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Functional Movement Screen: Exploring Interrater Reliability Between Students

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FUNCTIONAL MOVEMENT SCREEN: EXPLORING INTERRATER RELIABILITY BETWEEN STUDENTS

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This Scholarly Project, submitted by Austin Weisz, Lindsey Knoll, Emily Schuster, and Cooper Tietz, in partial fulfillment of the requirements for the Degree of Physical Therapy from the University of North Dakota, has been reviewed by the Advisor and Chairperson of the Physical Therapy program under whom the work has been done and is hereby approved.

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Title Functional Movement Screen: Exploring Interrater Reliability Between Students

Department Physical Therapy

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Abstract

Purpose: The purpose of this study was to assess the interrater reliability of the most recent Functional Movement Screen (FMS), between four second-year physical therapy students. The most recent FMS has added the ankle clearing test (pain and mobility categories) after the inline lunge and modified the rotary stability movement pattern and criteria for scoring. To our knowledge, there has not been a reliability study completed with the most recent additions and modifications of the FMS.

Methods: Forty-five physical therapy students participated and were videotaped completing the Functional Movement Screen (FMS) and were rated by four current second-year physical therapy students. The videos were then independently observed and scored by four second-year physical therapy students, also known as the raters in the study. The intraclass coefficient (ICC) was analyzed using reliability analysis: statistics on SPSS.

Results: The inter-rater reliability was highest for scoring the rotary stability test ICC 0.96, while the deep squat was the least reliable ICC 0.78. Overall, the total scores showed reliability between the four raters with an ICC of 0.95. All the new scoring criteria produced good to great inter-rater reliability, with the exception of the ankle mobility clearing test.

Conclusion: This study showed the inter-rater reliability between four second-year physical therapy students was good to excellent across all portions of the FMS.

CHAPTER I

INTRODUCTION

Movement is essential to human life. It is a vital aspect to the overall health and well-being of every human. Good movement quality has been defined as the performance of fundamental movements in a properly balanced and well-coordinated manner.[1] On the contrary, poor movement quality has been defined as the inability to complete those same fundamental movements in accordance with accepted theoretical norms.[1] Theoretical norms for movement have been created by screening and scoring the human population. There have been many screens created over the years, but none of the screens have been standardized or utilized by everyone in the world regarding quality of movement. Screening these fundamental movements have helped clinicians and trainers identify movement quality dysfunctions. If movement quality dysfunctions were identified, then clinicians and trainers may be able to prevent a future injury or worsening dysfunction. This is one reason why the Functional Movement Screen (FMS) was created by Gray Cook, et al.[1]

The FMS has movement professionals screen an individual's functional and fundamental movement patterns to produce a quantifiable measure of their movement quality (0, 1, 2, or 3).[1] The FMS has been utilized by many movement professionals to identify movement quality dysfunctions in individuals that may be at risk of, but not currently experiencing, signs or symptoms of a musculoskeletal injury.[2] Although the FMS is not intended to diagnose or test for any specific orthopedic problems, it has been created to improve movement quality in

individuals that are screened.[3] The FMS has seven separate movement patterns that were specifically designed to place an individual in extreme positions where movement deficits will become noticeable if appropriate stability and mobility are not used.[4] The seven movement patterns include: deep squat, hurdle step, inline lunge, shoulder mobility, active straight-leg raise, trunk stability pushup, and rotary stability. A scale from 0-3 has been used to score the seven movement patterns.

Past studies have found that there was good to excellent interrater and intrarater reliability between the raters. Gribble et al[5] found evidence that was moderate to strong supporting intrarater reliability. Gulgin and Hoogenboom[6] had 4 raters (3 novices and 1 expert) that were all certified in FMS. Another study by Leeder et al.[7] found good to excellent reliability of the FMS when the raters were untrained and were only given instructions on how to score the recorded individuals on DVD. A study conducted by Teyhen et al.[8] had novice examiners go through 20 hours of training regarding the FMS to get good to excellent interrater reliability. A study by Shultz et al.[9] demonstrated poor interrater reliability with 5 raters that were trained in FMS and 1 rater that was self-trained. Many other studies continue to demonstrate good to excellent interrater reliability[10-12], however, no study has looked at the new criteria of the FMS with the ankle clearing test and the updated scoring criteria for the rotary stability test.

It is important to understand that the FMS is reliable for second-year PT students because it allows students to confidently screen the quality of movement within their patients. If poor movement qualities are observed, then recommendations can be made to improve the movement pattern, potentially reducing the risk of future injury. Many studies have reported that having a score of less than 14 on the FMS increases the individual's risk of injury.[13-21]

The research question that the authors are asking is: Is the FMS reliable between second-year Doctor of Physical Therapy (DPT) students following the addition of the ankle clearing test and modifications in the rotary stability scoring criteria? Past studies have suggested that the FMS intrarater reliability was strong and appeared to strengthen when the individuals had experience using the FMS in addition to clinical experience.[22] The purpose of this study was to assess if the updated FMS has good to excellent interrater reliability so that it can be used confidently in the clinic and community to improve the wellness of the human population.

CHAPTER II

LITERATURE REVIEW

Use of FMS

Most of the research involved in the FMS has been focused on athletes or fit individuals. There has been a lack of research completed on individuals that are older, are not involved in sports, and may have other health complications. Multiple studies have examined if the FMS can be used as a diagnostic tool and used as a tool to predict future injury. A study done by Kiesel et. al[13] asked the question; "If injuries sustained in professional football could be predicted and prevented by a functional movement screen done in the preseason?" It was found that athletes with a score of 14 or less on the FMS had a higher risk for injury. Bardenett et. al[22], found that the screen was better off used as an "assessment of quality" rather than used for diagnostic purposes. Another study by Dorrel et. al[23] found that the screen did not provide discriminatory predictive values for future musculoskeletal and overall injury. On the other hand, a study by Bushman et. al[24] agreed with the study listed above by Kiesel et. al[13], which said that physically active men who scored lower on their FMS (<14) put them at higher risk for future injury. At this time, there is mixed evidence as to whether the FMS may or may not be a good predictive tool for future injuries.

Reliability

Another area of research that involved the FMS was the interrater reliability and the intrarater reliability of the screen. Interrater reliability is the ability of multiple people to be able

to assess an individual and score them similarly. Intrarater reliability is the ability of one rater to demonstrate consistency across multiple different scoring sessions. Interrater reliability is important so that multiple clinicians can complete the FMS on a patient and be consistent with their scoring.

Smith et al.[25] examined interrater reliability and intrarater reliability for individuals who took a two-hour training course on the FMS and then scored subjects across two assessment sessions. It was found that the interrater reliability was good for both session 1 and session 2 (ICC of 0.89 and 0.87, respectively). The intrarater reliability of each individual rater was examined across the sessions, resulting in good reliability as well (ICC range from 0.81-0.91). Secondly, a systematic review of 6 studies on FMS reliability, found the interrater and intrarater reliability to be ICC 0.81.[14] Both studies involved researchers that varied in FMS experience or only received a short training period prior to rating the subjects.

CHAPTER III

METHODS

Experimental Approach to the Problem

The purpose of this study was to determine the interrater reliability of the updated FMS on healthy individuals. To determine interrater reliability of the FMS, the study was designed to have four raters, who all received the same education, observe and score the FMS. Participants were taken through the FMS with standard instructions utilized per FMS guidelines. Each rater observed and scored 45 participants based on the scoring criteria created by the FMS. The study was approved by the Institutional Review Board (IRB) at the University.

Subjects

The study consisted of participants and raters. The participants were taken through the FMS by a licensed physical therapist and videotaped. The raters in the study were four second-year physical therapy students that observed and scored the FMS independently after videotaping was completed. Participants were recruited from a student cohort in a physical therapy department. The participants contained 45 individuals, both male (N=14) and female (N=31). The inclusion criteria for this study were current physical therapy students with no reports of a recent injury (recent is defined as less than or equal to 4 weeks ago). The exclusion criteria were recent injury (recent is defined as less than or equal to 4 weeks ago), an injury that is contraindicated to complete weight-bearing activities, and lack of compliance with research times. Recruitment was done through email in which the subjects received an explanation of the nature, purpose, and

risks of the study and were asked to volunteer to assist in the research. Fifty-five volunteers were recruited, and out of the 55 volunteers contacted, 10 volunteers declined. Before the FMS was completed and videotaped, participants and raters signed an informed consent document approved by the Institutional Review Board at the University (APPENDIX A).

Raters

The four raters were halfway through their second year in the Doctor of Physical Therapy Program at the University. All of them had received the same amount of prior learning and education in the field of physical therapy. For the FMS screen specifically, each rater had received a brief 1-hour presentation on how the FMS was conducted and used four months prior to testing. Two weeks before testing, the raters were presented with a 2-hour lecture on the FMS in their Clinical Evaluation II class. Each rater practiced completing and scoring the FMS 3 times, one week before videotaping the participants. Following the screening of the participants, the raters attended a 1.5-hour FMS review session given by a licensed physical therapist who was certified in FMS. The review session was held one week before observing and scoring the FMS videos of the participants. The raters were not certified in FMS at any time during the study.

Procedure

Two experts, both licensed physical therapists, one of which was certified in FMS, conducted the screening for this study. No warmup was allowed for the subjects prior to the screening. Next, tibial tuberosity height (from the ground to the top center of the tibial tuberosity) and hand length (from the distal wrist crease to the end of the longest digit) were measured using the FMS equipment per standard FMS instructions. Tibial height and hand length measurements were used for each participant during the hurdle step, inline lunge, and

shoulder mobility movement patterns. Each participant then underwent one FMS testing session while being recorded on video, which lasted approximately 15 minutes. For reliability purposes, word for word instructions were read to the participants on how to complete the 7 movement patterns and 4 clearing tests of the FMS, in addition to demonstrations of each movement pattern. If the subject needed more clarification, instructions or demonstrations were repeated, but no further directions were given. These instructions and demonstrations were not provided collectively before the testing began, but rather immediately before each individual movement. After demonstrative and verbal instructions were given, the participants were allowed three attempts to complete the movement pattern per FMS instructions, with the best score recorded. After each movement, the participant was asked if any pain was associated with the movement. During each movement, the participants were recorded from both the sagittal and frontal planes. The FMS was completed and recorded in a closed environment. Once the video recordings were completed, the four raters then individually observed and scored the FMS on each recorded participant. When the videos were put into a secured file to be scored, the recording was labeled with participants and then a number (i.e. - Participant 1). The four raters each completed the scoring from the video recordings in the same environment each time, and in the absence of any outside distractions.

Statistical Analyses

The scores for each participant were put into SPSS with reliability analysis statistics run for each movement. Descriptive statistics were calculated as mean values with standard deviation for normal interval data. The ICC from repeated-measures analysis of variance were calculated to determine the interrater reliability of each individual exercise component of the FMS and the

participant's overall FMS score. Interrater reliability was defined as poor for an ICC below 0.50, moderate for 0.50–0.75, good for 0.75-0.90, and excellent for 0.90 or higher.[26]

CHAPTER IV

RESULTS

The overall ICC for the total score was 0.95 (95% CI: 0.93, 0.97), demonstrating excellent interrater reliability between raters (Table 1).

Table 1: Intraclass Correlation Coefficient (ICC) for Final Scores on the Movement Patterns

Movement Pattern	ICC	Confidence Interval (95%)
Deep Squat	0.78	0.66, 0.87
Hurdle Step	0.92	0.88, 0.95
Inline Lunge	0.92	0.88, 0.95
Shoulder Mobility	0.94	0.91, 0.97
Active Straight-Leg Raise	0.94	0.90, 0.96
Trunk Stability Push Up	0.95	0.92, 0.97
Rotary Stability	0.96	0.93, 0.97
Total FMS Score	0.95	0.93, 0.97

As far as new criteria on the FMS regarding the clearing tests, the ankle mobility clearing test for the right inline lunge was ICC 0.76 (good), while the left side was ICC 0.63 (moderate). These tests both show good and moderate interrater reliability, respectively, and are shown in Table 2. All other clearing tests suggest good to excellent interrater reliability.

Table 2: Intraclass Correlation Coefficient (ICC) for the Clearing Tests

Clearing Test	ICC	Confidence Interval (95%)
Right Ankle Clearing Test for Pain	0.92	0.88, 0.95
Right Ankle Clearing Test for Mobility	0.76	0.55, 0.87
Left Ankle Clearing Test for Pain	1.00	-
Left Ankle Clearing Test for Mobility	0.63	0.34, 0.79
Shoulder Clearing Test for Mobility (Right and Left)	1.00	-
Spinal Extension Clearing Test	0.88	0.82, 0.93
Spinal Flexion Clearing Test	1.00	-

Table 3 displays the raw scores of the individual movement patterns. Examination of the individual movement patterns of the FMS showed rotary stability as the most reliable ICC 0.96 (95% CI: 0.93, 0.97), whereas the least reliable was deep squat ICC = 0.78 (95% CI: 0.66–0.87). The deep squat was still considered to have good interrater reliability.

Table 3: Intraclass Correlation Coefficient (ICC) for Raw Scores on the Movement Patterns

Movement Pattern	ICC	Confidence Interval (95%)
Deep Squat	0.78	0.66, 0.87
Right Hurdle Step	0.85	0.76, 0.91
Left Hurdle Step	0.91	0.86, 0.95
Right Inline Lunge	0.81	0.70, 0.88
Left Inline Lunge	0.82	0.72, 0.89
Right Shoulder Mobility	0.85	0.77, 0.91
Left Shoulder Mobility	0.94	0.88, 0.96
Right Active Straight-Leg Raise	0.94	0.88, 0.96
Left Active Straight-Leg Raise	0.95	0.92, 0.97
Trunk Stability Push Up	0.96	0.94, 0.98
Right Rotary Stability	0.88	0.80, 0.93
Left Rotary Stability	0.96	0.94, 0.98

Overall, the study found good to excellent interrater reliability for FMS raw scores, final scores, and total scores. Mean total scores are shown in the figure below. The results suggested that each rater's score was highly correlated with one another. The ICC of the final score of each movement pattern was above 0.90, except for the deep squat. This is in the "excellent" category for interrater reliability.

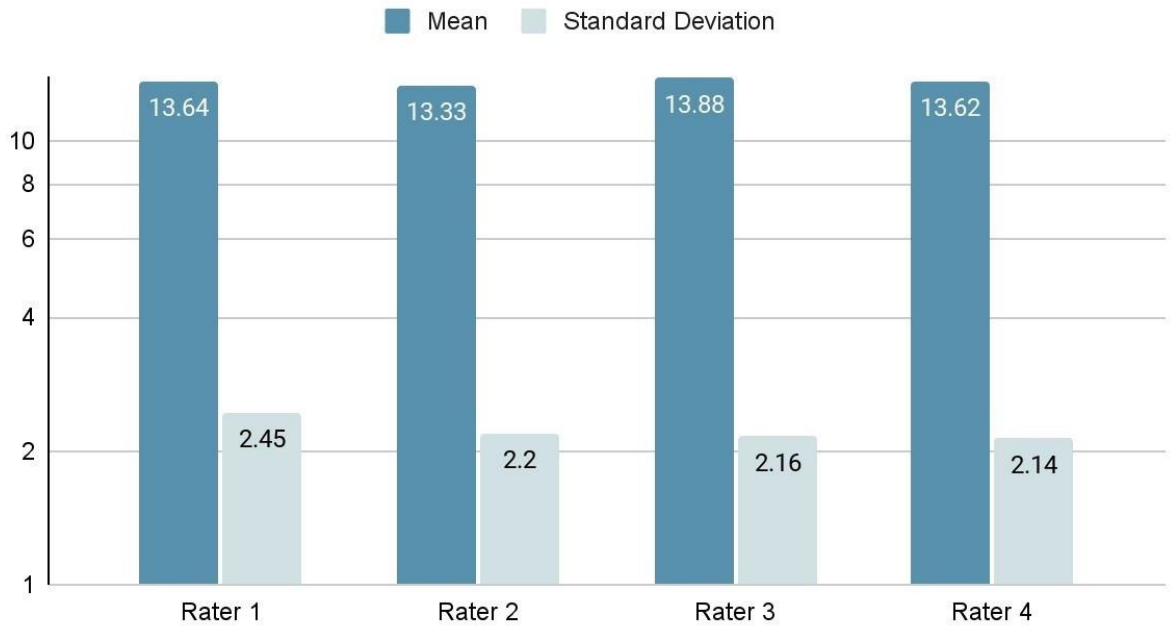


Figure: Mean Total Scores Between Raters

The new criteria for the FMS were found to show good to excellent interrater reliability, except for the left ankle clearing mobility test, which had a moderate agreement among raters. These results suggest that the new criteria are reliable between raters. There was a large difference between the right and left ankle mobility clearing test (ICC = R: 0.76, L: 0.63), indicating that an outside variable may have caused this difference in reliability. This may be due to viewing difficulties when participants wore pants rather than shorts, when participants did not hold the position long enough to view the end position, and when participants let the heel lift off the ground. Future studies should be aware of these factors when completing the mobility clearing test on the ankle.

CHAPTER V

DISCUSSION

The purpose of this study was to determine the interrater reliability for scoring the updated FMS by four second-year physical therapy students. Previous literature has examined interrater reliability using videotaping and multiple raters, but these studies were prior to the additions and modifications to the FMS and warranted further study. To the best of our knowledge, this study was one of the first studies to assess interrater reliability following the addition of the ankle clearing test and modifications to the rotary stability scoring criteria. Past studies have used raters who have different educational and clinical experience when using FMS.

Past studies [5-8, 10-12] have all demonstrated good to excellent interrater reliability of the original FMS. After our study, we found that the updated FMS continues to demonstrate good to excellent interrater reliability. This allows the FMS to be used confidently in the clinic and community to improve the wellness of the human population.

There were limitations related to rating the participants. The first limitation included a non-standard distance that the participant was from the video recording making some videos easier to see than others. The second limitation included the rater's choice of an area that was non-distracting to observe and score the participants. This location was supposed to be used each time the rater observed and scored a participant, however, the only way that this was monitored was through verbal confirmation. Lastly, all the participants were in their 20s or 30s, healthy,

and in graduate school. Future studies should look at participants that have comorbidities and are of varying ages.

In conclusion, four different raters following a strategic level of training can reliably score patients or clients using the updated FMS. This allows physical therapists to observe and intervene with their patients quicker, so that they can be proactive versus reactive in the community to potentially reduce the likelihood of future injury and/or pain. It was also found that students only require 4.5 hours of training and 3 practice attempts on their peers to demonstrate good to excellent interrater reliability when using the updated FMS. It may be beneficial for future studies to replicate this study to see if they get similar results or if the training can be completed in less time for students to demonstrate good to excellent interrater reliability.

Implications for Practice

The updated FMS is a reliable tool for second-year PT students. This is important because it allows students to be reliable in completing the screen during their clinical rotation, if provided with adequate training. The findings of this study empower students to confidently screen the quality of movement. If poor movement qualities are observed, then recommendations can be made to improve the movement pattern, potentially reducing the risk of future injury.

The authors of this study express that there are no conflicts of interest. The results shown are not endorsed or funded by the authors of the National Strength and Conditioning Association or any outside source.

APPENDIX A

THE UNIVERSITY OF NORTH DAKOTA CONSENT TO PARTICIPATE IN RESEARCH

Project Title: Reliability of the Functional Movement Screen (FMS) between Physical Therapy Students

Principal Investigator: Richard Morgan, richard.morgan@und.edu

Co-Investigator: Gary Schindler, gary.schindler@und.edu

Department: Physical Therapy Department

What should I know about this research?

- Taking part in this research is voluntary. Whether you take part is up to you.
- If you don't take part, it won't be held against you.
- You can take part now and later drop out, and it won't be held against you.
- If you don't understand, ask questions.
- Ask all the questions you want before you decide.
- Each participant will be videotaped to allow for students to observe and score the participant on the FMS.

How long will I be in this research?

We expect that your taking part in this research will be in the spring semester of 2022. Your participation will include a one-time videotaping that will take approximately 30 minutes.

Why is this research being done?

This study is being completed to assess the reliability of observing and scoring the Functional Movement Screen (FMS) between students (novices).

What happens to me if I agree to take part in this research?

If you decide to take part in this research study, you will be taken through the Functional Movement Screen (FMS), which consists of 7 fundamental movement patterns of the human body. The screen will be completed by a licensed physical therapist and videotaped. The videotape will be used by four second-year physical therapy students for observation and scoring. The results will be analyzed to determine inter-rater reliability among four 2nd year physical therapy students.

Could being in this research hurt me?

The most important risk or discomfort that you may expect from taking part in this research is being unable to complete a movement pattern because of pain or because of the inability to complete the pattern due to the difficulty of the pattern. Otherwise, there are no foreseeable risks to participating.

Approval Date: 3/1/2022

Expiration Date: 2/28/2023

University of North Dakota IRB

Date: _____

Subject Initials: _____

Will being in this research benefit me?

The most important benefit that you may expect from taking part in this research includes being aware of how you currently move with these 7 fundamental movement patterns. Possible benefit to others and you include reducing the risk of future injury.

How many people will participate in this research?

A minimum of 10 people will take part in this study at the University of North Dakota.

Will it cost me money to take part in this research?

You will not have any costs for being in this research study.

Will I be paid for taking part in this research?

You will not be paid for being in this research study.

Who is funding this research?

The University of North Dakota and the research team are receiving no payments from other agencies, organizations, or companies to conduct this research study.

What happens to information collected for this research?

Your private information may be shared with individuals and organizations that conduct or watch over this research, including:

- The Institutional Review Board (IRB) that reviewed this research

We may publish the results of this research. However, we will keep your name and other identifying information confidential. We protect your information from disclosure to others to the extent required by law. We cannot promise complete secrecy.

Data or specimens collected in this research might be de-identified and used for future research or distributed to another investigator for future research without your consent.

What if I agree to be in the research and then change my mind?

If you decide to leave the study early, there will be no penalty and you can exit the survey at any time.

You will be informed by the research investigator[s] of this study of any significant new findings that develop during the study which may influence your willingness to continue to participate in the study.

Approval Date: 3/1/2022

Expiration Date: 2/28/2023

University of North Dakota IRB

Date: _____

Subject Initials: _____

Who can answer my questions about this research?

If you have questions, concerns, or complaints, or think this research has hurt you or made you sick, talk to the research team at the phone number listed above on the first page.

This research is being overseen by an Institutional Review Board ("IRB"). An IRB is a group of people who perform independent review of research studies. You may talk to them at 701.777.4279 or UND.irb@UND.edu if:

- You have questions, concerns, or complaints that are not being answered by the research team.
- You are not getting answers from the research team.
- You cannot reach the research team.
- You want to talk to someone else about the research.
- You have questions about your rights as a research subject.
- You may also visit the UND IRB website for more information about being a research subject: http://und.edu/research/resources/human-subjects/research-participants.html

Your signature documents your consent to take part in this study. You will receive a copy of this form.

Subject's Name: _____

_____ _____

Signature of Subject Date

I have discussed the above points with the subject or, where appropriate, with the subject's legally authorized representative.

_____ _____

Signature of Person Who Obtained Consent Date

Approval Date: 3/1/2022

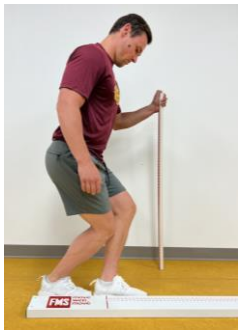
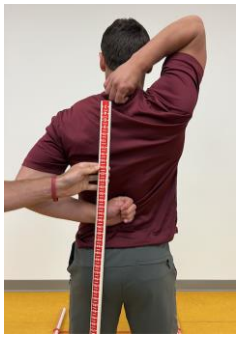
Expiration Date: 2/28/2023

University of North Dakota IRB

Date: _____

Subject Initials: _____

APPENDIX B

Functional Movement Screen plus the Clearing Tests		
 Deep Squat	 Hurdle Step	 Inline Lunge
 Ankle Clearing Test	 Shoulder Mobility	 Shoulder Clearing Test
 Active Straight Leg Raise	 Trunk Stability Push Up	 Extension Clearing Test
 Rotary Stability	 Flexion Clearing Test	

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