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Leveraging implementation science to prevent and reduce musculoskeletal overuse injury in musicians: A proposal for the study of a conceptual framework

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ABSTRACT

Background: Musician health and wellness, a fundamental requirement for safe, effective and optimal musical performance, is not guaranteed. Performance related musculoskeletal disorders (PRMD) affect between 60% and 90% of all musicians, and have serious consequences on musculoskeletal health, performance ability and the overall healthcare burden of musculoskeletal injury. The high prevalence of PRMD in musicians can be prevented and reduced via health-education programs designed to address risk factors and practice habits. Multiple studies demonstrate the efficacy of education and instructional exercises in reducing PRMD symptoms in musicians. *Despite the awareness of risk and the substantial consequence of non-adherence, implementation of health-education programs is complex and challenging and is rarely offered in music institutions.* For successful adoption of musculoskeletal health programs, it is important to identify system level barriers and facilitators and it is important to develop and pilot effective strategies to guide successful implementation of musculoskeletal health programs for musicians.

Purpose: This paper proposes a conceptual framework using implementation science methodology to study the factors that influence adoption of musician health education programs to prevent performance related injury. The overall goal of this methodology is to identify determinants of implementation by engaging key stakeholders, developing strategies for adoption of injury prevention programs and generate hypotheses for future studies.

Methods: The research plan is designed to accomplish the specific aims of this study. Through a mixed-method study we will use qualitative and quantitative methods to address potential barriers, and design and test implementation feasibility of health-education programs for musicians.

Results/Conclusions: Our findings will inform the development of a large-scale participant randomized hybrid trial to assess effectiveness and implementation outcomes of health education programs and ultimately reduce injury and promote musculoskeletal longevity and performance in musicians

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Introduction

Musician health and wellness, a fundamental requirement for safe, effective, and optimal musical performance, is not guaranteed. The cumulative reported lifetime prevalence of performance related musculoskeletal disorders PRMD affecting all musicians is 93%¹ with the highest incidence rates reported in musician-

students.^{2,3} PRMD is defined as symptoms that have a *negative impact* on the ability to play a musical instrument.⁴ These disorders have serious consequences for health-care burden, cost, and impact on musician's careers.⁵ In surveys of orchestral musicians, 84% reported a history of PRMDs, with over 50% reporting no recovery, and 20-24% reporting time off work and cancelled performances.^{1,6,7} The direct cost to treat musculoskeletal injury is \$7.9k per person with a cumulative annual cost of \$187 million in the musician population.⁸ In musicians, injury is related to risk factor exposure such as: high playing demands, repetitive movements over extended periods of time; sudden changes to practice

Conflicts of Interest: None.

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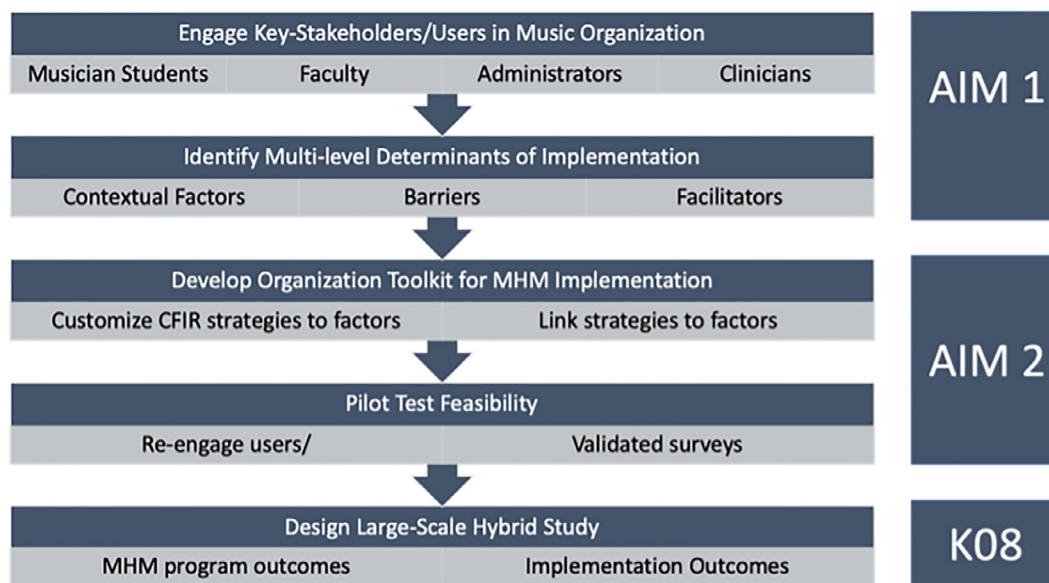


Fig. 1. Implementation Science Model to promote adoption of MHM programs.

schedules, repertoire, and technique; and prolonged awkward asymmetrical playing postures.^{9,10} Education that includes ergonomic training, exercise instruction, and guidance in playing habits to address risk factors is an effective approach to prevent and reduce PRMD incidence, and is reported to decrease symptoms and even prevalence by as much as 50%.^{7,11–13,17–19}

In 2006, the Health Promotion in Schools of Music project released consensus-based guidelines and recommendations to incorporate health educational programs as part of music training.²⁰ In 2011, the National Association of Schools of Music adopted standards that require music schools to provide students with basic information regarding the health and safety issues inherent in practice.²¹ *Despite the awareness of risk and the substantial consequence of non-adherence, implementation of health education programs is complex and challenging, and is rarely offered in music institutions.* The challenges to implementing formalized prevention programs in other fields such as sports medicine are complex, multifactorial and involve elements such as knowledge deficits, time constraints and other cultural or organizational factors.^{22,23} Identifying the challenges specific to musician injury prevention (such as attitude towards injury and knowledge of risk factors) is an important first step in facilitating formalized injury prevention approaches. A strategic implementation science approach to study and address pertinent factors can lead to widescale adoption of injury prevention approaches and an overall reduction in the prevalence and burden of musculoskeletal injury in musicians. The purpose of this paper is to describe the proposed methodology for an implementation science approach to study this problem.

We propose a framework to investigate why formalized prevention is not readily available by using a qualitative methods and implementation science approach to identify influencing factors and to drive the development of a toolkit that will strategically address barriers (Fig. 1). In this conceptual framework, we recommend developing strategies to address identified barriers that can then be pilot-tested for feasibility and fidelity in representative settings to guide implementation of an existing evidenced-based musician injury prevention program, outlined below. We suggest the use of *formative* and *process (summative)* evaluation to address potential barriers, and design and test implementation feasibility of an injury prevention program. Formative evaluation is ongoing

and ensures that a program is feasible, appropriate, and acceptable before it is fully implemented. Process evaluation determines whether program activities have been implemented as intended.²⁴ Our approach is designed to study and address the factors responsible for the gap between knowledge and practice with the ultimate goal of promoting musculoskeletal health and reducing injury in musicians.

Systems-level factors influence adoption of musculoskeletal health promotion programs for musicians.

A possible barrier to musician injury prevention implementation is the historical culture that promoted a deep collective denial towards playing related injuries. “Injury concealment” and a “playing through pain” mindset was frequently promoted for fear of career jeopardy.^{18,25} A gradual shift in attitude increased awareness of the risk factors implicated in the development of PRMD. Although the benefits of injury prevention are now well established,^{5,11,14,18,26} musicians still rarely receive formal instruction and education in proper techniques, mechanics, and exercise.¹⁴ While the reasons for this have not been formally studied, one possibility is that prevention approaches are typically targeted at the musician or musician student level, and not the organizational level. Musicians often do not have complete autonomy over performance and practice schedules, and without organizational and policy support, may be unable to implement recommended practice guidelines. A comprehensive implementation approach that includes all stakeholders by addressing attitudes and knowledge of risk factors at all levels within the system has the potential to be more effective in facilitating implementation of formal programs. Successful health promotion implementation initiatives target the individual level (health education, knowledge, and development of skills) to improve clinical outcomes and the broader society level (socio-economic, political, environmental, and community public health policy) to improve population level outcomes.^{22,23} While the challenges to implementing formalized health promotion and injury prevention programs are known to be complex and multifactorial in other fields such as sports medicine and attributed to culture, and time constraints,^{22,23} the factors and attitudes affecting implementation of programs have not been explored in the music injury population and likely involve a combination of factors at the individual level (eg, knowledge of specific risk factors

by instrument type) and the population level (eg, attitudes within musician organizations).

Historically, the musician organizational culture engaged in collective denial towards playing related injuries, and promoted “injury concealment” and a “playing through pain” mindset for fear of perceived problems and career jeopardy.^{18,25} Over the past two decades, there has been a gradual shift in attitude with increased awareness of the risk factors implicated in the development of PRMD. Common predisposing risk factors include: repetitive movements over extended periods of time; sudden changes to practice schedules, repertoire, and technique; and prolonged awkward asymmetrical playing postures.^{9,10}

Contributing factors are related to behavioral patterns and are, therefore, easily modifiable and particularly amenable to education and proper position. Awareness of risk factors led to the development of a range of exercise and education-based programs designed to reduce injury through awareness, instruction in proper playing habits and biomechanical position.^{11,14,27} Although the benefits of musculoskeletal health promotion activities for musicians have been studied in a variety of settings and are now known,^{5,11,14,18,26} musicians *rarely* receive formal instruction and education in proper techniques and mechanics.¹⁴ Health promotion implementation initiatives typically are targeted at the individual health literacy level (health education, knowledge, and development of skills) to improve clinical outcomes and at the broader society level (socio-economic, political, environmental, and community public health policy) to improve population level outcomes. These initiatives explore complex factors that are specific to the culture, population, and condition of interest.^{14,20} While the challenges to implementing formalized health promotion and injury prevention programs are known to be complex and multi-factorial in other fields such as sports medicine,^{22,23} the factors and attitudes affecting implementation of programs have not been explored in the music injury population.

A recent randomized controlled pilot study reported on the *feasibility* and effect of an educational musculoskeletal health for musicians (MHM) program on reducing pain and injury in musician-students participating in intensive summer festival programs. 56 participants of an 8-week long intensive summer program (ages 18-30, 28 females, 28 males) were randomized to an educational-workshop group or a control group. Participants in the treatment group participated in a 90-minute session focused on specific injury prevention strategies during the first week of the program. The session combined didactic lecture (30 minutes) with a hands-on practicum (60 minutes) and was led by a clinician with specialized expertise. The didactic component included a review of common risk factors, physiology of overuse injury, relevant anatomy, and musculoskeletal pain conditions.²⁸ The practical component included demonstration, and participation in *practical strategies* for prevention of injury in 4 categories: warm up, pacing/breaks, posture/playing position, and implementation of “smart” practice habits, and specific stretches and exercises to be performed prior to playing, while onstage and during backstage breaks. Musculoskeletal outcome data were collected pre- and post-festival, and adherence rates were monitored weekly via online surveys. Musculoskeletal outcome data were collected during the first and last week of the festival and 3 months post-festival, and adherence rates were monitored weekly via online surveys. Outcomes included pain interference/pain intensity subscales of the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians, and a customized adherence scale.^{29,30} Compared to controls, the intervention group reported lower pain interference (Post-Pre-Difference -4.58 , 95% CI -9.26 to 0.11 , $P.05$) supporting the premise that *exposure* to MHM education is effective in reducing pain and injury.³¹ These findings reinforce the im-

portance of *including* MHM education programs in intensive music education settings and underscore the need to further explore system-level barriers of MHM program implementation. A single recent study investigated opinions of a small group of string players ($n = 11$) regarding an exercise-based injury prevention program and reported that time constraints were the primary challenge to implementation.²⁵ This study reflects the perspective of just a small single user group (participating musicians). Except for this study, there is no evidence of in-depth analysis of organizational contextual factors, perspectives of multiple user groups, barriers, and facilitators. We, therefore, seek to apply implementation science methodology to rigorously study the many factors affecting successful implementation of MHM programs.

Implementation science methodology: a mechanism to accelerate adoption of prevention programs. Translating research into practice is the critical final stage of evidence-based practice research yet is frequently missing from the development and study of clinical interventions and prevention approaches. There is often an assumption that once efficacy and effectiveness are established, programs will automatically disseminate themselves. While a rapid progression from efficacy to implementation is expected, in fact it takes an average of 17 years to translate evidence into practice.³² In the past decade, multiple studies have demonstrated the efficacy and effectiveness of musician injury prevention programs that combine musculoskeletal health education and instrument-specific exercise instruction.^{11,12,14-16} Yet, music education institutions (conservatories and collegiate programs) as well as professional music organizations (orchestras and bands) rarely offer formalized education and instruction in injury prevention. Clinicians too are not knowledgeable in specific injury prevention approaches.⁹ Adoption can be expedited and facilitated with a rigorous dissemination and implementation science research approach that is already effective in a wide range of clinical and community settings.^{22,23,33,34} Implementation science evaluates the methods by which evidenced-based practice interventions and prevention approaches are incorporated into healthcare and wellness improvement programs. Implementation strategies utilize methods designed to improve, address, and measure multiple factors such as adoption, acceptability, appropriateness, cost, feasibility, implementation, adherence, fidelity, sustainability and scale-up of intervention or prevention programs.^{35,36} These strategies vary in complexity and target a range of stakeholders and multilevel contextual factors (barriers and facilitators) across all phases of implementation and may address a combination of patient, provider, organization, community, policy, and economic factors. The Consolidated Framework for Implementation Science (CFIR) is a recognized implementation science tool designed to facilitate these efforts. The CFIR synthesizes a spectrum of domains into one cohesive framework using multiple constructs to create a classification system for successful implementation of a program.³⁷ Application of this framework to musician musculoskeletal health and injury prevention can facilitate a comprehensive understanding of the factors influencing MHM adoption at multiple levels and development of models to improve implementation and delivery (Fig. 2). The second stage of the conceptual framework is the development and pilot testing of specific tailored strategies (customized to instrumental groups and genres) to address the identified factors and guide organizations through the implementation process.

The use of implementation science methodology for prevention of PRMD is a novel approach that will facilitate adoption of MHM programs by: (1) Engaging a range of key stakeholders and analyzing their perspectives on existing barriers and facilitators to implementation. (2) Synthesizing contextual data regarding barriers and facilitators into a strategy driven MHM organizational toolkit. (3) Producing an innovative toolkit to guide organizations in im-

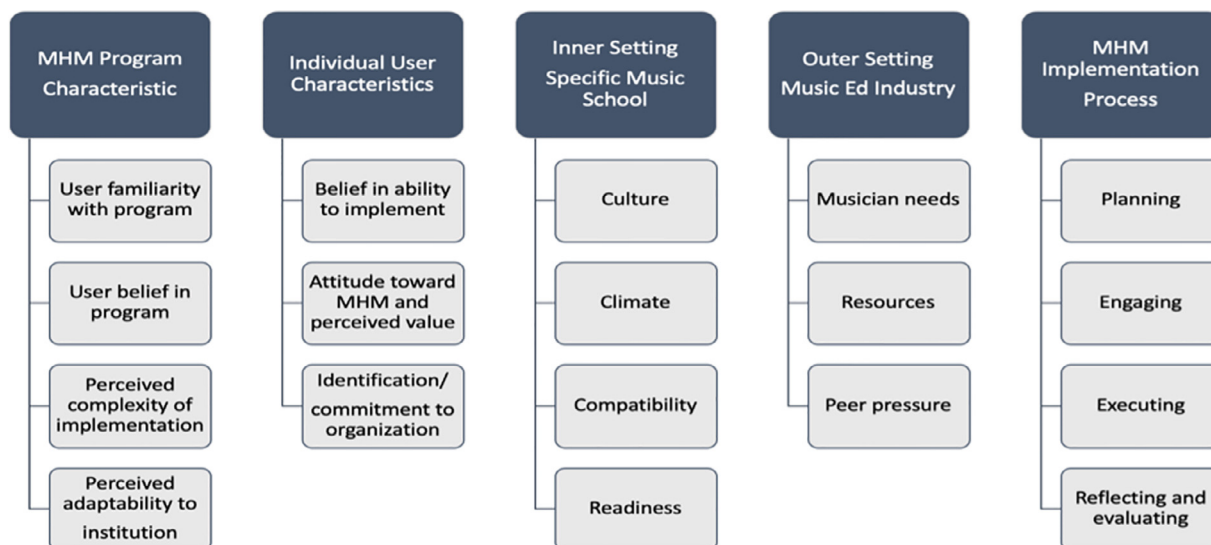


Fig. 2. CFIR Domains Customized for MHM Programs in Educational Organizations.

plementation of MHM programs that is customized to instrument and genre. (4) Pilot testing the MHM toolkit/guide in multiple organizational settings.

Proposed methods

Rationale

For successful adoption of musculoskeletal health programs, it is important to: (1) identify system level barriers and facilitators that will be used to (2) develop and pilot an effective organizational toolkit and implementation guide for successful adoption of musculoskeletal health programs. The proposed framework addresses both needs. The overall goal of this research is to identify determinants of implementation by engaging key stakeholders, developing strategies for adoption of injury prevention programs and generating hypotheses for future studies. The research plan is designed to accomplish the specific aims of this study. Through a mixed-method study we will use *formative* and *process* evaluation to address potential barriers, and design and test implementation feasibility of MHM programs. Formative evaluation is ongoing and ensures that a program is feasible, appropriate, and acceptable before it is fully implemented. Process evaluation determines whether program activities have been implemented as intended. Our findings will inform the development of a large-scale participant randomized hybrid trial to assess **effectiveness** and **implementation outcomes** of MHM programs.

STUDY 1: Qualitative Approach to identify systems-level determinants (barriers and facilitators) that influence adoption of injury prevention education in collegiate music programs.

Study design

We will use a qualitative methods approach to conduct semistructured interviews with key informants in music institutions.

Sampling and sample size

To ensure that the cohort studied adequately captures the range of viewpoints within organizations that service musicians at risk

for injury we will use criterion purposeful sampling. The primary criterion will be **musician injury** and all participants will have direct or indirect exposure to musician injury. Purposeful sampling will allow us to identify and represent a range of institutional (public versus private music education institutions, geographic location, size, budget) and participant (age, gender, musical instrument, stakeholder group) characteristics. The musical instrument groups will include strings, keyboard, woodwinds, percussion, and brass. The 4 stakeholder groups will include musician-students, faculty, administrators, and clinicians. For our initial 20 participants, we will recruit 5 participants for each of the 4 stakeholder groups while attempting to represent a range of the other institutional and participant characteristics. Participants will be recruited from 5 local music institutions. We will approach potential recruits via telephone, face-to-face or by email. All participants selected for final inclusion will have reported experience playing at least one musical instrument, and the clinicians will have experience treating injured musicians. We anticipate that data saturation will be achieved with 20 participants; in the unlikely event that it is not, we will continue to recruit and enroll participants for semistructured interviews until data saturation is achieved and no new information is provided.

Enrollment and data collection

Eligible participants will be consented per institutional review board (IRB) guidelines. Protection of human subjects will be ensured per IRB guidelines. Participants will partake in a 45-60-minute in-person semistructured interview that will be guided by a topic guide with probes to allow for expansion and exploration of topics to assure reliable and comprehensive qualitative data. The probes will address key domains that include perceived barriers and facilitators to implementation of prevention programs. Prior to the interview, all demographic data (age, sex, musical instrument, years of playing experience, and job title) will be collected and recorded. Interviews will be conducted in a private location and will be digitally recorded with an iPhone extension microphone. We will ensure confidentiality by removing identifying details prior to transcription. Anonymized recordings will be transcribed verbatim using transcription software (Microsoft Word, Microsoft Corporation, Seattle).

Development of the interview guide

We will use the Consolidated Framework for Investigative Research (CFIR) to develop the interview guide.³⁷ The CFIR is composed of 35 constructs organized into 5 major domains: intervention characteristics, outer setting, inner setting, characteristics of the individuals involved, and the process of implementation. The interview guide will be customized to address these domains for MHM in the music education industry and will include questions about perceptions and attitudes of health promotion and injury prevention programs, barriers to and facilitators of implementation, the best way to engage with students and faculty, and development of staff capacity (Fig. 2).

Data analysis

Descriptive statistics will be used to analyze demographic data (means, standard deviations) of all participants. Qualitative data will be transcribed from the auditory interviews and will be conducted throughout the data collection phase. The PI will initially review all transcripts, assign codes and develop categories and evolving themes. A second team of 2 external researchers/clinicians will review transcripts and conduct independent coding to develop validity and reliability of the data, and ensure integrity, consistency, and agreement between reviewers. The group will then meet to discuss differences in code interpretations and develop a set of unifying themes from the 20 transcribed interviews. Discordant findings will be handled by consensus-forming discussions with the qualitative research expert. We will identify key domains that emerge from the transcribed interviews and develop a final thematic framework. We expect to achieve data saturation with our 20 participants. If we achieve data saturation and find no new emerging themes from the transcribed data of our 20 participants, additional participants will not be recruited. In the unlikely event, that we do not achieve data saturation within 20 participants, we will continue to recruit participants until data saturation is achieved. Data analysis will be facilitated using a specialized software program for qualitative data analysis (nVivo 12, QSR International, Cambridge, MA) to store, sort, and retrieve qualitative data.

Results

Expected outcome

We expect to identify recurring barriers and facilitators that will inform unique themes and will guide the implementation of health promotion and injury prevention programs for musicians. These themes will be used to construct an organizational toolkit to facilitate and guide institutions in implementation for pilot testing in aim 2 of the proposal.

Potential Problems and Alternative Approaches

A common problem with purposeful sampling is recruiting an ample sample size to achieve data saturation. If we are unable to achieve data saturation via purposeful sampling with our 20 subjects, we will include snowball sampling (participants refer other participants) to increase our sample population. It is also possible that the in-depth interviews will not yield robust enough data due to the participant's hesitancy to share information that will be audio recorded. If, despite our best efforts to mitigate this problem we are unsuccessful, we will consider switching from individual semi-structured interviews to a focus group discussion model. The focus group model encourages additional sharing of information by

combining multi-level users in a single group. We will continue to add participants and collect data until we achieve data saturation.

STUDY 2: QUALITATIVE APPROACH to develop and pilot a facilitation based MHM organizational toolkit to support implementation of an MHM program.

Methods

Study Design

We will use a mixed-methods approach to develop strategies and pilot test a facilitation-based implementation guide to target identified determinants of implementation. *Development of the MHM organizational toolkit:* The CFIR will be used as an evaluation framework to assess the barriers and facilitators identified in Aim 1. The CFIR matching tool will be used to link strategies to barriers. The matching tool is based on expert recommendations for implementing change (ERIC) and provides a compilation of 73 implementation strategies that are mapped to CFIR constructs.²³ The study team will meet to review and agree on the recommended strategies. Discordant findings will be handled by consensus-forming discussions with the qualitative research expert (LR). An MHM toolkit will be developed containing a summary of specific contextual factors, barriers and facilitators with specific recommended strategies. *Pilot-testing:* We will pilot test the implementation guide on 4 representative participating music institutions (two public and two private). School administrators will receive a summary of barriers and facilitators with recommendations for specific actions and will be guided through a facilitation process. They will be provided with access to the MHM program that was previously developed and tested for efficacy.³¹

Outcome measures

We will conduct additional in-depth semi-structured interviews with school administrators following implementation of the MHM program using the CFIR framework as a guide. We will also quantitatively measure acceptability, appropriateness and feasibility with 3 validated surveys: Acceptability of Intervention Measure (AIM), Intervention Appropriateness Measure (IAM), and Feasibility of Intervention Measure (FIM).³⁸ Participants will complete these surveys following implementation. Acceptability is the perception among users that the MHM program is satisfactory and agreeable. Appropriateness refers to the MHM program correctly addressing the need or issue. Feasibility is defined as the extent to which the MHM program can be used and implemented in the given setting. Each measure is a 4-item measure that is rated on a 5-scale spectrum from completely disagree to completely agree. To test for fidelity to the implementation guide, participants will complete a responsiveness scale (Likert) that measures specific fidelity criteria and adherence and integrity to specific aspects of the program: content, activities, time spent, attendance, participant response

Data analysis

Qualitative data from semistructured interviews will be analyzed according to the procedure described in Aim 1. We will identify key domains that emerge from the transcribed interviews and develop a final thematic framework to identify additional information to complement findings from the quantitative surveys.

Statistical analysis

Fidelity data obtained from this pilot-testing will be compared to pre-established performance targets to determine the degree

to which each component (fidelity criterion) of the program was implemented, and a total fidelity percentage will be calculated for each participating site. A between groups analysis of variance (ANOVA) will compare fidelity outcomes between participants from 3 site categories (clinical, public, and private education settings). Quantitative survey data obtained from this pilot-testing will be used to calculate a sample size ($\alpha = 0.05$; $\beta = 0.2$; power = 0.8) for the 3 outcome variables (AIM, IAM, FIM scores) to design a future, larger, more definitive participant-randomized hybrid trial to assess effectiveness and implementation outcomes of MHM programs.

Results

Expected outcome

We will identify CFIR constructs to guide successful piloting of the MHM program and identify additional contextual factors that may limit implementation of MHM programs. We expect to establish feasibility by successful implementation of MHM in this pilot group.

Potential problems and alternative approaches

A common problem with implementation of programs in real world settings is maintaining fidelity to the original program. If our Aim 2 pilot data reveal that fidelity was not maintained, we will conduct a component analysis to identify which components of the program are necessary for effectiveness and remove components that may be less effective.³⁹ This information will be used in subsequent studies to investigate the interactions between implementation factors and different MHM program parameters and content.

Discussion

The use of implementation science methodology for prevention of PRMD is a novel approach that will facilitate adoption of MHM programs by: (1) Engaging a range of key stakeholders and analyzing their perspectives on existing barriers and facilitators to implementation. (2) Synthesizing contextual data regarding barriers and facilitators into a strategy driven MHM organizational toolkit. (3) Producing an innovative toolkit to guide organizations in implementation of MHM programs that is customized to instrument and genre (4) Pilot testing the MHM toolkit/guide in multiple organizational settings.

Current approaches to management of PRMD do not systematically address prevention at the organizational level. In this project we will study system-level determinants and design an MHM organizational toolkit to influence implementation of MHM programs and address the gap between knowledge and practice of musculoskeletal health and injury prevention in musicians. By identifying and addressing factors to support adoption of MHM programs, we aim to increase use of prevention programs and bridge the practice gap. This project is significant because it will identify the key components that can be modified to drive implementation and adoption of programs with the potential to significantly reduce and prevent PRMD.

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