MusicCohort: Cross-sectional feasibility study of an assessment protocol for student musicians

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Research

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Abstract

This study examined the feasibility of employing an assessment battery developed in Germany, investigating mental and physical health of university music students, in Canada. Using a cross sectional design, first-semester music and control students were recruited at two university campuses. Eligibility criteria were: 1) first-semester, full-time undergraduate music major (case) or in another university program (control), 2) over the age of 16. Exclusion criteria were: 1) diagnosis of neurological, orthopaedic or psychological condition, 2) diagnosis of infection or systemic disease, 3) regular consumption of medication for pain or mental health diagnosis, 4) varsity athlete, 5) for controls only, enrollment in music courses where a grade is assigned for music performance (e.g. studio lessons). Both groups completed questionnaires and physical testing, including range of motion, core strength and pressure pain threshold. Data for 19 music and 50 control students were analysed. Musician participants demonstrated tendencies towards poorer mental and physical health. This German protocol is feasible in a Canadian university setting. Canadian music students demonstrate similar mental and physical health outcomes to those in the literature and in the parent study. The results of this feasibility study should be confirmed in a larger study.

Background And Objectives

Music has been part of human life and culture for all of recorded history (1). Most of us connect music - particularly listening - with joy and awe for the musician’s creativity, perfection and accuracy when they perform incredibly difficult pieces. The long and challenging path that musicians must take to get to the top tends to be overlooked.

In the research literature, Playing Related Musculoskeletal Diseases (PRMD) are primarily examined in professional musicians, where prevalence rates typically range between 70-80% (9-11). Studies focusing on music students’ playing-related health also suggest elevated stress and anxiety level in children and tertiary students (12, 13). Furthermore, repetitive strain injuries in children and tertiary students have been found to be as high as 90% (12-14). In comparison, 66% of Canadian youth aged 12-19 injure themselves while engaging in sports (15). In this journal, Stanhope et al. (2019) suggested that more consistency is needed in research of musician's PRMD, including the development of more valid tools specific to the task (16).

Given these high prevalence rates, it is important to determine risk factors connected to the development of PRMD, and to develop consistent and reliable assessment methods. To this end, the University of Applied Sciences Osnabrück has launched a longitudinal study, monitoring the health of music students throughout their entire degree. The research team developed a detailed assessment protocol to monitor the student's health over this period (16).

The goal of the present study was to replicate the assessment protocol developed in the German longitudinal study and test its feasibility in a Canadian music program. In particular, we aimed to ensure that processes and management were reproducible and that all necessary resources were available (17). Feasibility in the Canadian educational system would allow for transcultural comparison of health in music students due to standardized procedures. A secondary goal was to examine the prevalence of health conditions in Canadian music students at the beginning of their university studies as compared to non-music students.

Subjects And Methods

Study design

For this feasibility study, a cross-sectional design was selected. Participants were first-semester undergraduate students at the University of Alberta, Edmonton, Canada. They were tested once without follow-up. Inclusion criteria were: 1) enrolled in first-semester as a full-time undergraduate student majoring in music (case) or in any other faculty at the University of Alberta (control), 2) voluntary participation, 3) over the age of 16. Exclusion criteria were: 1) diagnosis of neurological, orthopaedic or psychological condition, 2) diagnosis of infections or systemic disease, 3) regular consumption of pain medication or medication for mental health diagnosis, 4) varsity athlete, 5) for controls only, enrollment in selected courses (e.g. studio lessons) from the music department, where a grade is assigned for playing an instrument.

Recruitment and testing took place from 2016 until 2018, each semester between September and November for 2016-18 fall cohorts (3), and between March and May for the 2018 spring cohort (1). Seventy-nine students contacted the researchers to indicate interest in participation. Data from ten participants were excluded for the following reasons: a non-music student taking music courses; a varsity athlete; participants with mental health diagnoses; participants choosing to withdraw without stating reasons; and participants lost to follow-up. Data from a total of 69 students were included in the analysis, of which 19 were music students and 50 were non-music/control students. No sample size calculation was conducted for this feasibility study. Ethics approval for this study was obtained from the Research Ethics Boards at the Osnabrück University of Applied Sciences and the University of Alberta.

This feasibility study used the following procedure: students were recruited through posters displayed across campus, on social media (Twitter and Facebook), through a campus-wide email distribution system, and via flyers distributed in-person in a first-year music class. Potential participants were

informed that they would receive a $5 coffee gift card for participation, plus one additional gift card for referring additional eligible participants.

Initial eligibility of participants was confirmed via email. Eligible participants were then invited to be tested at the investigator's lab on campus. On testing day, the procedure, as well as inclusion and exclusion criteria, were explained to the participant. Eligible participants were then asked to provide written informed consent. Testing started with participants completing a baseline questionnaire asking general demographic information and history of pain and musculoskeletal complaints. This was followed by additional questionnaires assessing self-reported mental and physical well-being. The second part of the protocol included physical testing of range of motion (ROM), mechanosensitivity, core strength, and general mobility. At the end of the assessment, participants were briefed about their performance. Overall, testing took approximately 70 minutes. All assessments were performed by an investigator who was either a trained physiotherapist, occupational therapist or an occupational therapy student. Every investigator received a minimum of 2 hours of instruction/training for the assessments.

This pilot study adhered as closely as possible to the study protocol used by Ballenberger et *al.* to allow for comparability and to test feasibility of the protocol in a different geographical and cultural setting (16). Furthermore, through continuous communication with the authors of the parent study in Germany, refinements to the original protocol were reflected in our study protocol at the earliest convenience. This paper describes the final protocol used. Changes are discussed in the discussion.

Assessment of physical and mental health

The original participant questionnaire was translated from German into English by a native German speaker who is fluent in both languages. This study aimed to compare music and non-music students. In the initial cohort, music students answered a playing-related pain questionnaire. Neither music nor control students, however, were asked to answer any questions about general musculoskeletal pain prevalence. For better comparison, 20 questions about general pain were added before recruitment of the third cohort. Those questions were based on the general pain questions used in the German parent study.

Health-related Quality of life

To screen health-related quality of life, we used the RAND 12 questionnaire, which is free and does not require a license. This makes the test more user-friendly for replication of the study and future implementation in clinical settings. Furthermore, a custom scoring algorithm that is more appropriate for

chronic conditions was employed, which does not rely on the basic assumption that physical and mental health component scores are not related (18). Test-retest reliability is reported to be excellent (ICC=0.78) and adequate (ICC=0.60) for physical and mental health composites, respectively (19).

Initially, the parent study in Germany used the Stress-Coping-Inventory (SCI) (16). An optional, more versatile, mental health screening questionnaire was found in the 21-item Depression Anxiety Stress Scales (DASS-21), which –unlike the SCI – has also been translated into multiple languages. The DASS-21 screens and distinguishes between the three mental health dimensions of depression, anxiety and stress (20). It demonstrates good internal consistency of 0.82-0.97, for both clinical and non-clinical populations (21, 22).

Core endurance

Core strength was assessed using four tests: a full plank, lateral planks on the right and left sides, and the Biering-Sørensen test for extensor endurance (23). Both the Biering-Sørensen test and plank tests have excellent inter-rater reliability (ICC = 0.8-0.99 and ICC = 0.95, respectively) (23, 24). Investigators demonstrated the correct positioning and allowed participants to try. Participants were then asked to hold each position until fatigued or needing to stop for any other reason. Other reasons participants in this study gave for stopping included pain, discomfort or vigorous shaking. A 30 second break between planks was given to eliminate confounding fatigue. Any position change was verbally corrected once; any further correction led to termination of the test.

General mobility

To assess general mobility/ hypermobility, the Beighton score and the Sitting-Rising Test (SRT) were utilized. The Beighton score assigns a score of 0 to 9 reflecting general mobility (25). Participants performed four movements bilaterally, which were assessed by the investigator. The SRT assesses general mobility out of 10-points. Participants were asked to sit cross-legged on the floor, and rise with minimal support (26, 27). For any additional support needed, points were deducted from a 10-point scale. Both tests have good intra- and inter-rater reliability (26; 28).

Kenny Music Performance Anxiety Inventory

Music Performance Anxiety was evaluated using the Kenny Music Performance Anxiety Inventory (KMPAI-R). The inventory was first developed in 2004 and is the only validated tool that not only measures cognitive, behavioral, and physiological aspects of performance anxiety, but also “underlying

psychological vulnerability" (29). The latest, revised version consists of 40 items, subdivided into eight domains. A participant can score a maximum of 240 points, where a higher score indicates more severe MPA symptoms. Questions address playing-related anxiety and the influence of different external sources. It has shown excellent internal consistency (Cronbach's Alpha =0.94) (30). The questionnaire is musician-specific, and was therefore only answered by music students.

Mechanosensitivity

To test mechanical pressure pain threshold, the same nine bilateral testing points as the original protocol by Ballenberger et al. were assessed (16). For the first cohort, a mechanical algometer (Pain Diagnostics & Thermography, Italy) was used, which was then exchanged for a digital model (FDIX Wagner Instruments, Greenwich, CT, USA). Each point was tested three times, with a recovery period of 5 seconds in between.

Playing-related Musculoskeletal Disorders and pain/complaints interfering with daily living

Musicians answered the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM). The tool, containing 13 questions, evaluates musicians' current playing-related health concerns (31). It generates two sub scores for pain interference (0-40) and pain intensity (0-50) (32). There are currently no cut-off scores established for this tool. It has adequate internal consistency and test-retest reliability (31).

Statistical Analysis

IBM SPSS, version 25, and Microsoft Excel 2013 were used to analyse collected data. Alpha was set at $p<0.05$. Most characteristics were not normally distributed, so non-parametric tests were chosen, using Mann-Whitney U test and the Chi-square-test for continuous and categorical variables, respectively. A preliminary analysis showed that musician and control groups were comparable in terms of both age and gender, and therefore, data were not adjusted for these variables. Effect size r was calculated by dividing the z-value by square root of N (33).

Results

General demographics

Between October 2016 and November 2018, 19 music and 50 control students were tested and included in data analysis. Gender distribution of participants was similar in both

groups with 68.4% female among musician participants, and 62% female in the control group.

Differences in the baseline characteristics between musicians and controls were statistically significant for both nutrition (p=0.022) and physical activity (p=0.001). Musicians' self-reported scores were lower for both of these health behaviours than controls. Participants were grouped into those who reported physical activity (PA) at/above the suggested 90 minutes per week (34), and those who reported lower PA. Analysis showed that musicians were significantly less likely to engage in PA (χ^2= 6.25, p=0.016, OR 4.20). For the remaining characteristics, both groups were comparable (see table 1).

The average course load in hours per week (excluding labs) for musicians and controls was 18.87± 3.3 and 18.638 ± 5.20, respectively. In addition, musicians spent an average of 24.67 hours playing either their primary or secondary instrument.

Table 1. General demographics*

	Total	Musicians	Control	Statistics
Total	69	19	50	
Female gender	44 (63.8%)	13 (68.4%)	31 (62%)	p= 0.781, X^2= 0.246
Age, yrs	18.00 (2)	18.00 (2.00)	18.00 (0)	p= 0.480, r= -0.085, Z=-0. 707
Height, cm	164.5 (0.12)	164.5 (12.00)	166.5 (13.00)	p= 0.961, r= -0.049, Z=-0.049
Body weight, kg	59.5 (10.50)	59.5 (10.5)	61.00 (13.75)	p= 0.829, r= -0.216, Z=-0.216
BMI	21.77 (5.30)	21.77 (3.06)	21.70 (2.85)	p= 0.565, r= -0.070, Z=-0.578
Sleep duration, hr	7.00 (0.63)	7.00 (0.63)	7.00 (1.44)	p= 0.309, r= -0.124, Z=-1.028
Course hours/ wk	17.75 (5.80)	17.75 (5.80)	18.00 (4.00)	p= 0.941, r= -0.010, Z=-0.080
Physical activity	1.25 (2.80)	1.25 (2.8)	4.00 (4.00)	**p= 0.001***, r= -0.391, Z= -3.249
Alcohol glasses/wk	0.25 (1.30)	0.25 (1.3)	0.00 (0.90)	p= 0.321, r= -0.123, Z=-1.002
Nutrition	6.00 (1.30)	6.00 (1.30)	7.00 (2.00)	**p= 0.022***, r= -0.274, Z=-2.281
Instrument Playing hours	NA	21.75 (18.38)	N/A	N/A

(musicians only)				

Values represent as median and Interquartile Range or frequency and percentage for each respective group, test statistics for Man-Whitney-U-Test,* α=0.005, **Bold * *show* α *<0.005, r = effect size*

Core strength

Musicians demonstrated lower core strength, with all but the full plank test times being significantly different between groups. It is noteworthy that the control group also performed on average below the norm in all four endurance tests (35).

Table 2. Core endurance

Test	Total*	Musician*	Control*	Statistics
Right side plank	49.00 (45.00)	30.00 (37.00)	56.50 (38.64)	**p= 0.008***, r= -0.315, Z=-2.614
Left side plank	49.00 (40.50)	29.00 (35.00)	53.50 (34.25)	p= 0.054, r= -0.240, Z=-1.995
Full plank	69.00 (60.00)	52.00 (67.00)	74.00 (55.75)	**p= 0.046***, r= -0.232, Z=-1.928
Biering-Sorensen-test	111.00 (69.00)	80.00 (69.00)	123.00 (49.50)	**p= 0.009***, r= -0.313, Z=-2.599

Values represent median and Interquartile Range, statistics for Mann-Whitney-U-test,* α=0.005, **Bold * *shows* α *<0.005 r = effect size*

Mechanosensitivity

Mechanosensitivity testing showed that musicians had lower mean pain thresholds for every testing point. A Mann-Whitney U test revealed statistically significant difference in mean mechanosensitivity (of all measuring points) for musicians and controls, respectively ($p=0.029$). Gender-specific differences were present, with females having consistently lower mean ranks, although these were not statistically significant. However, there was no clear pattern as to which testing points were significantly different.

Table 3. Mechanosensitivity, measured by mechanical pressure pain threshold

Test point	All (N=69)*	Musician (N=19)*	Control (N=50)*	Statistics
R Trapezius	45.30 (26.69)	41.84 (29.00)	47.30 (28.67)	p=0.200, r=-0.155, Z=-1.290
L Trapezius	42.17 (33.40)	37.10 (17.49)	46.48 (35.41)	**p=0.050***, r=-0.236, Z=-1.961
R Supraspinatus	47.33 (34.47)	40.54 (22.17)	49.39 (40.83)	p=0.227, r=-0.147, Z=-1.216
L Supraspinatus	44.70 (28.89)	35.00 (26.21)	51.09 (32.41)	**p=0.008***, r=-0.315, Z=-2.619
R Wrist Extensor	39.40 (17.88)	30.40 (15.53)	40.59 (17.14)	**p=0.023***, r=-0.272, Z=-2.257
L Wrist Extensor	31.20 (19.36)	29.00 (11.20)	35.50 (22.01)	p=0.184, r=-0.161, Z=-1.337
R Wrist Flexor	51.50 (28.86)	41.68 (27.40	56.75 (26.51)	**p=0.021***, r=-2.297, Z=-0.277
L Wrist Flexor	40.83 (23.08)	33.70 (19.94)	42.77 (22.06)	**p=0.030***, r=-0.260, Z=-2.163
R Temporalis	23.17 (12.92)	18.96 (9.02)	25.05 (12.02)	**p=0.009***, r=-0.310, Z=-2.573
L Temporalis	21.00 (10.00)	19.29 (7.00)	21.58 (11.00)	p=0.169, r=-0.167, Z=-1.384
Mean	37.43	30.53	38.76	**p=0.029***,

algometer	(15.28)	(11.20)	(16.29)	r=-0.265, Z=-2.190

Values represent median and Interquartile Range in Newton, statistics for Mann-Whitney-U-test,* α=0.005, **Bold * *shows* α *<0.005, r = effect size*

Range of Motion

Range of motion (ROM) was tested with the same strategy as implemented by Ballenberger et al. (16). There were no significant differences between musicians and controls on any of the ROM movements tested. Furthermore, both cohorts' ROM did not differ significantly from the norms.

Table 4. Range of motion

Movement	All (N=69)*	Musician (N=19)*	Control (N=50)*	Statistics
Mean CROM	59.17 (10.08)	59.83 (11.00)	58.97 (10.33)	p=0.648, r=-0.077, Z=-0.643
Mean ROM	74.44 (8.25)	74.31 (7.31)	74.69 (8.55)	p=0.486, r=-0.085, Z=-0.705

Values represent median and Interquartile Range of range of motion in degrees, test statistics for Mann-Whitney-U-test,* **Bold * *shows* α=0.005, *r = effect size*

General mobility

Hand span was not statistically different between musicians and controls and was similar to that of the general public for both samples. Although differences were not significant,

musicians did have larger hand span for all four measurements (digit one-to-five and two-to-five on both hands). Both the Beighton score and Sitting-Rising Test did not show any significant differences between musicians and controls.

Self-Reported Mental Health

Musicians had poorer self-reported mental health scores in all three domains on the DASS-21. Only on the stress domain, however, was this difference statistically significant ($p=0.043$). Comparing female and male students, the scores for female students were lower; however, this difference was not statistically significant.

Figure titles:

Figure 1: Frequency (%) of symptomatic participants by DASS21 domain.

For the Kenny Music Performance Anxiety Inventory (KMPAI-R), over half of the tested musicians (63.6%) scored above the suggested cut-off of 84 (30), indicating more severe symptoms of Music Performance Anxiety, with a mean score of 94.27 ($\pm$56.64).

Self-reported Quality of Life

When compared to normative data for the SF-36 for Canadians of a similar age (36), the largest differences were observed in the following domains: Bodily Pain, Vitality, Role emotional, Mental Health and Mental Composite Score (MCS). However, these differences were not statistically comparable, since they employ two different questionnaires. When compared Differences between music students and controls were statistically significant for

Bodily Pain (p=0.004) and approached statistical significance for General Health (p=0.053). Mental Composite Scores were below the norm for both cohorts.

Table 5. RAND12 results for total sample and by cohort

RAND12	Overall (N=69)	Musicians (N=19)	Non-Musicians (N=50)	Statistics
Physical functioning	55.95 (8.50)	55.95 (8.50)	55.95 (8.50)	p= 0.560, r=-0.560, Z=-0.575
Role physical	57.17 (9.51)	52.42 (9.51)	57.17 (5.94)	p= 0.190, r=-0.159, Z=-0.190
Bodily pain	57.27 (9.41)	47.86 (9.41)	57.27 (0.00)	**p= 0.004***, r=-0.348, Z=-2.887
General health	55.49 (10.38)	45.11 (10.38)	55.49 (10.38)	p= 0.053, r=-0.231, Z=-1.918
Vitality (energy)	44.91 (10.38)	44.91 (20.77)	44.91 (10.38)	p= 0.170**,** r=-0.167, Z=-1.391
Social functioning	56.17 (10.12)	56.17 (10.12)	56.17 (10.12)	p= 0.459, r=-0.092, Z=-0.770
Role emotional	44.98 (17.34)	39.20 (17.34)	44.98 (13.00)	p= 0.175, r=-0.164, Z=-1.365
Mental health composite score	48.99 (10.76)	44.68 (14.67)	54.74 (5.97)	p= 0.169, r=-0.171, Z=-1.424
Physical health composite score	53.90 (6.29)	51.60 (5.91)	49.50 (10.59)	p= 0.055 r=-0.231 Z=-1.921

Values present median and Interquartile Range for RAND12 scores, test statistics for Mann-Whitney-U-test, α=0.005. **Bold *** *shows* α *<0.005*

Pain/complaints

The point prevalence (7-day) of Playing-Related Musculoskeletal Disorder (PRMD) in this sample was 31.6%, whereas lifetime prevalence was 68.4%. Life-time-prevalence rate of 68.4% was also consistent with findings in the literature (9-14). The most prevalent playing-related pain location, as recorded by the MPIIQM, was the right forearm (N=4). Right wrist, shoulder-neck region, and left and right hand (N=3, respectively) were the next most frequently reported locations. The most common pain locations were similar to those reported in the literature (6-14). Participants reported a mean playing-related pain intensity of 4.06 on a Likert scale of 0 to 10 as measured by the MPIIQM. Pain interference with participants' ability to play at the level to which [they] were accustomed was reported as a mean of 8.53 on a scale of 0 to 10.

Feasibility

The trial of the German assessment protocol in a Canadian educational setting was considered feasible. All tools were either available in English or were unvalidated demographic collection forms that were translated by the first author, who is fluent in both languages. Furthermore, all clinical tests were reproducible using the same procedures. This study highlighted recruitment as the main critical area in our setting for a successful and relevant reproduction. Despite differences in the university settings, we found that the protocol was feasible in both settings.

Discussion

Our results show that a protocol used for a longitudinal study in Germany/Europe is feasible to be reproduced in a Canadian university setting. In comparison to the German parent study, these cohorts presented with similar health profiles, although no in-depth comparative analysis has yet been conducted (37). Additionally, the data presents a clear trend that first year music students in a Canadian university have poorer mental and physical health than other, non-music first year students.

Music students and control students reported very similar numbers of course hours per week. Music students, however, spent an average of 24.76 hours playing their instrument outside of classes. We speculate that this might be a contributing factor as to why music students spend significantly less time on physical activity. Long hours spent on school work and practicing, significantly less physical activity, significantly worse self-reported nutrition, as well as tendencies toward more alcohol consumption and less hours of sleep might all be contributing factors to worse physical and mental health in music students.

The point prevalence (7 day) of PRMD in this study, 31.6%, was comparable to that reported in the literature (14). This is lower than in a comparative study by Berque and colleagues using this tool (38). Since their study examined PRMD in professional musicians, this difference may reflect variation between post-secondary student musicians and professionals.

It is striking that music students had a lower pressure pain threshold on all 18 testing points, as well as a higher mean mechanosensitivity ($p=0.029$), while simultaneously reporting higher levels of stress and anxiety symptoms. A link between stress and pain threshold has previously been suggested, which may explain these results (39). Furthermore, testing points with statistically significant differences were located on the forearm, left supraspinatus and left trapezius. Those muscle groups are often recruited in instrumental performance (40, 41). The wrist extensor muscle wad was the most commonly reported location for PRMD, likely reflecting its action in the performance requirements of several instruments (41, 42).

With respect to performance anxiety, there are currently no validated cut-offs developed for the KMPAI-R. Kenny, however, suggests a preliminary cut-off of 84 points (35). The mean score of students in this sample was well above this score. However, the large variability in the KMPAI-R scores of participants in our study implies the need for a larger sample.

Self-reported mental and physical health, as captured by the RAND 12, were not statistically different between groups, except for the Bodily Pain domain. By contrast, compared to the Canadian age-related norm, the total sample population performed worse in all domains except Bodily Pain. Considered as a whole, the participants in this study performed above the norm in the domain Role Physical; however, musicians scored below the norm, while control students scored above the norm. These differences were not significant; however, the difference of 5.77 points between the MCS scores of musicians and controls

was higher than the minimal clinically important difference in two patient populations (43, 44).Higher levels of stress and mechanosensitivity are also consistent with higher levels of Bodily Pain on the RAND 12.

The literature suggests that Physical Activity (PA) has a beneficial effect on pain threshold (45, 46). This is congruent with our sample, where musicians did significantly less PA and reported lower pain threshold. This finding must also be viewed with caution because the RAND 12 is a self-report measure. Kreutz et al. have demonstrated that music students' self-report of their health is more optimistic than objective findings (47). Clinicians must therefore be cautious when assessing musicians' health through self-report.

The research literature suggests gender difference in several of the measured outcomes. A preliminary analysis of gender differences showed a trend for females to present with poorer physical and mental health outcomes. These results were, however, not statistically significant and need to be studied further (48, 49).

In summary, a preliminary comparison of the Canadian data to the original longitudinal study in Germany showed similarities in student's health profiles, however, a larger sample and more research are needed (37).

Study Limitations

A limitation of this study is that the procedure had to be adapted throughout data collection. For example, it was discovered that in the parent study, all participants were being asked about general pain ratings. This was added later in our study, resulting in missing data for this parameter from earlier participants. Furthermore, unlike in the German study, the age cut off was adapted to 16 years of age. This age was chosen to capture situations where younger students were attending university (typically in Canada, they would be 18 or older), and were mature enough to provide informed consent.

After the first cohort, the investigators realized that a revised version of the Kenny Music Performance Inventory was being used in the German parent study. The protocol was then adapted to include the revised version**.** Hence, the eight students in the first cohorts completed an earlier version (KMPAI), for which no cut-off-scores are available (50). These participants' data were therefore excluded from data analysis concerning performance anxiety.

Another limitation is the relatively small number of participants, which reduces statistical power. Recruiting music students proved to be more challenging than we had anticipated. There may be a number of explanations for this difficulty, including the length of time required for testing (70 minutes) and the fact that our lab was located a 15 minute walk away from the Department of Music. Participants in Germany were expected to take part in testing annually. Since health promotion and injury prevention are relatively new concepts in post-secondary music education in Canada, program culture and research ethics requirements meant we were reliant on the goodwill of students and a $5 gift card incentive to encourage participation. A cultural change towards health promotion in schools of music in North America has been recommended by educators, researchers and clinicians (51), and this change is supported in Canada through curriculum guidelines that recommend health education (52).

This study is a helpful step in understanding differences between music student's and other student's health habits, and in understanding how Canadian music students compare to music students around the world. It also helps to highlight the difficulties in recruiting music students for research studies. Anecdotally, music students often tell clinicians and researchers that they are very busy, and our findings related to class and practice time seem to support this.

Thus far, our study has not included a longitudinal component, but this could be an important addition in future studies. Since the demands of different instruments require specific postures and may cause instrument-specific strain on the body, future studies may also examine instrument-specific risk factors. The results encourage further study in the area, but larger samples are needed for more meaningful conclusions.

In conclusion, our study has demonstrated that the protocol developed by our German colleagues is feasible in a Canadian university population. We have also demonstrated similar trends in Canadian post-secondary students as compared to German students. Future studies with larger sample sizes can provide further insight into the risk factors affecting post-secondary music students, providing a basis for prevention and intervention.

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Abbreviations

PT	Physiotherapy
OT	Occupational therapy
MSc	Master
BSc	Bachelor
PhD	Doctor of Philosophy
CAOT	Canadian Association of Occupational Therapists
CAD	Canadian Dollar
GDP	Gross Domestic Product
PRMD	Playing Related Musculoskeletal Diseases
ROM	Range of Motion

RAND-12	The 12-question version of the RAND Corporation quality of life measure
ICC	Interclass Correlation Coefficient
SCI	Stress-Coping-Inventory
DASS-21	Depression Anxiety Stress Scales, 21-question version
SRT	Sitting-Rising-Test
KMPAI-R	Kenny Music Performance Anxiety Inventory – Revised
MPIIQM	Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians
PA	Physical Activity
OR	Odds Ratio
MCS	Mental Composite Score (of the RAND-12)
PCS	Physical Composite Score (of the RAND-12)

Declaration

Ethics approval and consent to participate

This study has been approved by the Human Research Ethics Board at the University of Alberta (name: Music Cohort, ID: Pro000673590). All participants gave written, informed consent before the start of testing and the protocol adhered to ethical standards for human subjects.

Consent for Publication

Not applicable

Availability of data and materials

Data for this study contains sensitive health information and is unfortunately not available to share outside of the research team, as we do not have ethics approval to share the data.

Competing interests and funding

This study did not receive any external funding. No other financial arrangements or organizational affiliations are present and there are no competing interests.

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All authors have approved the manuscript for submission.

Figures

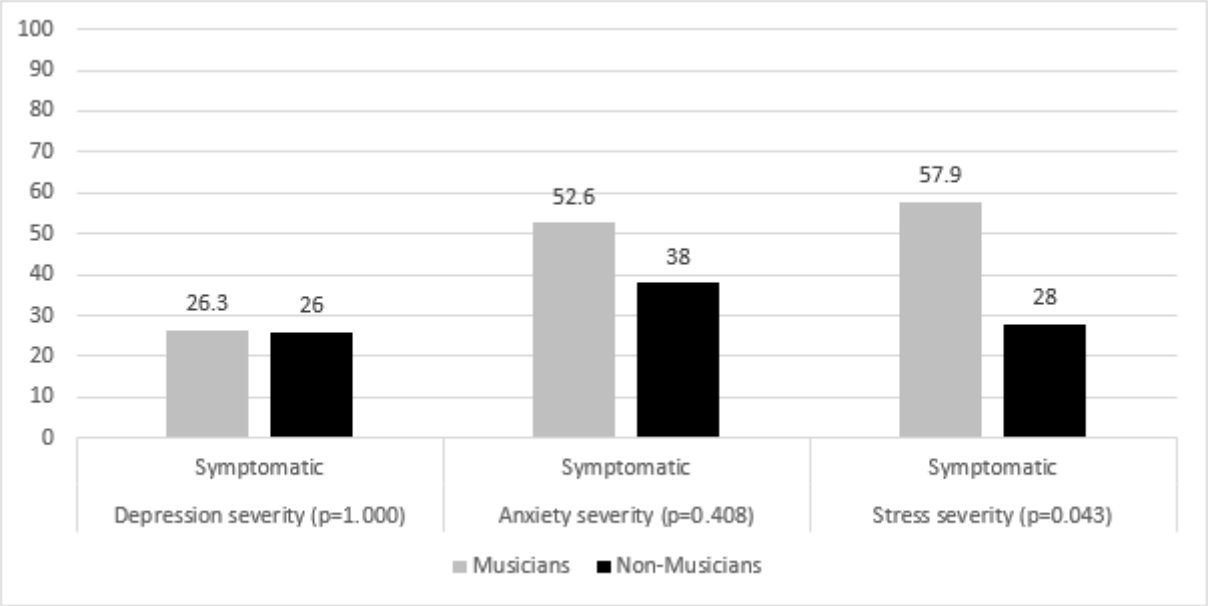

Figure 1

Frequency (%) of symptomatic participants by DASS21 domain.

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