Feasibility and impact of a musculoskeletal health for musicians (MHM) program for musician students: A randomized controlled pilot study

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ABSTRACT
Background: There is a high incidence of performance-related musculoskeletal disorders in musicians that may be reduced via education programs. However, the efficacy of formalized injury prevention programs has not been rigorously studied.

Purpose: To assess the feasibility and effect of a formalized injury prevention education workshop on incidence and severity of musculoskeletal pain in a cohort of musician-students attending an intensive summer music festival compared to controls.

Study design: Randomized-controlled-pilot trial.

Methods: Musicians at an 8-week long intensive summer festival were randomized to an intervention (workshop) or control group. Workshop attendees participated in a 90-minute session of injury prevention strategies. Musculoskeletal outcome data were collected at the start and end of the festival. Outcomes included presence of musculoskeletal pain, adherence level, and sub-scales of the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians.

Results: A total of 57 musician-students (ages 17-30, 23 females) participated in the study, and 48(84%) completed the study. Seventy-five percent of workshop participants reported adherence over 8 weeks. At baseline, 84% of participants reported a history of playing-related pain, and 47% recent or current pain. Participants played a range of instruments (50% string, 34% piano, 16% woodwind/brass). At baseline, average weekly reported playing time was 39 hours (±11). At follow-up, reported pain decreased by 32% in the intervention group and increased by 8% in controls (P = .01). Pain interference scores were lower (Post – Pre = -4.58, 95% CI -9.26 to 0.11, P = .055). There was no statistically significant difference between groups for pain intensity.

Conclusions: The high compliance and willingness to participate suggests that injury prevention education implementation is feasible. Our preliminary findings suggest a positive effect on pain incidence and pain interference in the intervention group. Future studies will examine the relationship between adherence levels and injury rates in a larger cohort and identify obstacles to implementation.

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Introduction
Musician health and wellness is fundamental for safe, effective and optimal musical performance. Unfortunately, musculoskeletal overuse injuries affect between the 60-90% of the 30 million
professional musicians in the United States.\textsuperscript{1,2} These injuries have serious consequences on musculoskeletal health, occupational performance ability (20% cancellations and lost time at work), career longevity (≤50% recovery), and the overall healthcare burden ($187 million in annual costs).\textsuperscript{3-6} In musicians, injury is associated with exposure to specific risk factors (prolonged awkward asymmetrically playing postures, repetitive motion) that lead to musculoskeletal conditions such as nerve compression, muscle contracture, and tendinitis.\textsuperscript{4,5,6} There is evidence that ergonomic education and exercise instruction reduces and even prevents injury in musicians by targeting the mechanisms of injury and risk factors contributing to pain and disability.\textsuperscript{7-10,13} In other populations at risk for overuse these approaches are known to reduce injury incidence by up to 50%.\textsuperscript{17,18} Despite supporting evidence, there is no consensus on best approach, formalized musician injury prevention programs rarely exist, and injury prevention approaches are infrequently employed in clinical or music education settings.

Higher incidence rates of musculoskeletal overuse have been reported in musician-students compared to professional musicians, placing students at an even greater risk of musculoskeletal pain.\textsuperscript{5,6} Injuries vary in frequency, location, and type relative to the instrument played.\textsuperscript{4} The highest levels of injuries reported occur in string players, and the most frequently affected areas include the shoulders, arms, neck and back.\textsuperscript{3,4,19} Injury prevention approaches to address risk factors include a range of programs from health education, ergonomic training, and various exercise programs. Benefits have been reported in several studies that document improved physical and psychological well-being, and improved body awareness following a health education course in a group of university students.\textsuperscript{10,14,15} Other studies investigate the positive role of health education\textsuperscript{12,16} and exercise.\textsuperscript{11,16,20,21} There are few controlled studies that investigate the feasibility of implementing a program and the direct effect of education and exercise on preventing and reducing injury rates in musician-students. Based on the best available evidence, health education instruction that addresses specific risk factors and is combined with exercise instruction appears to be the best approach to prevent and lower musculoskeletal overuse injury incidence in musicians.

An intensive summer festival program is a high risk setting for performance related musculoskeletal injury because festival programs demand intense practice schedules in terms of frequency and duration of playing time and intensity of repertoire.\textsuperscript{22} An abrupt change in playing time, such as the sudden ramp up associated with summer music programs, is one of the major risk factors associated with increased symptoms and pain.\textsuperscript{4} For this reason summer programs have been specifically implicated in increased injury levels,\textsuperscript{22} yet despite the known risk and high incidence levels, formalized health education is rarely offered.

The purpose of this pilot study was to assess the feasibility and impact of an educational musculoskeletal health for musicians (MHM) program that combines education with exercise instruction on pain and injury in musician-students participating in an intensive summer festival program. We hypothesized that an MHM program would be feasible to implement at an intensive summer music program and that exposure to a formalized health education program will result in a high participation and compliance rate among participants. Early effectiveness on the incidence and severity of musculoskeletal injury and interference with performance will also be measured by musculoskeletal outcome measures and self-reported weekly logs.

Methods

The study protocol was approved by the Hospital for Special Surgery Institutional Review Board, study # 2019-0146.

Study participants

Participants were recruited from a large summer classical music festival program. The summer festival program is an 8-week program of high intensity playing for pre-college and college age musician-students between the ages of 12-30. Students were recruited via email and included if they were 12 years or older, played a musical instrument and were enrolled in the full-time 8-week program. Participants were excluded if they had a non-playing related musculoskeletal or neurological injury in the past year. Recruited participants completed the informed consent per institutional review guidelines. Parental assent was obtained for participants under the age of 18.

Randomization

Following consent, all recruited participants were randomized to either the intervention or control arm and were stratified by sex and musical instrument group. A computer-generated set of random numbers was used to create an allocation sequence, and an individual without direct participation in the clinical aspects of the study performed the randomization and preparation of allocation materials.

Sample size

For this pilot study, we used a convenience sample to recruit musician-students enrolled in an intensive summer music festival program that typically has 600-650 attendees. We expected to enroll a total of 10-15% of musician students (n=60-90). Data obtained from this pilot study will be used to calculate a post-hoc sample size (alpha =0.05; beta = 0.2; power = 0.8) for the primary outcome variables to design a larger, more definitive study to be conducted in the future.

Intervention

Participants in the intervention group participated in a 90-minute MHM workshop led by a clinician with specialization and expertise in performing arts medicine. The content for the workshops was developed based on best available evidence in collaboration with multi-disciplinary practitioners (physiatry, sports medicine, occupational therapy, and physical therapy) who are experts in performing arts medicine and music educators. This MHM workshop has been previously delivered to students at music conservatories and schools. The 90-minute workshop is a combination of didactic lecture (30 minutes) and a hands-on practicum (60 minutes). The didactic component included a review of common risk factors, and an explanation of the physiology of overuse injury, relevant anatomy and musculoskeletal pain conditions. The practical component includes a 60-minute discussion, demonstration, and participation in 1) practical strategies for prevention of injury in 4 categories: warm up, pacing/breaks, posture/playing position, and implementation of “smart” practice habits, and 2) specific stretches and exercises to be performed prior to playing, while on-stage and during backstage breaks.

Students participated in 30 minutes of supervised warm-up routine, stretches, and exercises. The warm-up routine included a 2-3-minute cardiac warm-up of marching/jogging in place followed by 10-15 reps of “big arm movements” such as arm circles. Students participated in supervised stretches such as a supine foam roller pectoralis stretch, extrinsic forearm flexor/extensor stretches, upper trapezius and levator scapulae stretch, and side-bending, trunk and sitting lower back stretch. Students were instructed to perform 5 repetitions of stretches with a 5 second hold, during


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longer practice breaks, minimum 2 sets per day not to exceed 4 sets per day. Students also participated in a brief exercise routine targeted at strengthening the scapular stabilizers and posterior chain, muscles typically underused in most musician instrumentalists. These exercises included prone scapular stabilization, serratus anterior activation, and deep neck flexion exercises. Active participation allowed for additional supervised instruction of correct form during exercise. All students in the intervention group received written and digital instructions with figures that included the practical strategies, stretches, and strengthening exercises including recommendations for frequency. For instruction in proper posture and playing position, representatives from each instrumental group volunteered to play in front of the group. The instructor analyzed the playing position and mechanics and made ergonomic or postural recommendations. Additional suggestions were offered by attending music faculty and other students. At the end of the session, students had the opportunity to ask specific individualized questions during an additional optional 30-minute question and answer segment. Students in the control arm were offered an opportunity to participate in the educational workshop at the conclusion of the study and received the educational material at the conclusion of the 8 weeks.

Data collection

Data was collected by a research coordinator who was blinded to the arms of the study. Demographics and a detailed performance history were collected at baseline prior to the start of the festival. The performance history data included information on practice habits, type of instrument played, number of years playing that instrument, instrument playing level, and other instrumental points. The Musculoskeletal Pain Interference and Impact Questionnaire for Musicians (MPIIQM) was used to collect musculoskeletal outcome data at baseline, 8 weeks (the end of the festival), and 12-weeks. It includes 5 categories: frequency, intensity, duration and location of pain, and impact of pain on playing habits. The MPIQM is specific to musician injury, and is a well validated, reliable instrument with established psychometric properties. Participants in the workshop group also received a weekly online survey with a question regarding frequency of adherence to each of the 5 preventative components instructed in the MHM workshop: warm-ups, pacing/breaks, posture/playing position, “smart practice”, and exercises. Participants were asked to rate the frequency of their performance over the past week as: not at all or 1-2 times (low adherence), 3-4 or 5-6 times (medium adherence), once a day or more than once a day (high adherence).

Statistical analysis

Data were summarized using descriptive statistics (sample means and standard deviations) for both groups pre/post participation in the workshop and at 3-month follow up. Presence or absence of pain (pain incidence) was calculated using Fisher’s exact test. Independent sample t-test was performed for the difference in improvement between treatment groups. Statistical significance was set at P < .05. To assess the dose response between adherence and injury and pain levels, we categorized adherence rates into tertiles (high, medium, and low) depending on the data distribution across the adherence scores for all participants. A one-way ANOVA test was used to compare injury levels across the 3 adherence levels.

Results

A total of 77 respondents were screened for the study. 66 met inclusion criteria and were consented for the study. Six participants declined to participate. Ultimately, 60 participants were recruited. 3 additional participants from the control group were excluded due to incomplete baseline questionnaires. Of the 57 remaining participants, 48 (84%) completed the study. Baseline data of one participant was found to be incomplete and excluded from analysis. The final analysis included 47 participants (24 intervention, 23 controls). Figure 1 illustrates the progress through the phases of the trial. Table 1 describes participant characteristics for both groups (age range 17-30, 23 females, 23 males). Participants played a range of instruments (50% string, 34% piano, 16% woodwind/brass). At baseline, average weekly playing time was 39 (±11) hours and 47% of participants reported musculoskeletal pain.

Feasibility

Overall, our recruitment efforts yielded a 13% response rate (77/660 festival registrants). All of the 60 participants who met the inclusion criteria and consented to participation agreed to be randomized. 84% of participants completed the 8-week study, and 75% of participants in the intervention group (18/24) demonstrated compliance with the program by completing adherence questionnaires.

Table 1
Baseline characteristics across groups (mean/Stddev)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Workshop (n = 30)</th>
<th>Control (n = 26)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age [years, mean (SD)]</td>
<td>22 (4)</td>
<td>21 (4)</td>
</tr>
<tr>
<td>Sex [# female, (%)]</td>
<td>14 (47)</td>
<td>14 (54)</td>
</tr>
<tr>
<td>Years played instrument [mean (SD)]</td>
<td>14 (4)</td>
<td>15 (3)</td>
</tr>
<tr>
<td>Weekly playing hours [mean (SD)]</td>
<td>37(10)</td>
<td>40(11)</td>
</tr>
<tr>
<td>Participants reporting history of playing related pain (%)</td>
<td>25 (83)</td>
<td>22 (85)</td>
</tr>
<tr>
<td>Current/recent reports of playing related pain (%)</td>
<td>16 (53)</td>
<td>11 (42)</td>
</tr>
<tr>
<td>Pain location:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand/arm (% of participants reporting current/recent pain)</td>
<td>8 (47)</td>
<td>3 (43)</td>
</tr>
<tr>
<td>Back/neck (% of participants reporting current/recent pain)</td>
<td>9 (53)</td>
<td>4 (57)</td>
</tr>
<tr>
<td>Instrument played by participants (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strings: violin, cello, bass</td>
<td>12 (40%)</td>
<td>15 (57%)</td>
</tr>
<tr>
<td>Piano</td>
<td>11 (37%)</td>
<td>9 (35%)</td>
</tr>
<tr>
<td>Woodwinds: flute/piccolo/bassoon/oboe</td>
<td>4 (13%)</td>
<td>2 (7%)</td>
</tr>
<tr>
<td>Brass: horn, trombone</td>
<td>3 (10%)</td>
<td>0</td>
</tr>
<tr>
<td>MPIIQM pain interference at baseline [mean (SD)]</td>
<td>4.23 (7.75)</td>
<td>5.23 (5.75)</td>
</tr>
<tr>
<td>MPIIQM pain intensity at baseline [mean (SD)]</td>
<td>6.57 (12.08)</td>
<td>9.72 (11.27)</td>
</tr>
</tbody>
</table>
A total of 18/24 participants completed a minimum of 3 weekly adherence surveys over the 8-week course. Individual adherence responses were categorized based on frequency of adherence: low (0-2x/week), medium (3-6x/week), or high (once or more daily) and averaged across weeks by participant for each of 5 components of the intervention (Table 2). Adherence across components was inconsistent within and across participants. The highest adherence was reported for stretches/exercises, pacing, and “smart” practice, and the lowest adherence for physical warm-up and posture/playing recommendations.

Musculoskeletal pain incidence

Presence or absence of pain (musculoskeletal pain incidence) was recorded at the start and end of the festival and documented as the number of participants reporting current pain on the MPI-IQM (question #11). Over 80% of participants reported a history of musculoskeletal pain at baseline (25/30 in intervention group, 22/26 in control group). At baseline testing current pain was reported by 27/56 (48%) participants, 16/30 (53%) in the intervention group and 11/26 (42%) in the control group. Among participants who identified pain location, pain was distributed between the neck/back (53%) and hands/arms (47%) across all instrumentalists. There were no significant differences at baseline between groups for presence of pain, pain intensity or pain interference (Table 1). There were 47/56 participants who completed the MPI-IQM questionnaire at the 8-week follow-up point at the end of the festival (24 in the workshop group, and 23 in the control group). At 8-week follow-up the overall pain incidence level reported as persistent playing related pain was reduced by 32% from 16/30 (53%) in the workshop group to 5/24 (21%) compared to 53% at baseline and increased in controls 11/23 (48%) compared to 42%, P < .01.

Table 2

<table>
<thead>
<tr>
<th>Component</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical warm-up</td>
<td>8 (44%)</td>
<td>5 (28%)</td>
<td>5 (28%)</td>
</tr>
<tr>
<td>Pacing</td>
<td>6 (33%)</td>
<td>2 (11%)</td>
<td>10 (36%)</td>
</tr>
<tr>
<td>Posture/playing</td>
<td>7 (39%)</td>
<td>3 (17%)</td>
<td>8 (44%)</td>
</tr>
<tr>
<td>“Smart” practice</td>
<td>4 (22%)</td>
<td>4 (22%)</td>
<td>10 (56%)</td>
</tr>
<tr>
<td>Stretches/exercises</td>
<td>5 (28%)</td>
<td>4 (22%)</td>
<td>12 (50%)</td>
</tr>
</tbody>
</table>

Intervention adherence
Musculoskeletal pain interference and pain intensity

Musculoskeletal Pain Interference was calculated as the average of the questions on the 3 questions of the MPIQIQM related to pain that interferes with playing performance. Participants in the intervention group showed a decrease in pain interference whereas the controls showed an increase in pain interference score (Post-Pre-Difference: -4.58, 95% confidence interval (CI) -9.26 to 0.11, \(P = .055\)) (Table 3). Musculoskeletal Pain Intensity was calculated as the average of 3 questions on the MPIQIQM that relate to pain intensity. Pain intensity post-scores were also lower in the intervention group compared to baseline and lower compared to controls, but not statistically significant (Difference: 95% CI = 4.41, 8.17, \(P = .55\)). Only 7/47 participants completed the 12-week follow-up questionnaire despite multiple email and phone attempts for contact.

Musculoskeletal pain by adherence

There were no significant differences in dose response (low, medium, high) across all components of the intervention for change in pain interference and pain intensity. The “smart practice” group approached statistical significance with greater improvements (pre-post) with increased adherence: change in pain interference scores (low = -4, medium = 2.24, high = 6, \(P = .06\)) and change in pain intensity (low = -5.5, medium = -2, high = 7.8, \(P = .07\)).

Discussion

Feasibility of program implementation

We set out to assess the feasibility and impact of an educational injury prevention program at an intensive summer music festival program. Our experience indicates that while we were able to implement and conduct the program and demonstrate moderate effects, there were considerable challenges that underscore the difficulty in implementing prevention education programs. Addressing these challenges will be critical to influencing future study design and implementation processes. Overall, we successfully recruited participants and were able to implement a single session workshop at an intensive summer festival. This was possible due to the support and collaboration of festival organizers, administrators, and teachers who were aligned in promoting healthy habits among their students and participants. We chose to target one of the largest and most prestigious classical music summer festivals with the expectation that a festival with a high registration rate will increase our recruitment efforts.

Despite multiple internal announcements, promotion by faculty and administration, and a robust email campaign, our recruitment efforts remained below 15% of overall festival participants. This highlights a number of challenges. First, students who participate in these intense programs are driven, ambitious and are intensely scheduled with lessons, practice sessions, orchestra rehearsals, and performances leaving very little time for additional programming. The initial challenge of securing a 90-minute time slot during orientation week was difficult and only possible with the advocacy and support of senior music teachers and high-level administrators who recognized the importance. Second, the value of health and injury prevention education may not be appreciated by young students. Over half the participants in our study reported no pain at the start of the festival. Despite these challenges, the students who responded to recruitment efforts demonstrated a higher rate of participation, willingness to be randomized, and high compliance with the program suggesting that once recruitment challenges are overcome, an injury prevention program is feasible to implement. Furthermore, the limited data from this study demonstrates the value of this type of program and could influence the likelihood of implementation at future festivals.

Our findings highlight the need for further studies to identify system-level barriers to implementation and participation at both the organization level and the user level. A single recent study by Ajidahun et al investigated opinions of a small group of string players (n=11) in South Africa regarding an exercise-based injury prevention program and reported that time constraints were the primary challenge to implementation. The Ajidahun study reflects the perspective of a small single user group (string players). Except for this study, there is no evidence of in-depth analysis of organizational contextual factors, perspectives of multiple user groups (music teachers, administrators, musician students), and barriers, and facilitators of implementation.

Musculoskeletal pain incidence at intense summer music programs

Of note, 47% of participants reported some level of musculoskeletal pain at the start of an intensive workshop schedule with demands of upwards of 36 hours of scheduled weekly playing time. This underscores the need for proper screening at the start of the festival to identify injuries in a timely manner and provide proper instruction and treatment to avoid further injury and dropout. Sudden increases in playing time, and playing intensity typical at summer programs are known contributors to musculoskeletal pain in musicians. A recent study reported an increase in playing time from 14 hours to 23 hours in 93 students attending 3 elite summer camps in Quebec, Canada. Complaints in pain frequency increased from never to most of the time and pain intensity increased from 19mm to 24mm on a visual analog scale after just one week of playing at an increase rate. These changes were statistically correlated to changes in playing time. Our cohort reported an average of 36 hours of playing time per week with increased pain interference in the control group compared to the workshop group. The percentage of pain incidence reported also decreased in the workshop group compared to controls.

Effects of injury prevention education on musculoskeletal pain and incidence

Participants in the workshop program demonstrated overall decreased incidence of pain. Of those reporting persistent pain, our preliminary findings suggest moderate pain interference improvement, particularly with high adherence to “smart” practice habits implying that exposure to musculoskeletal health education may be effective in reducing pain and injury. Our findings contrast
with other studies reported by Chan et al. and Roos et al who reported stronger effects following exercise and rehabilitation programs in both pain intensity and pain interference. There are several explanations that may account for the differences in our findings. First, we studied a young group of musician students compared to other studies of seasoned orchestral professionals who are more likely to value health promoting activities. Second, the cohort in this group was studied immediately prior to a known increase in practice schedule and intensity and are at a greater risk of injury.

Our study had several limitations. Due to geographical constraints the workshop was delivered in a single session. This likely affected our recruitment efforts due to practice and performance scheduling conflicts. We were also unable to provide additional in-person oversight throughout the program. While we sent weekly reminders to follow up with the strategies and recommendations, there was no further in-person interaction. Other studies in professional orchestral groups report stronger effects with additional oversight, such as mid-session follow up sessions and supervised exercise routines. Our results may have also been influenced by the heterogeneity of musculoskeletal pain (location, intensity) and instrument played. We used a general program that may not have been adequately customized to instrument group. While the response rate to the outcome surveys was high at the 8-week follow-up, the drop rate at 12-weeks following the program was response was poor and precluded analysis for carryover effects. Lastly, as a pilot study our sample size was not sufficiently powered to demonstrate significant changes. Due to the small sample size we were unable to conduct a detailed analyses of the effect of individual variables or adequately assess the effect of adherence levels.

In conclusion, our findings of decreased injury incidence and possible pain interference in the workshop reinforce the importance of further studying the impact of MHM education programs in intensive music education settings and underscore the need to further explore system-level barriers of MHM program implementation and larger efficacy studies that also address recruitment and long-term retention. Our findings are a necessary first step to shape current prevention programs and will be used to generate hypotheses to conduct larger-scale participant-randomized hybrid trials in future studies to assess effectiveness and implementation outcomes of MHM programs. Larger studies will stratify injury and response to intervention by multiple variables such as instrument, injury location, and adherence levels. Future studies will lead to the ultimate goal of one day achieving wide scale implementation of injury prevention programs for musicians, thus improving long-term musculoskeletal health and performance longevity in instrumental musicians and bridging an important gap between knowledge and practice.

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**References**


