

PSYCHOMETRIC EVALUATION OF THE MUSCULOSKELETAL PAIN
QUESTIONNAIRE FOR MUSICIANS AND THE MUSCULOSKELETAL PAIN INTENSITY
AND INTERFERENCE QUESTIONNAIRE FOR MUSICIANS

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ABSTRACT

There is currently no standard method to measure the incidence and prevalence of musculoskeletal injury among musicians. The purpose of this study was to evaluate the validity and reliability for the Musculoskeletal Pain Questionnaire for Musicians (MPQM) and the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM) in collegiate musicians. Participants completed a packet containing the MPQM and MPIIQM, with two baseline instruments (SF-36 and QuickDASH). Convergent validity was evaluated using a correlation between the scores of the baseline instruments and the MPQM and MPIIQM. Reliability was evaluated using the split-half method and Cronbach's alpha. The readability was evaluated with the Flesch-Kincaid score. The MPQM and MPIIQM showed weak correlations to the SF-36 and moderate correlations to the QuickDASH and the sports/performing arts optional module. Both showed strong reliability and good readability. Both should be used with caution in future research.

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LIST OF ABBREVIATIONS

MPQM	Musculoskeletal Pain Questionnaire for Musicians
MPIIQM.....	Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians.
SF-36.....	36-Item Short Form Survey.
QuickDASH.....	Quick Disabilities of the Arm, Shoulder, and Hand.
PRMD	Playing-Related Musculoskeletal Disorder.
IBQ.....	International Bassoonists Questionnaire.
EFA	Exploratory Factor Analysis.
ICC	Intraclass Correlation Coefficient.
CPGQ.....	Chronic Pain Graded Questionnaire.
WHO	World Health Organization.
ICF	International Classification of Functioning, Disability, and Health.
COSMIN.....	Consensus-based Standards for the selection of health Measurement Instruments

CHAPTER 1. INTRODUCTION

Athletes and musicians have more in common than one would first assume. Both groups require skill and an ability to perform to be successful. Furthermore, both often train for long hours each day starting from a young age and can have their careers affected by injury. While there are many sports medicine specialists, there are relatively few performing arts medicine specialists. One possible reason for this deficit is a lack of consistent research of the incidence, prevalence, and risk factors for injuries among musicians.

There have been numerous attempts to measure the prevalence and risk factors of injury among musicians.¹⁻⁷ Many studies report an alarmingly high prevalence of injury among musicians of all ages and types. However, many of the reports also suffer from methodological issues that can affect the reliability of the reported results.⁶ The methodological concerns can make it difficult to trust the reported results.

One of the methodological issues that has plagued past research is a lack of a standardized method for data collection.⁸ One common method is to use a patient reported outcome measure as the standard. However, in the past some researchers have used a questionnaire that may or may not be optimized for musicians.^{4,5,9} Others create their own questionnaire, but often do not include the psychometric properties of the new questionnaire in their reports^{2,3} while other researchers use a combination of both a questionnaire and a physical exam.^{1,10} The variety of methods of data collection has led to difficulties in being able to compare the data from one study to another.

There are instruments that while not developed specifically for musicians, also have the potential to be used effectively among a population of musicians. The 36-item Short Form Survey (SF-36) has been used for many years in health outcome measurement research.¹¹ The

instrument was designed to be used by researchers in any population of patients by using generic, coherent, and easily administered questions in order to obtain quality of life measurements. It has been tested for reliability and validity numerous times¹¹⁻¹⁴ and has shown good reliability across a variety of populations. Another instrument is the QuickDASH,¹⁵ which is used to identify disability of the arm, shoulder, and hand. It has been designed to be used by both clinicians and researchers¹⁵ in a general population. One advantage that it does have over other instruments is the inclusion of a sports/performing arts module. While, it does not have as an extensive amount of psychometric evaluation, it has been shown to be valid and reliable using both classical test theory and Rasch analysis.¹⁶

In recent years, there have been two questionnaires that have been developed to address many of the methodological issues of past research. One questionnaire is the Musculoskeletal Pain Questionnaire for Musicians (MPQM),¹⁷ which was developed for use by clinicians and researchers. It was designed to incur minimal time for administration and to be scored on a simple 0-10 scale. So far it has only been validated among a population of professional musicians.¹⁷ The other instrument, the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM),¹⁸ was developed to follow guidelines of classification of functioning disability, and health from the World Health Organization. It has only been psychometrically evaluated among a population of professional musicians. Because of the recent development of the MPQM and MPIIQM, there is limited psychometric data available for each to support or refute their use in research. Further testing of the psychometric properties of these two questionnaires could lead to expanded use and possible standardization of reported incidence and prevalence rates in future research.

Purpose of the Study

The purpose of this study was to determine the reliability, validity, and readability of the MPQM and MPIIQM. By establishing the reliability and validity of the questionnaires, researchers will have a simple and cost-effective method for determining the prevalence of injury among groups of musicians. It will also help in identifying individuals or types of performers that have higher rates of injury prevalence, so that prevention programs can be developed.

Research Question

1. Is the MPQM a psychometrically sound instrument?
2. Is the MPIIQM a psychometrically sound instrument?

It was hypothesized that both the MPQM and MPIIQM will prove psychometrically sound.

Definition of Terms

Musculoskeletal Pain Questionnaire for Musicians (MPQM) – An instrument developed in 2012 specifically for finding the incidence of injury among musicians in the past six months.¹⁷

Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM) – An instrument developed in 2014 specifically for finding the rate of injury among musicians as well as the amount of disability it causes.¹⁸

36-Item Short Form Health Survey (SF-36) – A set of generic, coherent, and easily administered quality of life measurements. The measures rely upon patient self-reporting.¹¹

QuickDASH – A shortened version of the DASH patient outcome measure. It consists of 11 items to measure physical function of the upper extremity.¹⁵

Psychometrics – Using statistical techniques to evaluate the quality of a psychological test.¹⁹

Content Validity – The extent to which the measure relates to all aspects of a construct according to an expert.¹⁸

Face Validity – The measure appears to be effective in its stated aims according to the test taker.¹⁸

Concurrent Validity – The measure agrees with a previously established measure.²⁰

Convergent Validity – The measure shows a correlation relationship to variables that it is theorized to correlate with.²⁰

Discriminate Validity – The measure shows that variables that are theorized to no correlate show no correlation.²⁰

Ceiling Effect – The scale does not capture the true range of scores, because it does not go high enough.¹¹

Floor Effect – The scale does not capture the true range of scores, because it does not go low enough.¹¹

Instrument – A device used to aid in some kind of process. In this paper, the questionnaires and surveys are often referred to as instruments.

Playing-Related Musculoskeletal Disorder (PRMD) – Pain, weakness, numbness, tingling, or other symptoms that interfere with the ability to play their instrument at the level the musician is accustomed to.⁸

Importance of Study

There is little consistency in the method of data collection among different researchers. This has led to a disparity between the results being published.⁶ By using a standardized method of data collection, it will be easier for the results of future research to be compared. It also has the potential to show the need for clinicians to be trained in treating a specific population.

Limitations

1. Lack of transferability
2. Self-report Bias

Delimitations

1. Male and female participants aged 18-50
2. Collegiate musicians who have played in the last six months
3. Student participating in an on-campus musical activity
4. Play an instrument in the string, woodwind, brass, or percussion category

CHAPTER 2. REVIEW OF LITERATURE

The purpose of this study was to determine the optimal self-reported instrument for the prevalence of injuries among musicians. The following research questions will be used to guide this study: Is the Musculoskeletal Pain Questionnaire for Musicians (MPQM) a psychometrically sound instrument? Is the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM) a psychometrically sound instrument? Which instrument do the subjects prefer? There has been little consistency in past research regarding the method of data collection is used by researchers for musculoskeletal injuries among musicians. Both instruments that were evaluated have been developed in the last five years and have the potential to be useful for future research if evidence supports the idea that the instruments are psychometrically sound. This review of literature has been organized into the following areas: the musician's perception of injury, the history of measuring prevalence, instrument assessment, and instruments for musicians.

The Musician's Perception of Injury

It is easy to draw a parallel between musicians and athletes. Both groups put a high demand on their bodies, regularly practice for several hours each day, and suffer from both psychological and physical stress. Injuries among musicians is a very real threat⁶ and to begin treating them, one must consider the musician's perception of injury, why it occurs and the impact it can have on performance.

In a qualitative study, Schoeb and Zosso²¹ identified the mindset of professional musicians about health and illness and its perceived impact on performance. Professional musicians engaged in semi-structured interviews which were recorded, transcribed and analyzed. Out of the 11 musicians, five were healthy and six were suffering from some health-related

problem. Schoeb and Zosso reported that musicians described pain as a sign of not doing the right thing, usually related to body posture. A difference existed in the way that healthy musicians approached physical issues compared to those who suffered from a past injury. Healthy musicians had a whole-body approach to their health. In contrast, the musicians with a history of injury focused on specific body parts, usually the hand.²¹

Guptill²² also sought to understand the experiences of musicians who suffered from playing-related injuries. Interviews were conducted with 10 professional musicians, followed up with a focus group in which preliminary results were presented and feedback was received from the participants. The study highlighted three roles of a musician: worker, teacher, and musician. All three were affected by injury. The participants also noted that the healthcare system was insufficient to meet their needs because of lack of specialized care, cost and lack of insurance coverage, and treatments often failed to allow them to perform at their former level.²²

The services offered by an athletic trainer could be a benefit and could be an improvement in the delivery of healthcare to musicians. The traditional role of an athletic trainer is to help individuals return to work, sport, and play. This role could be applied to a performing arts medicine setting in returning musicians to playing their best.²³

Injured musicians that are still students have unique stresses placed upon them. In addition to the demands of practicing and performing, they also have the pressure to compete to succeed and achieve good grades. To explain the unique stresses placed upon injured musicians McCready and Reid²⁴ examined the experiences of student musicians who had suffered from physical injury. Seven students who had been limited in their ability to play their instrument for two or more days because of a physical injury were interviewed. Six of the students attended a special arts high school and one was a university student. The student musicians would continue

to play their instrument after their pain resolved, despite the risk of further injury, because of a love for music and the need to improve.²⁴

University music students will also often play through the pain.²⁵ They often dream of a future career in music that can be destroyed by an untimely injury. Yet despite this risk, they still pursue a career in music. In a study by Park,²⁵ a total of nine students who participated in one of two focus groups to understand why students major in music despite the associated risk. Park²⁵ reported university music students studied music because it was something that they loved and they wanted the social aspect. It was common for them to play through the pain and not seek medical attention because of limited time and availability of providers. The students reported when they sought medical attention in the past, the health professional had little knowledge of the needs and demands of a musician. The students desired a holistic, client-centered approach, which Park noted is an occupational therapist's approach to patient care.²⁵ Athletic trainers also provide patient care in this manner which has been shown to provide excellent results in the care of musicians and other performing artists.²³

The History of Measuring Prevalence

There have been many studies up to this point attempting to establish prevalence rates among different populations of musicians.^{1-6,8,10,26} In a systematic review performed in 1998, Zaza⁸ reported the prevalence of Playing-Related Musculoskeletal Disorders (PRMD) as ranging from 39-87% in adult musicians and from 34-62% in secondary school music students. With prevalence rates of PRMD among musicians that high, then it is an issue that needs to be addressed by the medical community

The articles included in the Zaza⁷ systematic review were plagued by many methodological concerns.⁸ Similarly, the investigator of a systematic review¹ in 2007 noted many

of the same methodological concerns. After nine years of research on this topic, the methods of prevalence collection still had not improved. The methodological concerns included: a lack of definition regarding PRMD, low response rate, lack of content and face validity, vague self-reported answers being used to establish the presence of injury, a lack of the same outcome measures⁶, misreporting incidence as prevalence, components that did not add up to the reported total, incorrect calculations, and a lack of statistical significance testing.⁸

Instrument Specific Rates

Because of the varying physical demands of different musical instruments, some researchers have focused on smaller groups of musicians to examine unique factors of the specific group. A report by Rickert,¹⁰ describes the history of right shoulder pain in cellists. In order to explain the unique physical demands of cellists, Rickert used both a questionnaire and a physical assessment.¹⁰ A copy of the questionnaire was not included, but information was collected on physical profiles, exercise and recreation, playing habits, and occurrence rates of past and present injuries. The physical exam included shoulder special tests for impingement, range of motion, scapular dyskinesis, rotator cuff dysfunction and trigger point sensitivity. The special tests for impingement used were the painful arc test and Hawkins-Kennedy test. The range of motion was tested using Apley's scratch test and scapulohumeral rhythm was tested using Kibler's lateral slide test. To assess trigger point sensitivity, 5kg of pressure was applied on a trigger point approximately halfway between C7 and the acromion process. The sample included 47 professional orchestral cellists and 25 performance-major university cellists. A prevalence rate of 89% and 56% in the past 18 months for the professional and college cellists, respectively was reported. In addition, the cellists reported rates of 59% and 48%, respectively for current pain and injury.¹⁰

Another instrument specific study was performed on bassoonists.³ The prevalence data was collected using an online questionnaire, with the link being posted to an online forum for bassoonists and available on the author's personal website. The questionnaire, known as the International Bassoonists Questionnaire (IBQ) was designed by the author using previous musician survey and the author's own experience teaching and playing the bassoon. Out of the 166 bassoonists who responded to the survey, 78% reported playing-related pain, a PRMD symptom. Sixty-five percent of the respondents reported experiencing more than one PRMD symptom, i.e. pain, weakness, numbness, tingling, loss of dexterity, or loss of flexibility.³

The prevalence of PRMDs was also evaluated among percussionists by Vervainioti and Papandreou.⁹ To collect the data, the researchers used a questionnaire called the Musicians Health Questionnaire. The questionnaire was not included were not analyzed for validity. A group of 11 students and 19 professional percussionists were included in the sample. The results did not include overall prevalence, but the authors stated that out of the reported PRMD, 32% were in the upper limb, 20% in the vertebral column, 8% in muscle tissue, 13% psychological problems, and 27% in the rest of the body.⁹ There is a high prevalence of PRMD regardless of instrument played. Playing of certain musical instruments can increase the risk of injury to a specific site, but the risk is still high regardless of the instrument.

Age Specific Rates

The majority of studies have examined the rates in adult musicians.^{1,5,10,22,27,28} Musicians often begin training on instruments when they are children. Ranelli⁴ examined the prevalence of PRMD among children in Perth, Australia. The data was collected using the Young Peoples Activity Questionnaire that had been modified to include music specific questions. Seven-hundred thirty-one students aged between seven and 17 years completed the survey. The authors

reported a rate of 67% of the students had experienced some sort of PRMD symptom. Thirty percent had reported experiencing symptoms severe enough to interfere with their ability to play their instrument at some point. The data also revealed that the prevalence of PRMD symptoms increased with age for both male and female students.⁴

Later in 2009, Brandfonbrener² reported similar rates of prevalence among college freshman.² The entering freshman class of a university school of music for four consecutive years were surveyed on their history of PRMD symptoms. The students took a 22-item questionnaire, designed by the researchers, which collected data on demographics, years playing an instrument, practice habit, history of injury and pain, and type of medical care that was sought while injured. The psychometrics of the questionnaire were not included with the report. A total of 330 students between the four freshman classes completed the questionnaire. The reported rates varied from 67-92% with a mean of 79% reporting a history of PRMD.²

Abreu-Ramos¹ attempted to capture the lifetime prevalence of PRMD among professional musicians. The subjects of the study were fulltime members of the Puerto Rico Symphony Orchestra who were at least 21 years old at the time of the study. The data were collected using a combination of a questionnaire and a physical examination that was developed by the researcher. The questionnaire collected information regarding playing habits, instrument played, and medical history for establishing risk factors. The questionnaire also included questions asking if the musicians had ever had any of the following symptoms of PRMD: pain, allodynia, neuropathic symptoms, weakness, cramps, and involuntary movements. The report did not list the psychometric data for the questionnaire. The physical exam was performed by Abreu-Ramos and was based upon the medical history as found in the questionnaire. Out of the 75 musicians who completed the study, 81.3% reported a PRMD that affected their ability to play.¹

While the lifetime risk of developing a PRMD increases with age, the risk remains high even for young musicians because of the high demands that are placed upon them. Those who work with musicians of any age should be aware of the possibility of a PRMD affecting their ability to perform at an optimal level.

Instrument Assessment

As can be seen from the previous section there is a variety of methods that have been used to report the prevalence of PRMD among musicians. This variety and other methodological issues has led to difficulties comparing studies to one another.⁸ It has also resulted in a lack of viable studies for those actually performing systematic reviews.⁶ This section will address the different methods of testing the validity and reliability of a data collection instrument.

Validity

Validity is the foundation of ensuring the accuracy of any test as^{19,20,29} validity is the degree that evidence supports an interpretation of test scores. Meaning that if the evidence of an instrument does not support the interpretation then the scores are not actually measuring what they are supposed to measure. The validity of a test can also be affected by extraneous, or confounding, variables.¹⁹

Evidence to support the interpretation of the results can come from a variety of sources, but an instrument does not need all sources to be considered valid. The types of evidence required depends on the intended use of the instrument. The possible sources of evidence include evidence based on: test content, response processes, internal structure, and relations to external variables.²⁹

Test Content

Test content is the themes, wording, and format of items or questions of a test. Evidence that comes from test content represents how accurately the test content represents the content domain and if the content domain is relevant to the interpretation of test scores. Evidence from test content can be obtained through logical or empirical analysis and through expert opinion.²⁹ Experts in the content area are often the source of evidence for content validity. Analyzing the test content, by obtaining the content validity, will show the relevance of each item to the intended content domain. Content validity is evidence based on logical decision making and interpretation.²⁰ The existence of content validity is established in the mind of an expert interpreter. Face validity on the other hand relates to the perceptions of the one taking the test.³⁰ It is the relevance of the test items to someone who is not considered an expert in the area being tested.³⁰

Response Processes

Evidence obtained from response processes involves making assumptions about the cognitive processes of those taking the test. The process of obtaining the evidence is based on an analysis of the individual responses of a test taker. The analysis will look at recorded data such as, eye movement or response time. It will also consider performance strategies of the test taker. Analyzing this evidence will help to show if there are differences in responses among different groups of test taker.²⁹ Evidence is collected through processes like think-alouds and Rasch modeling. A think-aloud involves having the participants speak their thoughts while performing an action.¹⁹

Rasch analysis modeling provides measurement properties to provide evidence for response processes. By using a Rasch analysis, it is possible to reduce the number of items of a

test.³¹ Many variables measured in health care studies are ordinal.³¹ This means that the data collected only shows a ranking of the results, not the distance between them. There is a large number of statistical tests usually performed in studies that require interval data, or data that has a set distance between each point. Rasch analysis provides a way to analyze ordinal data as if it was interval data.³¹

For a Rasch analysis to be performed all of the items of a test must be unidimensional. Therefore it only measures one variable and allows the researcher to make stronger inferences about the data.³² If there are more than one dimension then a separate analysis should be run for each dimension. As the number of dimensions increases, the amount of work required to report those results will also increase. Rasch analysis provides a useful tool for instrument assessment, even though it is the most complex of the discussed tools.³¹ That complexity also leads to a more accurate result. Being a unidimensional scale, it is limited in the situations it can be used.

One method to determine the number of dimensions in a scale is known as factor analysis. When the number of factors in a scale is unknown the process is called an exploratory factor analysis (EFA). EFA is used to identify the contributions of an item in a scale to each scale dimension.¹⁶

Internal Structure

Next, evidence based on the internal structure of a test is referring to the how each item in the test relates to the each other. The evidence needs to show that changes in the independent variable correspond with changes in the dependent variable.¹⁹ The internal structure, or framework, of a test can contain just a single dimension or it may contain several. Some studies have shown that within identifiable subgroups can have different answers to the same question.²⁹ A type of validity normally associated with internal validity is construct validity, which is a

combination of content and statistical validity procedures.²⁰ By using construct validity, evidence can be obtained to show the relationships of normally unobservable variable, such as a person's perception.²⁰ The two most used method of gathering evidence for internal validity is known as classical test theory and item response theory.

Classical test theory is a set of concepts and techniques that are widely used in health research.³³ There have been many instruments and tools that have been designed to measure unobservable variables. The results of these instruments need to be accurate to be of use to any researcher. Classical test theory was designed to determine how accurately an instrument is at measuring an unobservable variable.³³

As the name would suggest, classical test theory has been around and used for a long time. It is still being used because of some advantages that it provides over newer methods of assessment.³³ It is familiar to many researchers, because of its long use. It is also relatively easy to use and get access to analysis help, as many statistical software programs include components of classical test theory in basic packages. It also will work even if the individual items of an instrument are only moderately related to the underlying variable.³³

The disadvantages of using classical test theory causes greater problems in some areas than it does in others.³³ Redundancy is an important piece of classical test theory, therefore scales are usually long and there can be many similar items. This can result in covering the deeper desired variable with another more superficial one. Classical test theory also is prone to differential sensitivity. This means that a two-point difference at the ends of a range may have a different variance than a two-point difference at the center. A final disadvantage is that the accuracy is affected by the sample, therefore the information is only valid for the specific data that is analyzed and cannot be transferred to other datasets

Relation to External Variables

Validity evidence based on external variables is an important source of validity. Evidence should show that variables have a causal or correlational relation and that they are not the result of an extraneous variable.¹⁹ By comparing the results to the measure it is supposed to predict or the results of a separate test, the causal relationship of the items to the domains of the test can be shown. This form of evidence is particularly important when generalizing results to another situation.²⁹ Types of validity used to gather this type of evidence are concurrent, convergent, and discriminate validity. Concurrent validity is established by comparing a test to another one that is already shown to measure the variable.²⁰ Convergent validity and discriminate validity are related in that they both show the correlational relationship between variables. While convergent validity provides evidence with variables that should correlate, discriminate validity shows evidence with variables that should have no correlation.²⁰

In order to evaluate discriminate validity it is common to use multi-trait scaling techniques which is used to determine the scaling success or the correlation of an item to the scale.¹¹ The process is considered a scaling success whenever an item's correlation is significantly higher with its hypothesized scale than with another scale. Scaling success rates is determined by dividing the total number of item scaling tests by the number of successful tests.¹¹

For an instrument to be valid, all of the existing evidence should be used to form a good support for the specific uses of the test results. The process of validation will never end, as new evidence and information will be gathered each time the test is used.²⁹ Anytime an instrument is changed or new evidence emerges the validity of the test should be reevaluated to ensure accurate results in the future.

Reliability

A person's performance is rarely identical every time they perform a task. Reliability is the measure of consistency of the result over time. Therefore, for a test to be considered reliable, the results of a person's performance will be consistent across multiple times performing the task.^{19,20,29} Reliability is measured by obtaining a reliability coefficient. The methods of obtaining the coefficient include: test-retest, parallel forms, interrater and intrarater reliability, and internal consistency.

One of the simplest forms of obtaining a reliability coefficient is test-retest method.^{20, 29} In this form of analysis, a person will take the test and then after a period of time they would retake the test. The correlation of the two scores will be found, with high correlations meaning that the test is reliable.²⁰ The amount of time between testing is critical for this method of reliability calculation. If the time period is too short, the results might be similar because the participant remembers their previous responses. In contrast, if the time period between testing is too long, the results could change due to changes in the participants.¹⁹ The ideal time period will depend on the type of test being administered and should always be included in the report along with the reliability coefficient.

A parallel forms method of reliability of uses alternate forms of the same test.²⁹ The different forms are designed to have the same general content and item distribution, the same procedures, and approximately the same score mean and standard deviation. The participants will then complete both forms in a short period of time and the resulting scores will be correlated.²⁰ This form of reliability calculation does have some drawbacks, it is difficult to construct two equivalent forms of a test because they cannot contain the same items. It can also be difficult for

participants to take the same test twice in a short period of time, as tester fatigue or familiarity with the testing material could become an issue.¹⁹

Interrater and intrarater reliability both refer to measurement errors while recording the score of a test. Interrater reliability is the consistency of scoring the same test between different evaluators, while intrarater reliability refers to the consistency of the same evaluator giving the test multiple times.^{19,20} Intraclass correlation coefficient (ICC) modeling is used to find the measurement error of a test. There are many forms of ICC and each one can give different results when applied to the same data.³⁴ Therefore, it is important to know and understand the different kinds of coefficients.

The kind of coefficient used will depend on one of three cases. Case 1 is when each subject is rated by a different set of judges that were randomly selected from a larger population of judges. For case 2 is when a random sample of judges is selected and each judge rates each subject. Finally, in case 3 each subject is rated by each judge, who are the only judges of interest.³⁴ The form $ICC(x,y)$ is used to show which coefficient was used, where x is the case and y is the type of equation used. Table 1 shows each possible configuration and their uses

Table 1. Forms of Intraclass Correlation Coefficients.^a

	1	k
Case 1	(1,1) 1-Way Random	(1,k) 1-Way Random
Case 2	(2,1) 2-Way Random	(2,k) 2-Way Random
Case 3	(3,1) 2-Way Fixed	(3,k) 2-Way Fixed

^aThe different configurations of ICC equations adapted from Weir, 2005³⁵

Using internal consistency is a less direct method of evaluating the reliability of tests.²⁹ Estimates of internal consistency are found by comparing the different parts of one test to each other and looking for agreement between the parts. Tests can be either homogenous, containing a single dimension or heterogeneous, containing more than one. Homogenous tests will have

higher internal consistency, because of a narrower content area.¹⁹ In a heterogeneous test the internal consistency should be evaluated for each construct in the test. This form of reliability estimate is less accurate when looking at tests that rely on timed tasks.²⁹ Two methods used to calculate internal consistency are known as item-to-total correlation and Cronbach's alpha.

Item-to-total correlation examines the correlation of each item to the total score.¹⁶ It accomplishes this by obtaining a correlation of the item to the total score when the item being tested is omitted from the total.

Cronbach's alpha is a common measure of the internal consistency of a test or scale.¹⁹ It is very useful because it can be applied to a variety of tests. The value of Cronbach's alpha will be higher when the correlation between test items is strong. In a research setting, it is ideal to have a Cronbach's alpha of greater than or equal to 0.70.¹⁹ Caution should be used when interpreting a Cronbach's alpha score because it is affected by the number of items on a test. The more items on a test the higher the Cronbach's alpha will be, regardless of the internal consistency of the test.¹⁹

There is no ideal form of reliability measurement.²⁹ Therefore, the utilization of each method is determined by the needs of the researcher. Reliability and validity are always important factors in testing, but as the consequence of the result increases the need for reliability and validity also increases.

Instruments for Musicians

Many of the instruments used in previous studies have either not been properly validated or they were not developed for musicians. Therefore, they do not capture the entire picture when trying to assess the prevalence of injuries among a specific population. In this section of the review of literature, two instruments that have been specifically developed to find the prevalence

of PRMD among musicians and some previously well-established instruments that will be used for comparison will be discussed.

Musculoskeletal Pain Questionnaire for Musicians

The Musculoskeletal Pain Questionnaire for Musicians (MPQM) (Appendix A) was developed in 2012.¹⁷ The purpose of the MPQM is to provide a self-reported instrument for use by clinicians or researchers that targets musculoskeletal pain specific to musicians. The ten-item instrument that was developed is based on a simple scoring system from 0-10. This makes it possible to easily quantify the results in order to allow for ease of comparison.¹⁷

Psychometrics

The MPQM was evaluated for content validity, criterion validity, and internal validity in a population of professional musicians. The psychometric properties of the MPQM was tested using a sample of professional musicians, by having the subjects complete the questionnaire and another questionnaire known as the Chronic Pain Graded Questionnaire (CPGQ). At this point, it had been used on a sample of college students, but it was not psychometrically tested in that study.³⁶ The content validity was evaluated by performing a principal component analysis. Using a varimax rotation, three principal components were identified. The three principal components that the items were loaded onto were: disability, intensity, and frequency and duration.¹⁷

To test the criterion validity of the instrument, a correlational analysis was performed between the MPQM and the CPQG. The overall score of the MPQM correlated with the graded score of the CPGQ of $r=0.65$ ($p < 0.01$).¹⁷ This is considered to be a strong correlation. A correlation of $r=0.53$ ($p < 0.01$), moderate correlation, was found when comparing the disability scores from the CPGQ and the disability component of the MPQM. The intensity scores correlated at $r=0.99$ ($p < 0.01$), a nearly perfect correlation, for the intensity component of the

MPQM and the intensity score of the CPGQ.¹⁷ In order to test for internal validity, a Cronbach's alpha was calculated. The score was found to be a 0.768 for the overall scale, which is considered a good correlation. A Cronbach's alpha was also performed on each component's subscale. The resulting scores were: $\alpha = 0.888$ for pain-related disability, $\alpha = 0.836$ for pain intensity, both good results. An alpha level of $\alpha = 0.509$ for frequency and duration of pain was reported. This is often considered a poor result, but can be considered acceptable depending on the situation. Overall, the instrument showed good results in both reliability and validity.

Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians

In 2014, a new instrument for self-reported PRMDs was developed known as the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM) (Appendix A).¹⁸ The instrument was designed to not only be specific to musicians, but to follow guidelines by the World Health Organization (WHO) in international classification of functioning, disability and health (ICF). The purpose was so the instrument could be used by clinicians or researchers to collect data on the prevalence of PRMD and also measure the intensity of the pain and how much it interfered with normal function.¹⁸

Psychometrics

The instrument was psychometrically tested using many forms of validity including: content validity, face validity, construct validity, internal consistency, and test-retest reliability. The subjects used during the evaluation were professional musicians in Scotland. To date, there is no known study focusing on the validity of the instrument in college musicians.

Content validity was evaluated by following guidelines from the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN). A panel of four experts in the field of psychometrics, pain management, neurological and pain syndromes

affecting musicians was consulted. The experts were asked to comment on the relevance for each item and a content validity ratio was then calculated from their input. If at least half of the experts did not agree that an item was essential, they were marked as being possibly problematic and were considered for deletion during the construct validity assessment.¹⁸ For face validity, the panel of experts and a sample of three professional musicians were consulted. Their comments were used to address any issue with face validity.¹⁸

To evaluate the construct validity of the instrument, an exploratory factor analysis with principal axis factoring was used. This process uses statistical analysis to identify the underlying relationships between variables.³⁷ The process was iterative, meaning that the analysis was done again after each item deletion.¹⁸ In order to evaluate internal consistency, Cronbach's alpha values were calculated. Item-to-total correlations, as well as changes to alpha when an item is deleted were considered. The resulting alpha for both the pain intensity and pain interference factors were 0.91, a very strong correlation. Neither factor had an improvement in alpha levels with further item deletion. The overall Cronbach's alpha level for the scale was 0.88, meaning that the correlation was strong.¹⁸ To evaluate the test-retest reliability, an ICC Model (2,1) was used. This model is used to find the degree of consistency among measurement.³⁸ For the pain intensity factor, the ICC values ranged from 0.78-0.82, all considered strong correlations. This factor had a narrow 95% CI. The interference factor had values between 0.56-0.76 for five of the six items, moderate to strong correlations. The last interference item had poor reliability with an ICC value of 0.13.¹⁸

QuickDash

The QuickDASH was developed for use by clinicians or researchers as a self-assessment in a general population of subjects of the symptoms and function of the entire upper extremity.¹⁵

It consists of 11 items and has two optional modules, one for work and one for sport/performing arts. Lamontagne¹⁷ noted the sports/performing arts module had yet to be validated, except for some studies validating a foreign language translation of the instrument.

Psychometrics

The QuickDASH was recently psychometrically tested using classical test theory and Rasch analysis; the optional modules were unfortunately not included.¹⁶ Rasch analysis statistically evaluates psychometric properties of a questionnaire that are not evaluated by classical test theory. It has been used often in recent years to evaluate clinical tools for health care.¹⁶ The QuickDASH was evaluated for internal consistency and dimensionality using classical test theory. An iterative Rasch analysis was performed to evaluate the validity, reliability, and dimensionality of the instrument following the classical test theory evaluation. After analysis, it was found that the Cronbach's alpha for the QuickDASH was 0.87, a very strong correlation. All items except one had an item-to-total correlation between 0.55-0.72, moderate to strong correlations. The remaining item, tingling, had a poor correlation of 0.31.¹⁶ Following the initial Rasch analysis, the tingling item was deleted, because it did not fit into the Rasch model. The 10 item QuickDASH (QuickDASH-10) showed good distribution of items along the variable and subject ability was at a near-normal distribution. The item separation index for the QuickDASH-10 was 9.31 with a separation reliability of 0.99. The person separation index and reliability were 2.33 and 0.84 respectively. In addition, the QuickDASH-10 showed three levels of patient disability and had a Cronbach's alpha of 0.87.¹⁶ Therefore the instrument shows good reliability in testing.

SF-36

The 36-item short-form (SF-36) was developed for use by researchers in the Medical Outcome Study.³⁹ It allows for standardized scoring as a means of measuring general health status. Therefore, it can be used to measure the relative burden of a disease compared to the burden of another disease, as well as the relative benefit of different treatments. The SF-36 consists of generic, coherent, and easily administered quality of life assessments meant for any population of subjects. It contains one multi-item scale to measure eight health concepts: physical functioning, role limitations due to physical problems, social functioning, bodily pain, general mental health, role limitations due to emotional problems, vitality, and general health perceptions.³⁹

Psychometrics

The SF-36 was psychometrically evaluated when it was first developed in the late 1980's¹¹ and has since been validated multiple times among a variety of different population groups around the world.^{12-14,40-43} To develop and validate the SF-36, a sample was recruited from one large HMO in three cities: Boston, MA, Chicago IL, and Los Angeles CA.¹¹ The sample used for the analysis contained 3,445 patients with chronic medical and psychiatric conditions. The subjects completed a 245-item baseline questionnaire that included the items used to construct the SF-36. The analysis was completed for the entire sample as well as for 24 subgroups within the sample. These subgroups included differing sociodemographic characteristics, diagnosis, and disease severity.¹¹ The analysis included an evaluation of the following criteria: completeness of data in terms of both item and scale-level missing data, Likert's standards to test assumptions of summated rating scales, discriminant validity and scaling success rates, internal consistency reliability, and features of score distributions.

The completeness of the data was evaluated, because a scale score cannot be estimated if there is a high level of incomplete data. The percentage of completed items was calculated for each subgroup. By using standard proration techniques, the scale score could be calculated for those subjects that had left a small number of items blank. The missing value rates for the total sample was low averaging at 3.9%. Data completion was significantly lower among disadvantaged demographic subgroups: older patients, those without a high school education, African American patients, and those in poverty. It was also noted that completeness was significantly higher for males than it was for females.¹¹

When making assumptions using the method of summated ratings, it is assumed that the items on each of the eight health concepts could be summed without standardization or weights. To evaluate whether the items for each concept were parallel with each other or if standardization was needed, the symmetry of item response distributions, internal consistency, and the equivalence of item means and standard deviations was tested. The full range of each item was observed among the sample, meaning that the items are relevant among a diverse patient sample. Item internal consistency was observed to be roughly equal among all subgroups and scales. The means and standard deviations showed no significant difference for the items in each scale.¹¹ This shows that assumptions made were accurate and no standardization would be required.

To test item discriminant validity, multi-trait scale techniques were used by computing an overall measure of scaling success. For the entire sample, the correlation between each item and its hypothesized scale exceeded the correlations to all other scales by more than two standard errors. That is a 100% scaling success rate. The scaling success rate was 92.5%¹¹ among the

different subgroups. By looking at these high scaling success rates, it is easy to see that the test is valid.

To evaluate the internal consistency, the Cronbach's alpha for each scale was calculated. For each of the scales the resulting Cronbach's alpha exceeded the goal of 0.50-0.70, moderate to good, for group comparisons for the entire sample and among each subgroup. For individual comparisons, the scales physical functioning and general mental health had a value exceeding 0.90, this is an excellent correlation.¹¹

To determine if the range of health states defined by the eight scales were appropriate for all subgroups, the features of score distributions were analyzed. To determine this, the skewness of each scale was estimated and the floor and ceiling effects were calculated. For example, a subject would have scored 15, but since the scale only went to 10 they hit the ceiling and the score of 10 was recorded. All of the scales were negatively skewed, which indicates that the distributions had more respondents in positive health states. The floor and ceiling effects were observed among each scale, but they were within expected values, i.e. the ceiling effect appearing in the physical function scale among younger patients.¹¹ Overall, the SF-36 has been substantially and repeatedly tested and validated. It has shown good consistent results and therefore a good instrument to use to compare the results of the MPQM, MPIIQM, and QuickDash. The SF-36 does have a cost associated with its use, typically \$250-500 depending on the number of participants. Therefore, it will likely not be used as readily because it is cost prohibitive.

Summary

Musculoskeletal injuries and other disorders have long been an issue among musicians, but it is still a relatively new area of study for many medical professionals.⁶ The need for a

consistent instrument to measure the incidence and prevalence of injury could be one of the reasons that medical options are limited for injured musicians. The MPQM and MPIQM both have the potential to fill that gap, but because of lack of use in current research, they both have limited validity and reliability. By comparing the scores to the QuickDASH and SF-36, they could be validated. This would allow the correct measurement of prevalence and show the need for additional medical options. The knowledge and skills of athletic trainers could become a very effective option in the treatment and recovery of musicians from injury.

CHAPTER 3. METHODS

The purpose of this study was to identify the most valid and reliable self-reported instrument for use in discovering the prevalence of injuries among musicians. The following research questions guided this study: Is the Musculoskeletal Pain Questionnaire for Musicians (MPQM) a psychometrically sound instrument? Is the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM) a psychometrically sound instrument? Which musician specific measurement instrument do the subjects prefer? Validating these two instruments among a specific population will allow researchers to determine the prevalence of musculoskeletal injury among that specific population and help to simplify the comparison of the results of different studies. This chapter focuses on the experimental design, population of the study, instruments for data collection, procedures, and data analysis procedures.

Research Design

This study used a correlational design, looking at the relationship between the experimental, the MPQM (Appendix A) and MPIIQM (Appendix B) and two baseline instruments, the SF-36 (RAND Corporation, Santa Monica, CA) and QuickDASH (Institute for Work & Health, Toronto Ontario, Canada). The study consisted of a psychometric evaluation of the measurement instruments to establish validity, reliability and readability.

Population of the Study

The subjects of this study consisted of college-aged musicians at a Midwestern university. Inclusion criteria for the study included males and females ages 18-50, participating in an on-campus musical activity, play a musical instrument, and have participated in playing their instrument in the past six months. The subjects were recruited using a recruitment script (Appendix C) during a portion of the scheduled rehearsal time. The goal of this research study

was to obtain a minimum of 200 completed survey packets. A total of 185 survey packets were completed at the conclusion of the study.

Instrumentation

The SF-36 Health Survey (RAND Corporation, Santa Monica, CA) was one of the two baseline instruments because of its long use in health outcome studies.¹¹ It consists of 36 items and can be administered as either a computer-based test or using pen-and-paper method. The RAND Corp. provides a scoring software that calculates the scores of each subject.

The QuickDASH (Institute for Work & Health, Toronto Ontario, Canada) was also used as a baseline measure.⁴⁴ It consists of 11 items in the main questionnaire and an additional four items are in the optional sports/performing arts module. Each item is scored on a range from one to five, where one is the absence of pain or disability and a five is intense pain or complete disability.

The Musculoskeletal Pain Questionnaire for Musicians¹⁷ (Appendix A) was one of the experimental instruments. It consists of 10 items and is based on a simple scoring system from 0-10 on all the items. This will result in a total score from 0-100 and can be used to estimate the pain experienced by a musician in the last six months.¹⁷

The second experimental instrument was the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (Appendix B).¹⁸ It consists of 22 total items divided into two parts. The first half consisting of the first 12 items collects demographic information of the participants and a history of playing-related pain. The possible answers are either a total number of hours or a simple yes or no. The second half consists of the remaining 10 items. Items 14-22 consist of a rating scale from 0-10 and item 13 is an outline of the human body so that the participant can place a mark on the location of pain.¹⁸

Procedures

The procedures of this study were approved by the Institutional Review Board (IRB) of North Dakota State University. The researcher recruited participants using a short presentation about the research to the ensemble. Using an oral script (Appendix C), the researcher presented the details of the study to the participants and the risks and benefits of participation. An instrument packet was then given to each participant to complete. Each packet contained the four previously mentioned questionnaires and an additional survey, written by the researcher, designed to assess the participants' perceptions of each instrument. Basic demographic information was also collected to identify inclusion criteria among the members of the ensembles. Each instrument is designed to take between 5-10 minutes to complete. It is anticipated that the majority of participants will complete the packet in no more than 40 minutes. When the participant has completed the packet, it was returned to the researcher. The researcher then scored each instrument per their individual scoring guidelines.

Data Analysis Procedures

The validity of each instrument was evaluated by obtaining a Pearson's Product-Moment Correlation coefficient between the scores of the experimental and baseline instruments. Reliability was evaluated through the split-half method by calculating the Spearman-Brown coefficient for the experimental instruments. The significance for both correlations was set at $\alpha \leq 0.05$. The internal validity was tested using Cronbach's alpha. The interpretation used in this paper of all the preceding values can be found in table 2. The calculations were performed using IBM SPSS statistics software version 23. The readability was tested using the Flesch-Kincaid scores calculated in MS Word version 15.0.4815.1001. The Flesch-Kincaid grade level measures

reading level based upon the U.S. grade level system. For example, a score of 8.5 would be the expected reading level of a student who is half-way through their 8th grade year.

Table 2. Interpretation of the Values of Validity and Reliability Statistical Tests

Statistical Test	Strong/Excellent	Moderate/Good	Weak
Pearson's Product Moment Correlation	> 0.70	0.30-0.70	0.00-0.30
Spearman-Brown	>0.80	0.60-0.80	<0.60
Cronbach's alpha	>0.80	0.50-0.80	<0.50

**CHAPTER 4. MANUSCRIPT: PSYCHOMETRIC EVALUATION OF THE
MUSCULOSKELETAL PAIN QUESTIONNAIRE FOR MUSICIANS AND THE
MUSCULOSKELETAL PAIN INTENSITY AND INTERFERENCE QUESTIONNAIRE
FOR MUSICIANS***

Abstract

There is currently no standard method to measure the incidence and prevalence of musculoskeletal injury among musicians. The purpose of this study was to evaluate the validity and reliability for the Musculoskeletal Pain Questionnaire for Musicians (MPQM) and the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM) in collegiate musicians. Participants completed a packet containing the MPQM and MPIIQM, with two baseline instruments (SF-36 and QuickDASH). Convergent validity was evaluated using a correlation between the scores of the baseline instruments and the MPQM and MPIIQM. Reliability was evaluated using the split-half method and Cronbach's alpha. The readability was evaluated with the Flesch-Kincaid score. The MPQM showed weak correlation with the SF-36 ($r=-0.197$, $P=0.05$), but correlated moderately with the QuickDASH ($r=0.539$, $P=0.05$) and the sports/performing arts optional module ($r=0.588$, $P=0.05$). The MPIIQM intensity score showed weak correlation with the SF-36 ($r=-0.155$, $P=0.05$) and moderately correlated with the QuickDASH ($r=0.418$, $P=0.01$) and the optional module ($r=0.492$, $P=0.05$). The MPIIQM interference score showed weak correlation with the SF-36 ($r=-0.145$, $P=0.05$) and a moderate correlation with the QuickDASH ($r=0.409$, $P=0.05$) and the optional module ($r=0.499$, $P=0.05$).

* The material in this chapter was co-authored by Brian Schmidt and Shannon David. Brian Schmidt had primary responsibility for collecting samples in the field. Brian Schmidt was the primary developer of the conclusions that are advanced here. Brian Schmidt also drafted and revised all versions of this chapter. Shannon David served as proofreader and checked the math in the statistical analysis conducted by Brian Schmidt.

The MPQM and MPIIQM both showed strong Cronbach's alpha scores ($\alpha=0.928$ and $\alpha=0.753$). The MPQM and MPIIQM showed strong split-half reliability ($p=0.895$ and $p=0.966$). The readability of the MPQM was 7.9 and the MPIIQM was 5.0. Both the MPQM and MPIIQM showed weak correlations to the SF-36, but moderate correlations to the QuickDASH and the optional module. Both showed good reliability and readability. Both should be used with caution in future studies.

Introduction

Athletes and musicians have more in common than one would first assume. Both groups require skill and the ability of the body to perform to be successful. Furthermore, both often train for long hours each day starting from a young age and can have their careers impacted by injury. While there are many sports medicine specialists, there are relatively few performing arts medicine specialists. One possible reason for this deficit is a lack of consistent research of the incidence, prevalence, and risk factors for injuries among musicians.^{6,8} The numerous attempts to find injury rates among musicians have been plagued by methodological issues that question the validity of the results.^{6,8} The common research methods in patient reported outcomes include use of a questionnaire or a physical exam. Research involving a physical exam is less common as the physical exam requires specialized training for the researcher and a greater time commitment from both the researcher and participant.⁴⁵ Some researchers have used a combination of both a questionnaire and a physical exam.^{1,10,45} While use of both the questionnaire and physical exam can provide accurate results, it requires an even greater time commitment from the participants when compared to each method individually, which is often noted as a cause of decreased participation by musicians with busy performing schedules.^{6,8,17,18}

Thus, use of a self-reported questionnaire is a more common method of data collection in research.⁴ Questionnaires, such as the QuickDASH and SF-36 have been used for many years

among general populations to understand the diagnosis of injury through a quantitative method. The QuickDASH has been used among a sample of musicians and it also includes an optional sports/performing arts module.⁴⁶ While the SF-36 has also been used among musicians, the physical component score was not used to compare to another questionnaire.⁴⁷ Some researchers have used a general questionnaire with performing artists such as the Young Peoples Activity Questionnaire and the Job Content Questionnaire.^{4,5} However, these questionnaires have not been psychometrically evaluated among a sample of musicians. Others have created their own questionnaires specific to musicians but did not include the psychometric properties in their reports, making it difficult to know if these tools are viable in other studies.^{2,3}

In recent years, two questionnaires have been developed with the potential to help alleviate the methodological issues of researching injury among musicians: the Musculoskeletal Pain Questionnaire for Musicians (MPQM)¹⁷ and the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM).¹⁸ The MPQM was developed in 2012 and has been validated among a sample of professional musicians who played in symphonic orchestras.¹⁷ It has been used in a study among college musicians, but it has not been validated for this population group.³⁶ The MPIIQM was developed in 2014 and showed acceptable validity among a population of professional orchestral musicians.¹⁸ Because both questionnaires are relatively new, they do not have the weight of psychometric evidence to justify their use as a standard method of data collection.

The objective of this study was to provide further psychometric evidence for each of these questionnaires among a population of college musicians. This will provide data to help future researchers make an informed decision about which instrument to use and would help increase the comparability of future studies.

Methods

Research Design

This study used a correlational design, evaluating the relationship between the experimental, the MPQM (Lamontagne, 2012) and MPIIQM (Berque, 2014) and two baseline instruments, the SF-36 (RAND Corporation, Santa Monica, CA) and QuickDASH (Institute for Work & Health, Toronto Ontario, Canada). The study consisted of a psychometric evaluation of the measurement instruments to establish evidence for validity, reliability and readability.

Sample of the Study

The participants of this study consisted of university students attending a Midwestern university. The inclusion criteria for the study included male and female students ages 18-50, that participated in an on-campus musical activity, and have participated in playing their instrument in the past six months.

Instrumentation

The instruments used in the study consisted of two experimental and two baseline questionnaires. The questionnaires were compiled into a single packet for distribution to the participants. The packet also included the informed consent form for participants to read and sign, and demographic questions about the participants.

The first experimental instrument, the Musculoskeletal Pain Questionnaire for Musicians (MPQM),¹⁷ consists of 10 items and is based on a simple scoring system from 0-10 on all of the items. This results in a total score from 0-100 and can be used to estimate the pain experienced by a musician in the last six months.¹⁷

The second experimental instrument, the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM).¹⁸ consists of 22 total items divided into two parts. The

first half consisting of the first 12 items collects demographic information of the participants and a history of playing-related pain. The possible answers are either a total number of hours or a simple yes or no. The second half consists of the remaining 10 items. Items 14-22 consist of a rating scale from 0-10 and item 13 is an outline of the human body so that the participant can place a mark on the location of pain.¹⁸

The SF-36 Health Survey (RAND Corporation, Santa Monica, CA) is one of the two baseline instruments because of its long use in health outcome studies.¹¹ It consists of 36 items and can be administered as either a computer-based test or a pen-and-paper method. The RAND Corp. provides a scoring software that calculates the scores of each subject. It has been validated in a variety of general and specialized populations throughout the world.^{12-14,42}

The QuickDASH (Institute for Work & Health, Toronto Ontario, Canada) is the second baseline measure.⁴⁴ It consists of 11 items in the main questionnaire and an additional four items are in the optional sports/performing arts module. Each item is scored on a range from one to five, where one is the absence of pain or disability and a five is intense pain or complete disability. It has also been shown to be valid among a general population.¹⁶

Procedures

After the study was approved by the University's Institutional Review Board, the members of the music department faculty were contacted through email asking for permission to recruit the members of the ensembles they directed. These ensembles included students who participated in a variety of musical activities including band, orchestra, chorus, and marching band.

The researcher then attended a class or rehearsal of the ensemble, read a recruitment script and provided directions while the paper-copy questionnaire packets were distributed to the

students. Participants were given the opportunity to ask questions before completing the questionnaire packet and the researcher was present while the packet was completed to answer any questions that arose. After completing the packet, the participants returned it to the researcher.

Data Analysis Procedures

The convergent validity was evaluated using a Pearson's Product-Moment Correlation to identify the relationship between the scores of the experimental and baseline instruments. To evaluate the reliability of the instruments, the split-half method was used by obtaining the Spearman-Brown score. The significance for all correlations was set at $\alpha \leq 0.05$. The internal consistency was evaluated using Cronbach's alpha. The calculations were performed using IBM SPSS statistics software version 23. The readability was tested using the Flesch-Kincaid scores calculated in MS Word version 15.0.4815.1001

Results

Descriptive Statistics

A total of 185 musicians began the survey packet. Table 3 contains the total completed surveys by each participant. Table 4 contains the average scores of each survey. For all of the surveys, except for the SF-36, the higher the score the more pain or disability the individual is experiencing. For the SF-36, a higher score represents a higher quality of life experienced by the individual. The demographic information of the participants who completed the surveys can be found in Table 5. A number of participants did not complete the final page of the survey packet which contained many of the demographic questions. They completed at least part of the survey packet, thus their scores were included in the calculation of results, but their demographic information is listed as unreported.

Table 3. Number of Completed Questionnaires

Questionnaire	Total Number of Completed Questionnaires
QuickDASH	185
QuickDASH Option Module	163
SF-36	183
MPIIQM Demographics	185
MPIIQM Intensity	44
MPIIQM Interference	41
MPQM	52

Table 4. Average Survey Scores

Name of Survey	Average Score
SF-36	54.84 ± 8.16
QuickDASH	4.21 ± 6.40
QuickDASH Sports/Performing Arts Module	6.32 ± 11.28
MPQM	11.73 ± 15.48
MPIIQM Intensity	2.61 ± 8.84
MPIIQM Interference	2.10 ± 8.60

Table 5. Sample Demographics

Gender	
Male	112 (60.54%)
Female	73 (39.46%)
Instrument Family	
String	7 (3.78%)
Woodwind	45 (24.32%)
Brass	42 (22.70%)
Percussion	22 (11.89%)
Voice	13 (7.02%)
Unreported	56 (30.27%)
Year in School	
First Year	54 (29.19%)
Second Year	30 (16.22%)
Third Year	15 (8.11%)
Fourth Year	17 (9.19%)
Five or More Years	13 (7.57%)
Unreported	55 (29.72%)
Years Playing Their Instrument	
Less than 1	2 (1.08%)
1-3 Years	6 (3.24%)
3-5 Years	3 (1.62%)
5-10 Years	78 (42.16%)
Greater than 10 Years	39(21.08%)
Unreported	57 (30.82%)
Average Playing Time in years	13.02 ± 10.33

Convergent Validity

The correlation coefficients for both the MPQM and MPIIQM compared to the baseline instruments can be found in table 6. The MPQM showed moderate validity when compared to the baseline instruments. It had a weak correlation with the SF-36 ($r = -0.197$), but a moderate correlation with the QuickDASH ($r = 0.539$) and the sports/performing arts optional module ($r = 0.588$). The MPIIQM showed similar validity when compared to the baseline instruments. The MPIIQM intensity score correlated weakly with the SF-36 ($r = -0.155$) and had a moderate correlation to the QuickDASH ($r = 0.418$) and the optional module ($r = 0.492$). The MPIIQM interference score as well had a weak correlation to the SF-36 ($r = -0.145$) and the moderate correlation to the QuickDASH ($r = 0.409$) and optional module ($r = 0.499$). All correlations were assessed using P value of ≤ 0.05 .

Table 6. Pearson correlation values for the MPQM and MPIIQM compared to the baseline instruments

Baseline Instrument	MPQM	MPIIQM Intensity	MPIIQM Interference
SF-36	-0.197*	-0.155*	-0.145
QuickDASH	0.539*	0.418*	0.409*
QuickDASH Sports/Performing Arts Module	0.588*	0.492*	0.499*

*. Correlation is significant at the 0.05 level (2-tailed).

Reliability

The MPQM showed excellent internal consistency with a Cronbach's alpha of 0.928. The MPIIQM had strong internal consistency with a Cronbach's alpha of 0.753. The MPQM showed excellent split-half reliability with a Spearman-Brown coefficient value of 0.895. The split-half

reliability of the MPIIQM was also excellent with a value of 0.966. These values can also be found in Table 7.

Table 7. Reliability coefficients for the MPQM and MPIIQM

Reliability Measure	MPQM	MPIIQM
Cronbach's alpha	0.928	0.753
Spearman-Brown	0.895	0.966

Readability

The readability of the MPQM was appropriate for the target population of college musicians with a Flesch-Kincaid score of 7.9. The MPIIQM has a Flesch-Kincaid score of 5.0, which is also appropriate for the target population of college age musicians.

Discussion

The goal of this study was to psychometrically evaluate the MPQM and MPIIQM among a sample of college musicians. While the results of this study showed good reliability and readability of both the MPQM and MPIIQM in a population of college musicians, it showed moderate convergent validity of the two instruments.

Both the MPQM and MPIIQM correlated moderately with the QuickDASH and the sports/performing arts module of the QuickDASH. The optional module had a stronger correlation with the MPQM and MPIIQM, which suggests that the module does a better job at capturing the needs of musicians than the QuickDASH alone. The addition of the sports/performing arts module appears to meet its purpose.

However, caution should be taken because the items on the QuickDASH relate to general activities of daily living and are not specific to playing a musical instrument. Using the optional module can help correct for this concern, but it is scored separately from the QuickDASH

resulting in an additional number to compare. The optional module also only consists of four items and this could cause aspects of the injury to be missed (i.e., missed signs or symptoms). Because of these concerns, it is possible that the QuickDASH with the sports/performing arts optional module may not capture all of the needs of musicians. If a clinician chooses to use the QuickDASH with their patients rather than a music specific instrument, they should consider adding the sports/performing arts module.

Neither music specific instrument correlated strongly with the SF-36. Interestingly, the QuickDASH and its optional module also did not correlate strongly with the SF-36. The SF-36 is intended for the general population and measures general quality of life but not specific conditions. The items found on the SF-36 are too general, meaning that the musician may still be able to perform the task without difficulty as it does not relate to their ability to play their instrument. Thus, it does not appear that it is able to quantify the needs of a physically active population, specifically musicians. The results found in this study seem to agree with the current literature suggesting the need for a specialized instrument for use among musicians.^{17,18}

When comparing the MPQM to the MPIIQM, either instrument could be used by clinicians and researchers. However, it is recommended that the MPQM be the preferred instrument. In addition to its stronger correlations with the QuickDASH and the sport/performing arts module, it is shorter and can be completed by most subjects within a few minutes, it provides a single score for easy identification of struggling individuals, and it can easily be administered in either an electronic format or traditional pen and paper methods. Each of these reasons could make it easier for a clinician to practically use and apply the MPQM. If the clinician used the MPQM rather than a general instrument such as the SF-36 or QuickDASH, it may help identify those individuals in need of additional care that may have otherwise been missed. Additionally,

having a consistent tool could help researchers to provide results of their studies because they are easier to compare among studies.

The validity could have been affected by a few limitations of this study. The sample size varied for each instrument that was completed. Clearer directions may have helped participants navigate each of the instruments better and increased the likelihood of completion. As the method of data collection was a self-reported survey, the results could have also been affected by a self-reporting bias.

In conclusion, both the MPQM and MPIIQM have moderate validity when used in a population of collegiate musicians, but are excellent methods of data collection when used among the specific population groups for which they were designed. It is recommended that future studies use the MPQM to increase comparability of studies, thus increasing the quality of future research. Clinicians would be able to use the MPQM to easily and quickly identify individuals in need of follow up care to address their pain and injury. Further studies should consider evaluation of the MPQM and MPIIQM among other populations such as full and part-time professional musicians, collegiate musicians living in other regions, and youth musicians.

CHAPTER 5. CONCLUSION AND SUMMARY

The results of the study have been presented in the chapter four and will be expanded upon in this chapter. Additionally, a deeper discussion, clinical implications, limitations, and future research will be discussed in this section.

Discussion

The goal of this study was to psychometrically evaluate the MPQM and MPIIQM among a sample of college musicians. While the results of this study show good reliability and readability of both the MPQM and MPIIQM in a population of college musicians, it shows moderate convergent validity of the two instruments.

Correlations of the MPQM and MPIIQM to the Baseline Instruments

Both the MPQM and MPIIQM correlated moderately with the QuickDASH and the sports/performing arts module of the QuickDASH. However, caution should be taken as the items on the QuickDASH relate to general activities of daily living and are not specific to playing a musical instrument. The optional module correlates more strongly with the MPQM and MPIIQM, which suggests that the module does a better job at capturing the needs of musicians than the QuickDASH alone. The addition of the sports/performing arts module appears to help identify musicians that are struggling with injury. The additional module helps accomplish this purpose by asking questions that relate directly to playing an instrument such as: Did you have any difficulty playing your musical instrument or sport as well as you would like? Questions such as this one are more relevant to the specific needs of musicians.

Using the optional module can help correct for general activities of daily living, but it is scored separately from the QuickDASH resulting in an additional number to compare. The optional module also only consists of four items and this could cause aspects of the injury to be

missed (i.e., missed signs or symptoms). Because of these concerns, it is possible that the QuickDASH with the sports/performing arts optional module may not capture all the needs of musicians. If a clinician chooses to use the QuickDASH with their patients rather than a music specific instrument, they should consider adding the sports/performing arts module.

Neither music specific instrument correlated strongly with the SF-36. Interestingly, the QuickDASH and its optional module also did not correlate strongly with the SF-36. One reason this may have occurred is because the SF-36 is intended for the general population and measures general quality of life but not specific conditions such as the inability to play a musical instrument because of pain. The items found on the SF-36 are too general, meaning that the musician may still be able to perform the task without difficulty as it does not relate to their ability to play their instrument. Thus, it does not appear that it is able to quantify the needs of a physically active population, specifically musicians. The results of this study found here seem to agree with the current literature suggesting the need for a specialized instrument for use among musicians.^{17,18}

Correlation of the Two Scores of the MPIIQM

The correlation between the two scores of the MPIIQM, intensity and interference, is strong suggesting that as the individual experiences a higher intensity of pain, they will also experience a greater interference to their life. The two scores can be used by a researcher to understand the amount of pain the individual is experiencing and its impact on their everyday activities. Both scores should be related and thus a strong correlation between the two scores of the MPIIQM should be expected.

Correlation of the MPQM and MPIIQM Compared to Each Other

When comparing the MPQM and the MPIIQM to each other, they are moderately correlated to each other. The correlation coefficient for the MPQM to the MPIIQM Intensity score is $r = 0.503$ ($P = 0.01$) and for the interference score is $r = 0.577$ ($P = 0.01$). Studies that only use one of the instruments may not be as comparable because the resulting scores are not as related to each other to allow for strong comparisons. Therefore, they would result in the same methodological issue that have previously been noted by Zaza⁸ and Wu.⁶

Comparison of the Current Sample to Previous Studies

When comparing the make-up of the current sample there is one difference, besides the playing level (collegiate vs. professional), between the current sample and the samples used by Berque¹⁸ and Lamontagne.¹⁷ The majority of the participants in the current study reported playing either a woodwind or brass type instrument (47.02%). Lamontagne reported that the majority of participants were string players (71%) with few brass and woodwind (29%).¹⁷ Berque did not report the types of instrument that were played by participants.

The current study, as well as the two previous studies on the MPQM and MPIIQM, used Cronbach's alpha to evaluate the reliability. This study found a Cronbach's alpha score for the MPQM of $\alpha = 0.928$, while Lamontagne reported a value of $\alpha = 0.768$.¹⁷ Berque¹⁸ reported a Cronbach's alpha of $\alpha = 0.88$ for the overall scale. The current study found a value of $\alpha = 0.753$. All reported numbers are considered excellent; the differences could be the result of the differences between collegiate and professional musicians.

Each study used a different method of evaluation for convergent validity. Therefore, the numbers cannot be directly compared.

Clinical Implication

Musicians are a specialized population, with specific healthcare needs, that are not always met by the typical healthcare provider. The lack of comparable research of the risk factors and prevalence of PRMDs in musicians could be one possible cause of this lack of proper healthcare. By using a standardized method of data collection such as the MPQM or MPIIQM, this issue could be improved by future researchers. Clinicians who use the MPQM or the MPIIQM and are interested in providing quality care to musicians will also be able to identify those musicians in need of extra care.

This study attempted to identify an instrument that could be used as the standard method of data collection in collegiate musicians. It is recommended that the MPQM be the preferred instrument. In addition to its stronger correlations with the QuickDASH and the sport/performing arts module, it is shorter and can be finished by most subjects within a few minutes, and it provides a single score for easy identification of struggling individuals. Each of these reasons could make it easier for a clinician to practically use and apply the MPQM. If the clinician used the MPQM rather than a general instrument such as the SF-36 or QuickDASH, it may help identify those individuals in need of specific care, unique to musicians, that may have otherwise been missed. Additionally, having a consistent tool could help researchers to provide clearer epidemiological studies because the results will become easier to compare among different studies.

Limitations

The validity could have been affected by a few limitations of this study. The sample size varied for each instrument that was completed. Clearer directions given by the researcher about each individual instrument may have helped participants navigate the instruments better and increased the likelihood of completion. Additionally, as the method of data collection was a self-

reported survey, the results could have also been affected by a self-reporting bias. Participants may not have completely remembered answers or answered as honestly as possible to questions.

Future Studies

Further research on the validity and reliability of the MPQM and MPIIQM needs to be conducted to provide additional evidence of the validity and reliability of each instrument. As more researchers provide evidence for the validity and reliability of each instrument, the quality of data collected will increase.¹⁹ If the quality of data are increased the need for healthcare providers trained in the unique needs of musicians can be determined.

Future researchers could compare the MPQM or MPIIQM to a different baseline instrument, such as the Chronic Pain Graded Questionnaire (CPGQ). This study could also be replicated among different populations of musicians. The researcher would be able to evaluate the instruments among populations based on type of musician, type of instrument played, age, playing level, or region.

Future research should also focus on the qualitative aspect of musicians suffering from injury. This could include consulting music teachers about their knowledge and perception of injury and interviewing musicians with a known injury to gather personal experiences dealing with injury.

Conclusion

Both the MPQM and MPIIQM have moderate validity when used in a sample of collegiate musicians, but show promise as a method of data collection when used among the specific population group for which they were designed. This can be seen because of the low correlation of the MPQM and MPIIQM with the SF-36, a measure that is meant for the general population.

It is recommended that future studies use the MPQM to increase comparability of studies, thus increasing the quality of future research. Clinicians would be able to use the MPQM to easily and quickly identify individuals in need of follow up care to address their pain and injury. Further study should consider evaluation of the MPQM and MPIIQM among other populations such as full and part-time professional musicians, collegiate musicians living in other regions, and youth musicians.

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APPENDIX A. MUSCULOSKELETAL PAIN QUESTIONNAIRE FOR MUSICIANS

(MPQM)

1. Musculoskeletal Pain Questionnaire for Musicians (Lamontagne & Bél...)

Musculoskeletal pain is pain that affects the muscles, ligaments and tendons, along with the bones. The following questions are about manifestations of musculoskeletal pain related to your musical activities.

1. In the past 6 months, how frequently did you experience pain?

	Never	On a Few performances	On Most performances	On Every performance
When performing your musical activities:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2. In the past 6 months, how long, on average, did your pain last?

	Few minutes	Few hours	Few days	Almost Always
Select:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. How intense is your pain at the present time rated on a 1-10 scale?

	1	2	3	4	5	6	7	8	9	10
Where 1 = "not intense at all", and 10 = "as intense as could be"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. In the past 6 months, how intense was the most painful pain manifestation rated on a 1-10 scale?

	1	2	3	4	5	6	7	8	9	10
Where 1 = "not intense at all", and 10 = "as intense as could be"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5. In the past 6 months, how intense was the least painful pain manifestation rated on a 1-10 scale?

	1	2	3	4	5	6	7	8	9	10
Where 1 = "not intense at all", and 10 = "as intense as could be"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. In the past 6 months, on average, how intense was your pain rated on a 1-10 scale?

	1	2	3	4	5	6	7	8	9	10
Where 1 = "not intense at all", and 10 = "as intense as could be"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. In the past 6 months, because of pain, did you have any difficulty:

	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty
7) Using your usual technique for playing your instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8) Playing your musical instrument because of your symptoms?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9) Playing your musical instrument as well as you would like?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10) Spending your usual amount of time playing your instrument?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

APPENDIX B. MUSCULOSKELETAL PAIN INTENSITY AND INTERFERENCE

QUESTIONNAIRE FOR MUSICIANS (MPIIQM)[†]

Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians

1. What is your age? _____ years

2. Gender: Male Female

3. What instrument do you play in the orchestra? _____

4. With respect to your position in the orchestra, do you work: Full time Part time

5. For how many years have you played your instrument? _____ years

6. For how many years have you played professionally in an orchestra? _____ years

7. On average, how many hours per week do you spend playing your instrument **in the orchestra** (this includes rehearsals, performances, recordings)? _____ hours per week

8. On average, how many hours per week do you spend playing your instrument **outside** orchestra duties (this includes individual practice, chamber music, solo performances, demonstration when teaching, gigs, other)? _____ hours per week

Playing-related musculoskeletal problems are defined as "pain, weakness, numbness, tingling, or other symptoms that interfere with your ability to play your instrument at the level to which you are accustomed". This definition does not include mild transient aches and pains.

9. Have you **ever** had pain/problems that have interfered with your ability to play your instrument at the level to which you are accustomed? Yes No

10. Have you had pain/problems that have interfered with your ability to play your instrument at the level to which you are accustomed **during the last 12 months**? Yes No

11. Have you had pain/problems that have interfered with your ability to play your instrument at the level to which you are accustomed **during the last month (4 weeks)**? Yes No

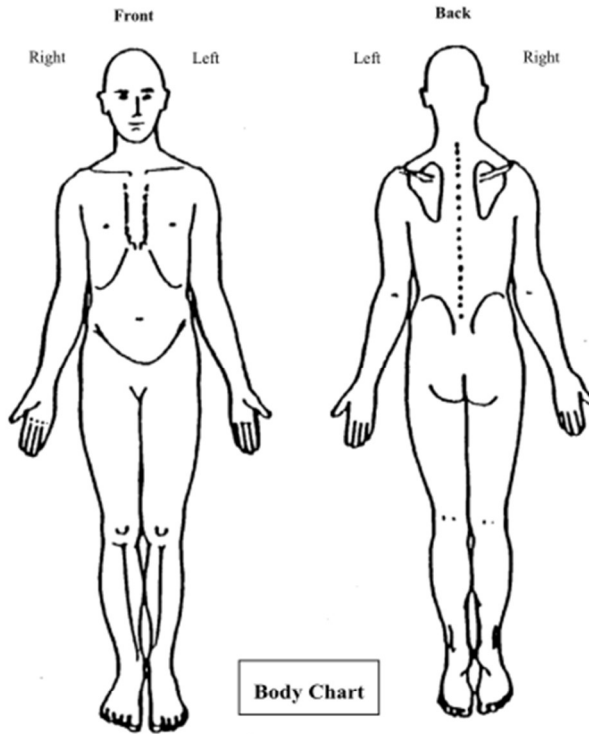
12. **Currently (in the past 7 days)**, do you have pain/problems that interfere with your ability to play your instrument at the level to which you are accustomed? Yes No

If your answer to questions 11 and/or 12 is YES, please continue. Otherwise stop here, and hand your survey back or post it back using the stamped addressed envelope provided.

[†] The inclusion of the MPIIQM in this appendix has been approved Patrice Berque, the copyright holder.

Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians

13. On the body chart, SHADE IN each of the areas where you experience pain/problems. Put an X on the ONE area that HURTS the most.



Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians

The next four questions relate ONLY to PAIN. Please answer with reference to the ONE area that you marked with an X on the body chart. Otherwise go to Question 20.

14. Please rate your pain by circling the one number that best describes your pain at its **worst** in the last week.

0 1 2 3 4 5 6 7 8 9 10

No pain

Pain as bad as
you can imagine

15. Please rate your pain by circling the one number that best describes your pain at its **least** in the last week.

0 1 2 3 4 5 6 7 8 9 10

No pain

Pain as bad as
you can imagine

16. Please rate your pain by circling the one number that best describes your pain on **average** in the last week.

0 1 2 3 4 5 6 7 8 9 10

No pain

Pain as bad as
you can imagine

17. Please rate your pain by circling the one number that tells how much pain you have **right now**.

0 1 2 3 4 5 6 7 8 9 10

No pain

Pain as bad as
you can imagine

Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians

<p>The remainder of the survey relates to both PAIN and/or PROBLEMS.</p>										
<p>For each of the following, circle the one number that describes how, during the past week, pain/problems have interfered with your:</p>										
<p>18. Mood</p>										
0	1	2	3	4	5	6	7	8	9	10
Does not interfere										Completely interferes
<p>19. Enjoyment of life</p>										
0	1	2	3	4	5	6	7	8	9	10
Does not interfere										Completely interferes
<p>For each of the following, during the past week, as a result of your pain/problems, did you have any difficulty (please circle ONE number):</p>										
<p>20. Using your usual technique for playing your instrument?</p>										
0	1	2	3	4	5	6	7	8	9	10
No difficulty										Unable
<p>21. Playing your musical instrument because of your symptoms?</p>										
0	1	2	3	4	5	6	7	8	9	10
No difficulty										Unable
<p>22. Playing your musical instrument as well as you would like?</p>										
0	1	2	3	4	5	6	7	8	9	10
No difficulty										Unable
<p>Thank you for your participation. Please hand your survey back or post it back using the stamped addressed envelope provided.</p>										

APPENDIX C. ORAL SCRIPT

**NDSU – North Dakota State University
Department of Health, Nutrition, & Exercise Sciences
PO Box 6050
Fargo, ND 58108-6050**

**NDSU RESEARCH STUDY
Oral Script**

The Ideal Questionnaire for Self-Reporting Musculoskeletal Injuries Among Musicians.

Dear *NDSU student*:

My name is Brian Schmidt. I am a graduate student in the Department of Health, Nutrition, & Exercise Science at North Dakota State University, and I am conducting a research project to look at the rates of musculoskeletal injuries, or injury to the muscle, tendon, joint, bone, or ligament, of musicians. It is our hope, that with this research, we will provide a more effective means of researching injury among musicians for future research.

You are invited to participate in this research study. The criteria for participating in the study is that you must be between 18 and 30 years of age, be a music student, and play a string, percussion, woodwind, or brass instrument. Your participation is entirely voluntary, and you may change your mind or quit participating at any time, with no penalty; however, your assistance would be greatly appreciated in making this a meaningful study. If you decide to complete this survey a copy of this information will be given to you to keep for your information.

It should take about 10-30 minutes to complete the questionnaires about your past history of musculoskeletal injury. To complete the surveys, please answer all questions honestly and to the best of your knowledge. At the end of the survey, you will be asked for your email address. This information will not be stored separately from your responses. If you so desire, your email address will be used in a drawing for one of five \$20 gift cards to Amazon.com.

Your identity will not be linked to your survey responses. Your information will be combined with information from other people taking part in the study, we will write about the combined information that we have gathered. You will not be identified in these written materials. We may publish the results of the study; however, we will keep your name and other identifying information private.

If you have any questions about this project, please contact me at 435.770.2614, brian.m.schmidt@ndsu.edu or contact my advisor, Shannon David at 701.231.5686, shannon.david@ndsu.edu. If you have questions about the rights of human participants in research, or to report a problem, you may contact the NDSU Human Research Protection Program, at (701) 231.8995, toll-free at 1-855-800-6717 or via email at ndsu.irb@ndsu.edu.

Thank you for your participation in this study. If you wish to receive a copy of the research results, please email me at: brian.m.schmidt@ndsu.edu.