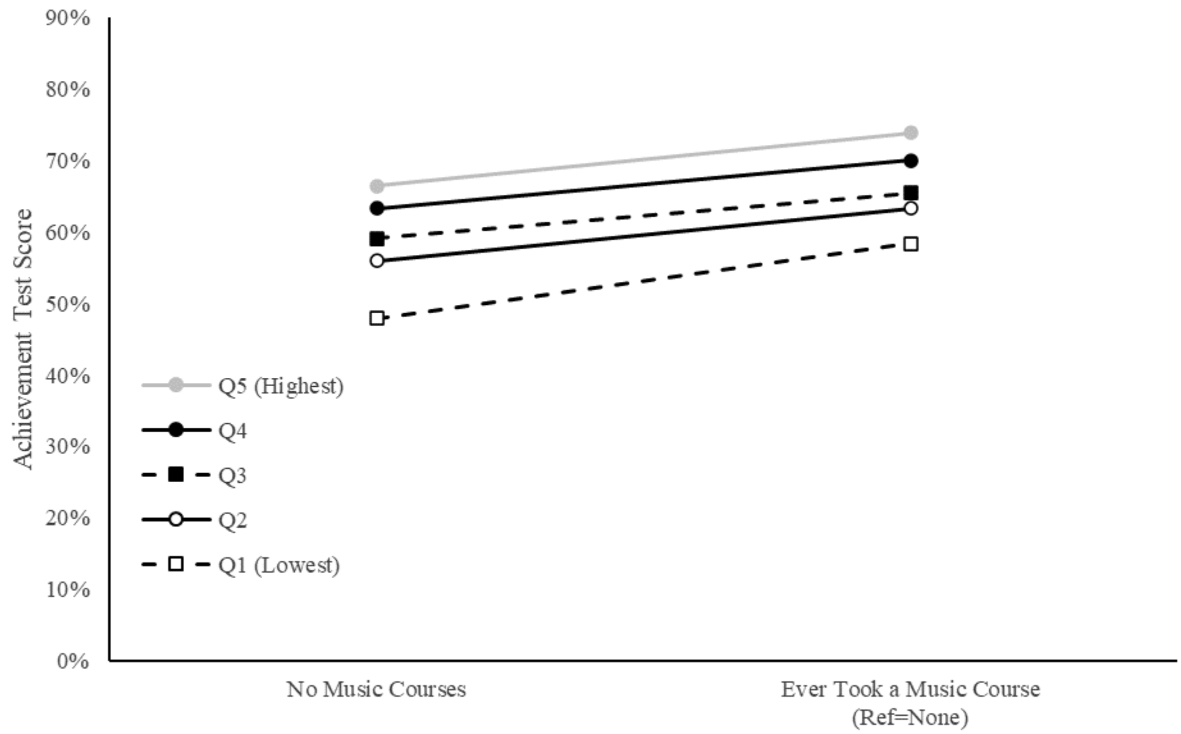
SE = Standard error

Note: The interaction between ever taking music courses and sex was not significant, and therefore not included in the analysis.

Appendix Table 12: Interaction Between Ever Taking Music Courses and Income Quintile for Grade 12 Language Arts Achievement Test Scores, 2012/13-2016/17

Adjustment Variables	Degrees of Freedon	Mean Squares	F Value	p-Value
Ever Took a Music Course	1	378,162.4	631.5	<.0001
Income Quintile	4	150,151.3	250.7	<.0001
Ever Took a Music Course*Income Quintile	4	2,895.5	4.8	0.0007

Appendix Figure 2: Relationship Between Ever Taking Music Courses and Grade 12 Language Arts Achievement Test Scores by Income Quintile, 2012/13-2016/17



Appendix Table 13: Adjusted Relationship Between Ever Taking Music Courses and Grade 12 Language Arts Achievement Test Scores, Final Model, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	38.92 (0.52)	<.0001
Ever Took a Music Course (Ref=None)	4.07 (0.26)	<.0001
Sex (Ref=Male)	5.62 (0.27)	<.0001
Quintile 1 (Ref=Quintile 5)	-8.59 (0.45)	<.0001
Quintile 2 (Ref=Quintile 5)	-6.15 (0.41)	<.0001
Quintile 3 (Ref=Quintile 5)	-5.01 (0.39)	<.0001
Quintile 4 (Ref=Quintile 5)	-2.26 (0.37)	<.0001
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	-9.22 (0.51)	<.0001
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	-9.31 (0.60)	<.0001
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	-6.10 (1.22)	<.0001
1 move in Grade 7 and 8 (Ref=No Moves)	-1.28 (0.35)	0.0002
2 moves in Grade 7 and 8 (Ref=No Moves)	-3.84 (0.80)	<.0001
ADHD Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	-8.30 (0.48)	<.0001
Mood and Anxiety Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	-2.93 (0.54)	<.0001
Substance Use Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	1.06 (3.48)	0.7597
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	7.91 (0.31)	<.0001
Meeting or Approaching Expectations in Grade 7 Numeracy Skills (Ref=Not Meeting or Approaching)	8.12 (0.34)	<.0001
Meeting or Approaching Expectations in Grade 8 Reading and Writing Skills (Ref=Not Meeting or Aproaching)	16.11 (0.43)	<.0001

SE = Standard error

Note: The interaction between ever taking music courses and sex or income quintile was not significant, and therefore not included in the analysis.

Appendix Table 14: Adjusted Relationship Between Number of High School Music Courses and Grade 12 Language Arts Achievement Test Scores, Final Model, 2012/13-2016/17

Adjustment Variables	Coefficient (SE)	p-Value
Intercept	39.08 (0.57)	<.0001
1-2 Music Courses (Ref=None)	1.79 (0.75)	0.0167
3-5 Music Courses (Ref=None)	5.07 (0.91)	<.0001
6+ Music Courses (Ref=None)	9.59 (0.97)	<.0001
Sex (Ref=Male)	5.55 (0.35)	<.0001
Quintile 1 (Ref=Quintile 5)	-8.78 (0.58)	<.0001
Quintile 2 (Ref=Quintile 5)	-5.70 (0.54)	<.0001
Quintile 3 (Ref=Quintile 5)	-4.36 (0.51)	<.0001
Quintile 4 (Ref=Quintile 5)	-2.07 (0.48)	<.0001
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	-8.98 (0.51)	<.0001
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	-9.23 (0.60)	<.0001
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	-5.95 (1.21)	<.0001
1 move in Grade 7 and 8 (Ref=No Moves)	-1.19 (0.35)	0.0006
2 moves in Grade 7 and 8 (Ref=No Moves)	-3.81 (0.79)	<.0001
ADHD Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	-8.28 (0.48)	<.0001
Mood and Anxiety Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	-2.89 (0.53)	<.0001
Substance Use Diagnosis Anytime Prior to January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	1.96 (3.47)	0.5723
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	7.75 (0.31)	<.0001
Meeting or Approaching Expectations in Grade 7 Numeracy Skills (Ref=Not Meeting or Approaching)	7.92 (0.34)	<.0001
Meeting or Approaching Expectations in Grade 8 Reading and Writing Skills (Ref=Not Meeting or Aproaching)	15.94 (0.43)	<.0001

SE = Standard error

Appendix Table 14: Continued

Adjustment Variables	Coefficient (SE)	p-Value
1-2 Music Courses and Female (Ref=None and Male)	1.78 (0.65)	0.0064
3-5 Music Courses and Female (Ref=None and Male)	-0.88 (0.83)	0.2866
6+ Music Courses and Female (Ref=None and Male)	-2.29 (0.94)	0.0148
1-2 Music Courses and Quintile 1 (Ref=None and Quintile 5)	-0.95 (1.04)	0.3598
1-2 Music Courses and Quintile 2 (Ref=None and Quintile 5)	-1.89 (1.01)	0.0617
1-2 Music Courses and Quintile 3 (Ref=None and Quintile 5)	-2.95 (1.00)	0.0031
1-2 Music Courses and Quintile 4 (Ref=None and Quintile 5)	-0.64 (0.96)	0.5075
3-5 Music Courses and Quintile 1 (Ref=None and Quintile 5)	3.59 (1.40)	0.0104
3-5 Music Courses and Quintile 2 (Ref=None and Quintile 5)	0.05 (1.27)	0.9690
3-5 Music Courses and Quintile 3 (Ref=None and Quintile 5)	1.19 (1.21)	0.3249
3-5 Music Courses and Quintile 4 (Ref=None and Quintile 5)	0.78 (1.14)	0.4925
6+ Music Courses and Quintile 1 (Ref=None and Quintile 5)	5.69 (1.74)	0.0011
6+ Music Courses and Quintile 2 (Ref=None and Quintile 5)	1.98 (1.48)	0.1808
6+ Music Courses and Quintile 3 (Ref=None and Quintile 5)	-0.78 (1.37)	0.5684
6+ Music Courses and Quintile 4 (Ref=None and Quintile 5)	-0.97 (1.26)	0.4418

SE = Standard error

Appendix B4: On-Time Graduation

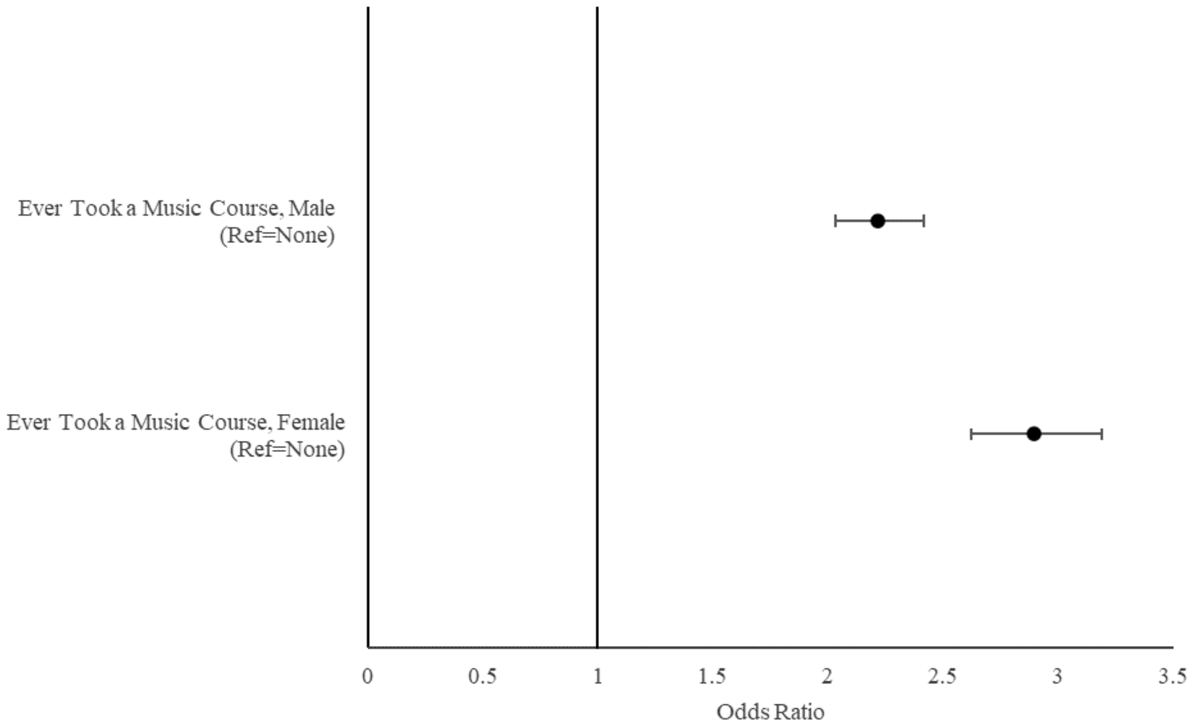
Appendix Table 15: Unadjusted Relationship Between Ever Taking High School Music Courses and On-Time High School Graduation, 2012/13-2016/17

Adjustment Variables	Odds Ratio	95% Confidence Interval	p-Value
Ever Took a Music Course (Ref=None)	2.56	2.40-2.74	<.0001

Appendix Table 16: Interaction Between Ever Taking High School Music Courses and Sex for On-Time Graduation, 2012/13-2016/17

Adjustement Variables	Chi-Square	p-value
Ever Took a Music Course	326.5	<.0001
Sex	37.6	<.0001
Ever Took a Music Course*Sex	16.1	<.0001

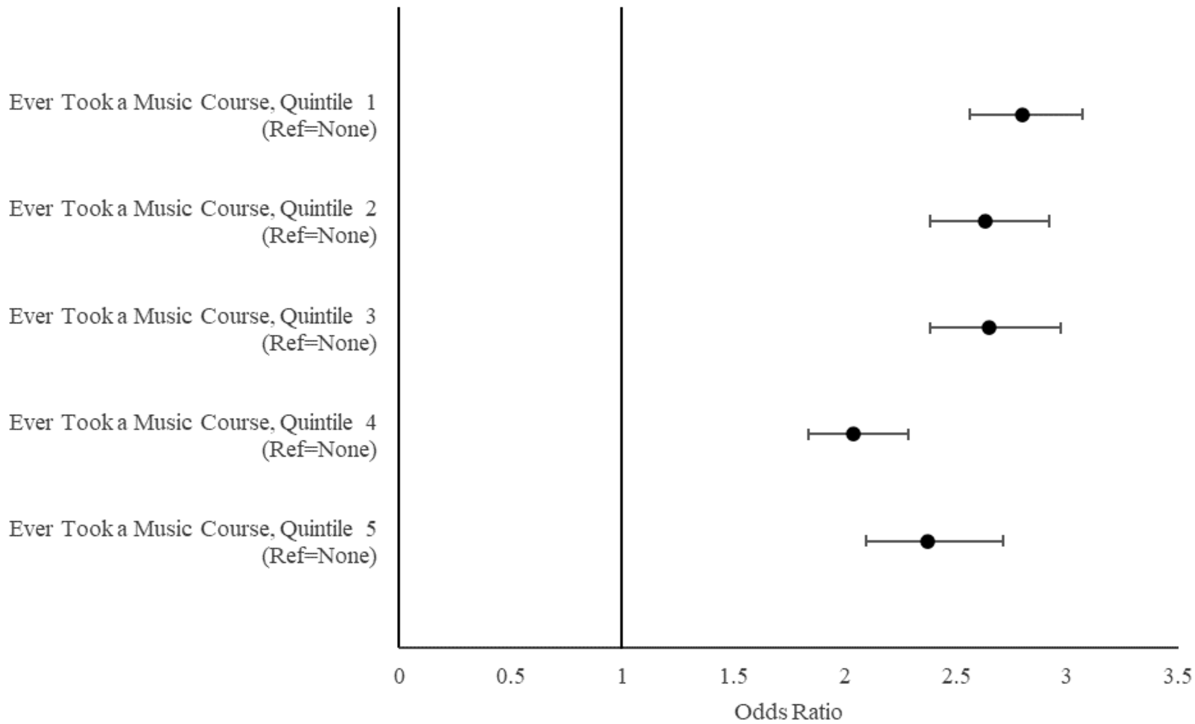
Appendix Figure 3: Relationship Between Ever Taking Music Courses and On-Time High School Graduation by Sex, 2012/13-2016/17



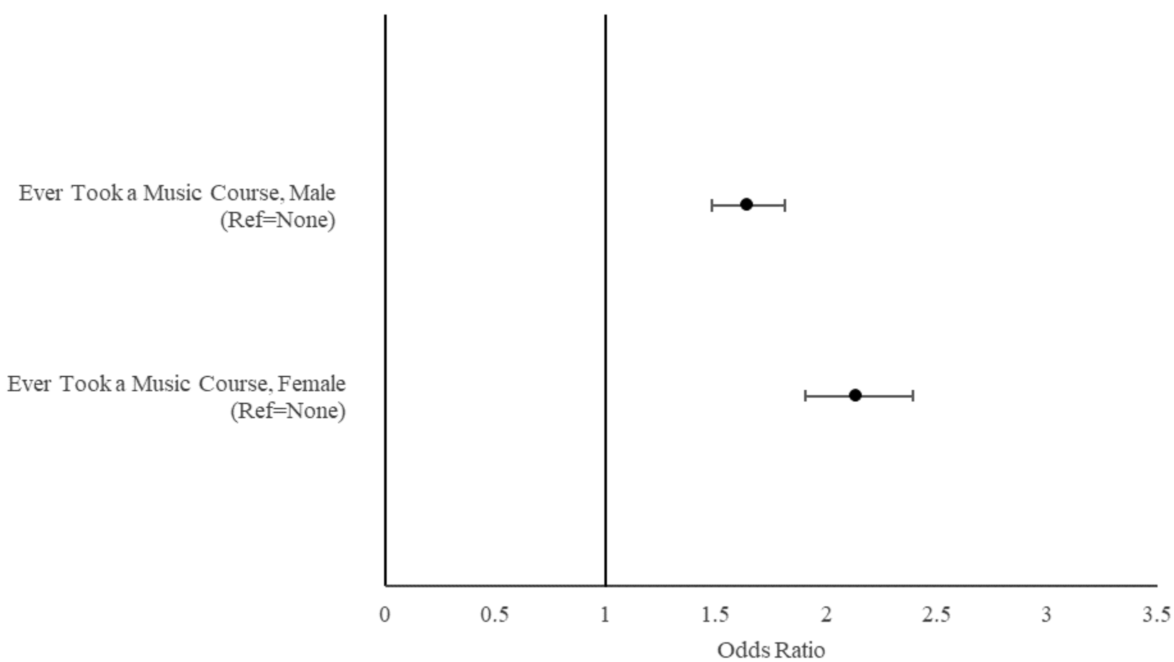
Appendix Table 17: Interaction Between Ever Taking High School Music Courses and Income Quintile for On-Time Graduation, 2012/13-2016/17

Adjustement Variables	Chi-Square	p-value
Ever Took a Music Course	635.7	<.0001
Income Quintile	1,809.3	<.0001
Ever Took a Music Course*Income Quintile	10.1	0.0394

Appendix Figure 4: Relationship Between Ever Taking Music Courses and On-Time High School Graduation by Income Quintile, 2012/13-2016/17



Appendix Figure 5: Adjusted Relationship Between Ever Taking Music Courses and On-Time High School Graduation, Final Model, 2012/13-2016/17



This model was adjusted for: income, residential mobility, living in a family receiving employment or income assistance, contact with Child and Family Services (CFS), being taken into care of CFS, previous mental disorder diagnosis, previous academic achievement, student engagement
Note: The interaction between ever taking music courses and income quintile was not significant, and therefore not included in the analysis..

Appendix Table 18: Adjusted Relationship Between Number of Music Courses and On-Time High School Graduation, Final Model, 2012/13-2016/17

Adjustment Variables	Odds Ratio	95% Confidence Interval	p-value
1-2 Music Courses (Ref=None) and Male	1.19	1.06-1.33	0.0031
1-2 Music Courses (Ref=None) and Female	1.49	1.31-1.69	<.0001
3-5 Music Courses (Ref=None) and Male	2.35	1.90-2.90	<.0001
3-5 Music Courses (Ref=None) and Female	3.93	3.11-4.97	<.0001
6+ Music Courses (Ref=None) and Male	11.25	6.91-18.33	<.0001
6+ Music Courses (Ref=None) and Female	10.81	6.31-18.54	<.0001
Quintile 1 (Ref=Quintile 5)	0.34	0.30-0.39	<.0001
Quintile 2 (Ref=Quintile 5)	0.41	0.37-0.47	<.0001
Quintile 3(Ref=Quintile 5)	0.57	0.50-0.64	<.0001
Quintile 4 (Ref=Quintile 5)	0.76	0.67-0.86	<.0001
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	0.35	0.32-0.38	<.0001
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	0.31	0.28-0.34	<.0001
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	0.50	0.41-0.61	<.0001
1 Move in Grade 7 or 8 (Ref=No Moves)	0.83	0.76-0.90	<.0001
2 Moves in Grade 7 or 8 (Ref=No Moves)	0.64	0.55-0.75	<.0001
ADHD Diagnosis Anytime Prior ro January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	0.61	0.55-0.67	<.0001
Mood or Anxiety Diagnosis Anytime Prior ro January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	0.56	0.49-0.63	<.0001
Substance Use Diagnosis Anytime Prior ro January 1 of Grade 9 School Year (Ref=No Prior Diagnosis)	0.63	0.33-1.20	0.1601
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	2.33	2.16-2.50	<.0001
Meeting or Approaching Expectations in Grade 7 Numeracy Skills (Ref=Not Meeting or Approaching)	1.70	1.57-1.83	<.0001
Meeting or Approaching Expectations in Grade Grade 8 Reading and Writing Skills (Ref=Not Meeting or Aproaching)	2.12	1.95-2.30	<.0001

Note: The interaction between the number of music courses and income quintile was not significant, and therefore not included in the analysis.

Appendix B5: Attention-Deficit Hyperactivity Disorder (ADHD)

Appendix Table 19: Unadjusted Relationship Between Ever Taking Music Courses and Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.84	0.74-0.95	0.0077

Appendix Table 20: Interaction Between Ever Taking Music Courses and Sex for Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Ever Took a Music Course	3.4	0.0672
Sex	0.0	0.9731
Ever Took a Music Course*Sex	0.0	0.9891

Appendix Table 21: Sex-Adjusted Relationship Between Ever Taking Music Courses and Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.84	0.74-0.96	0.0080
Sex (Ref=Male)	1.00	0.88-1.13	0.9584

Note: The interaction between ever taking music courses and sex was not significant, and therefore not included in the analysis.

Appendix Table 22: Interaction Between Ever Taking Music Courses and Income Quintile for Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Ever Took a Music Course	1.1	0.2951
Income Quintile	4.0	0.4038
Ever Took a Music Course*Income Quintile	1.7	0.7911

Appendix Table 23: Income-Adjusted Relationship Between Ever Taking Music Courses and Risk of ADHD Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.84	0.74-0.95	0.0077
Quintile 1 (Ref=Quintile 5)	1.03	0.84-1.25	0.8082
Quintile 2 (Ref=Quintile 5)	1.05	0.87-1.28	0.6095
Quintile 3 (Ref=Quintile 5)	0.85	0.70-1.03	0.1034
Quintile 4 (Ref=Quintile 5)	0.99	0.82-1.19	0.9167

Note: The interaction between ever taking music courses and income quintile was not significant, and therefore not included in the analysis.

Appendix Table 24: Adjusted Relationship Between Ever Taking Music Courses and Risk of ADHD Diagnosis Throughout High School, Final Model, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.87	0.76-1.00	0.0464
Sex (Ref=Male)	0.99	0.87-1.12	0.8623
Quintile 1 (Ref=Quintile 5)	0.91	0.73-1.13	0.3995
Quintile 2 (Ref=Quintile 5)	0.99	0.81-1.20	0.9032
Quintile 3 (Ref=Quintile 5)	0.83	0.68-1.01	0.0569
Quintile 4 (Ref=Quintile 5)	0.98	0.82-1.18	0.8345
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	1.06	0.87-1.28	0.5931
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	1.08	0.86-1.36	0.5146
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	1.52	1.10-2.11	0.0115
1 move in Grade 7 and 8 (Ref=No Moves)	1.11	0.94-1.32	0.2056
2 moves in Grade 7 and 8 (Ref=No Moves)	0.85	0.59-1.22	0.3827
Mood or Anxiety Disorder Diagnosis Anytime Prior to Grade 9 (Ref=No Prior Diagnosis)	1.24	1.03-1.48	0.0239
Substance Use Disorder Diagnosis Anytime Prior to Grade 9 (Ref=No Prior Diagnosis)	1.94	0.79-4.75	0.1485
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	0.85	0.75-0.97	0.0160

Note: The interactions between ever taking music courses and sex or income quintile were not significant, and therefore not included in the analysis.

Appendix B6: Mood or Anxiety Disorders

Appendix Table 25: Unadjusted Relationship Between Ever Taking Music Courses and Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	1.00	0.95-1.05	0.8922

Appendix Table 26: Interaction Between Ever Taking Music Courses and Sex for Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Ever Took a Music Course	0.0	0.9502
Sex	95.9	<.0001
Ever Took a Music Course*Sex	0.9	0.3347

Appendix Table 27: Sex-Adjusted Relationship Between Ever Taking Music Courses and Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.97	0.92-1.01	0.1573
Sex (Ref=Male)	1.33	1.26-1.39	<.0001

Note: The interaction between ever taking music courses and sex was not significant, and therefore not included in the analysis.

Appendix Table 28: Interaction Between Ever Taking Music Courses and Income Quintile for Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Ever Took a Music Course	0.8	0.3813
Income Quintile	4.6	0.3360
Ever Took a Music Course*Income Quintile	4.2	0.3733

Appendix Table 29: Income-Adjusted Relationship Between Number of Music Courses and Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	1.00	0.95-1.05	0.9769
Quintile 1 (Ref=Quintile 5)	1.05	0.98-1.13	0.1534
Quintile 2 (Ref=Quintile 5)	1.07	0.99-1.15	0.0711
Quintile 3 (Ref=Quintile 5)	1.04	0.96-1.11	0.3334
Quintile 4 (Ref=Quintile 5)	1.06	0.99-1.14	0.1059

Note: The interaction between ever taking music courses and income quintile was not significant, and therefore not included in the analysis.

Appendix Table 30: Adjusted Relationship Between Ever Taking Music Courses and Risk of Mood or Anxiety Disorder Diagnosis Throughout High School, Final Model, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	1.00	0.95-1.05	0.8535
Sex (Ref=Male)	1.37	1.31-1.45	<.0001
Quintile 1 (Ref=Quintile 5)	0.98	0.90-1.06	0.5320
Quintile 2 (Ref=Quintile 5)	1.04	0.96-1.12	0.3684
Quintile 3 (Ref=Quintile 5)	1.02	0.95-1.10	0.6004
Quintile 4 (Ref=Quintile 5)	1.06	0.99-1.13	0.1109
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	0.98	0.91-1.05	0.5418
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	1.13	1.04-1.22	0.0035
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	1.22	1.08-1.39	0.0022
1 move in Grade 7 and 8 (Ref=No Moves)	1.01	0.95-1.08	0.6642
2 moves in Grade 7 and 8 (Ref=No Moves)	0.98	0.87-1.11	0.7360
ADHD Diagnosis Prior Anytime to Grade 9 (Ref=No Prior Diagnosis)	1.18	1.09-1.27	<.0001
Substance Use Disorder Diagnosis Anytime Prior ro Grade 9 (Ref=No Prior Diagnosis)	0.89	0.58-1.37	0.6051
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	0.88	0.84-0.93	<.0001

Note: The interactions between ever taking music courses and sex or income quintile were not significant, and therefore not included in the analysis.

Appendix B7: Substance Use Disorder

Appendix Table 31: Unadjusted Relationship Between Ever Taking Music Courses and Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.65	0.56-0.77	<.0001

Appendix Table 32: Interaction Between Ever Taking Music Courses and Sex for Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Ever Took a Music Course	0.0	0.9502
Sex	95.9	<.0001
Ever Took a Music Course*Sex	0.9	0.3347

Appendix Table 33: Sex-Adjusted Relationship Between Ever Taking Music Courses and Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.66	0.56-0.77	<.0001
Sex (Ref=Male)	0.95	0.83-1.08	0.4051

Note: The interaction between ever taking music courses and sex was not significant, and therefore not included in the analysis.

Appendix Table 34: Interaction Between Ever Taking Music Courses and Income Quintile for Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Chi-Square	p-value
Ever Took a Music Course	0.8	0.3813
Income Quintile	4.6	0.3360
Ever Took a Music Course*Income Quintile	4.2	0.3733

Appendix Table 35: Income-Adjusted Relationship Between Ever Taking Music Courses and Risk of Substance Use Disorder Diagnosis Throughout High School, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.65	0.56-0.77	<.0001
Quintile 1 (Ref=Quintile 5)	1.90	1.55-2.34	<.0001
Quintile 2 (Ref=Quintile 5)	1.54	1.23-1.92	0.0001
Quintile 3 (Ref=Quintile 5)	1.30	1.03-1.63	0.0272
Quintile 4 (Ref=Quintile 5)	1.33	1.06-1.67	0.0134

Note: The interaction between ever taking music courses and income quintile was not significant, and therefore not included in the analysis.

Appendix Table 36: Adjusted Relationship Between Ever Taking Music Courses and Risk of Substance Use Disorder Diagnosis Throughout High School, Final Model, 2009/10-2016/17

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.76	0.64-0.89	0.0008
Sex (Ref=Male)	0.87	0.75-1.00	0.0444
Quintile 1 (Ref=Quintile 5)	1.29	1.03-1.62	0.0272
Quintile 2 (Ref=Quintile 5)	1.27	1.01-1.60	0.0377
Quintile 3 (Ref=Quintile 5)	1.19	0.95-1.51	0.1389
Quintile 4 (Ref=Quintile 5)	1.29	1.03-1.62	0.0270
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	1.19	1.00-1.42	0.0569
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	1.82	1.53-2.18	<.0001
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	1.38	1.10-1.73	0.0051
1 move in Grade 7 and 8 (Ref=No Moves)	1.09	0.93-1.28	0.2724
2 moves in Grade 7 and 8 (Ref=No Moves)	1.25	0.92-1.69	0.1501
Mood or Anxiety Disorder Diagnosis Anytime Prior to Grade 9 (Ref=No Prior Diagnosis)	1.24	1.01-1.51	0.0394
ADHD Diagnosis Anytime Prior to Grade 9 (Ref=No Prior Diagnosis)	1.22	1.03-1.45	0.0221
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	0.75	0.65-0.86	<.0001

Note: The interactions between ever taking music courses and sex or income quintile were not significant, and therefore not included in the analysis.

Appendix B8: Any Mental Disorder

Appendix Table 37: Unadjusted Relationship Between Ever Taking Music Courses and Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.92	0.88-0.97	0.0013

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder

Appendix Table 38: Interaction Between Ever Taking Music Courses and Sex for Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Chi-Square	p-value
Ever Took a Music Course	9.5	0.002
Sex	303.8	<.0001
Ever Took a Music Course*Sex	0.0	0.9738

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder

Appendix Table 39: Sex-Adjusted Relationship Between Ever Taking Music Courses and Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.88	0.84-0.92	<.0001
Sex (Ref=Male)	1.73	1.65-1.82	<.0001

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder
Note: The interaction between ever taking music courses and sex was not significant, and therefore not included in the analysis.

Appendix Table 40: Interaction Between Ever Taking Music Courses and Income Quintile for Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Chi-Square	p-value
Ever Took a Music Course	0.9	0.3504
Income Quintile	10.1	0.0387
Ever Took a Music Course*Income Quintile	5.6	0.2319

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder

Appendix Table 41: Income-Adjusted Relationship Between Ever Taking Music Courses and Risk of Any Mental Disorder Diagnosis Throughout High School, 2009/10-2016/17*

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Took a Music Course (Ref=None)	0.93	0.88-0.97	0.0017
Quintile 1 (Ref=Quintile 5)	1.07	1.00-1.16	0.0655
Quintile 2 (Ref=Quintile 5)	1.06	0.98-1.14	0.1280
Quintile 3 (Ref=Quintile 5)	1.02	0.95-1.10	0.5869
Quintile 4 (Ref=Quintile 5)	1.00	0.93-1.07	0.9778

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder
Note: The interaction between ever taking music courses and income quintile was not significant, and therefore not included in the analysis.

Appendix Table 42: Adjusted Relationship Between Ever Taking Music Courses and Risk of Any Mental Disorder Diagnosis Throughout High School, Final Model, 2009/10-2016/17*

Adjustment Variables	Hazard Ratio	95% Confidence Interval	p-value
Ever Received a Music Credit (Ref=None)	0.93	0.88-0.97	0.0022
Sex (Ref=Male)	1.75	1.66-1.84	<.0001
Quintile 1 (Ref=Quintile 5)	0.90	0.83-0.98	0.0108
Quintile 2 (Ref=Quintile 5)	0.98	0.91-1.06	0.6337
Quintile 3 (Ref=Quintile 5)	0.98	0.91-1.06	0.6054
Quintile 4 (Ref=Quintile 5)	0.99	0.93-1.07	0.8656
Living in a Family Receiving Employment or Income Assistance During Grade 7 or 8 (Ref=Not Receiving EIA)	1.10	1.02-1.19	0.0163
Student's Family had Contact with Child and Family Services During Grade 7 or 8 (Ref=No Contact with CFS)	1.36	1.25-1.48	<.0001
Student was in the Care of Child and Family Services During Grade 7 or 8 (Ref=Not in Care)	1.32	1.15-1.51	<.0001
1 move in Grade 7 and 8 (Ref=No Moves)	1.01	0.95-1.07	0.8469
2 moves in Grade 7 and 8 (Ref=No Moves)	1.01	0.89-1.15	0.8856
Established or Developing Skills in Grade 7 Student Engagement (Ref=Not Established or Developing)	0.82	0.77-0.86	<.0001

* Diagnosis with any of: ADHD, Mood or Anxiety Disorders, or Substance Use Disorder
Note: The interactions between ever taking music courses and sex or income quintile were not significant, and therefore not included in the analysis.