



Frequency of Biomechanical Faults in the Functional Movement Screen Overhead Deep Squat in Physically Active Individuals

EXERCISE SCIENCE
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ABSTRACT

The functional movement screen (FMS) is a graded system that uses seven fundamental movement patterns to observe an individual's movement competency. An FMS test that captures full body mechanics, is the overhead deep squat (ODS). The ODS assesses bilateral symmetry and mobility at the ankle, knee, & hip as well as the shoulder & thoracic spine. Subjects were scored based on their ability to meet the ODS criteria in the standard or modified test positions and were scored on a scale of 3-1. Previous studies have looked at differences in the kinematics of the ODS and selected dysfunctions, none have looked at the frequency of ODS dysfunctions in physically active individuals. **PURPOSE:** The purpose of this study was to investigate the frequency of common ODS dysfunctions across physically active individuals. **METHODS:** Forty-one physically active individuals (21F and 20M ± 1.4 yo; 68.5 ± 13.4 kg; 1.7 ± 0.17 m) performed the ODS with 37 demonstrating dysfunction. All subjects completed an informed consent and injury history questionnaire for this IRB approved study. Participants performed six trials of the ODS; 3 standard and 3 modified with 2x6 blocks elevating their heels. All participants were recorded using cameras capturing the frontal and sagittal plane of motion. Four criteria were used for scoring; 1. Torso was parallel to tibia or toward vertical, 2. Femur below horizontal, 3. Knees aligned over feet, 4. Dowel does not extend past feet. ODS dysfunctions were seen independently or in combinations of two or more. **RESULTS:** Thirty-seven participants demonstrated dysfunction on the ODS. There was no statistical difference in dysfunction frequency between males and females. The most common dysfunction was the combination of the torso/tibia alignment, the femur not reaching horizontal, and the bar moving beyond the toes. **DISCUSSION:** The results demonstrate that ODS dysfunctions tend to occur in combinations rather than individually. There appears to be a relationship between an individual's inability to maintain an upright torso while fully descending into a squat. The observed bar displacement may be a function of the forward torso lean. Future research should explore the biomechanical limitations that lead to this combination of dysfunctions. Additionally, investigations into the association between the most frequently observed ODS dysfunctions and injury risk should be carried out to validate the use of the ODS in movement screening.

What is the Functional Movement Screen (FMS)?

- The FMS is a battery of 7 fundamental movement patterns used to assess mobility and stability of the kinetic chain in healthy & active populations.¹
- The FMS helps to expose noticeable weaknesses, asymmetries, or imbalances within the kinetic chain.²

What is the Overhead Deep Squat (ODS)?

- The ODS is a complex, total body functional movement pattern that requires mobility of the ankle, knee, and hip as well as the shoulder and thoracic spine and assesses core stability.⁴
- Successful completion of the ODS requires the subject to meet four specific requirements while performing the functional movement pattern.

PARTICIPANTS

- 41 Physically active subjects participated in this IRB approved study
- All subjects completed informed consent and detailed injury history questionnaire
- 21 Females, 20 Males [21 ± 1.4 years old]
 - 68.5 ± 13.4 kg ; 1.7 ± 0.17 m
- All subjects were free of musculoskeletal injury that could be made worse by performing the ODS

METHODS

- Data was collected as part of a larger study examining performance of the ODS
- Feet were spaced evenly at a measurement equal to width between the subjects acromion processes
- Subjects were read scripted instructions and performed 6 trials of the ODS; 3 with their heels flat and 3 with their heels elevated on a 2x6 board.
- Frontal and sagittal plane video was captured using Microsoft Lifecam Cameras.
- The ODS was scored using standard FMS scoring criteria (Figures 1-4)
- A Chi Square statistic was calculated to determine if there was a significant difference in observed ODS dysfunctions between males and females. All statistics were calculated in SPSS v.24.

FMS Scoring Criteria

- Torso parallel to tibia parallel or toward vertical
- Femur below horizontal
- Knees aligned over feet
- Dowel does not extend past feet

Figure 1: FMS Scoring Criteria

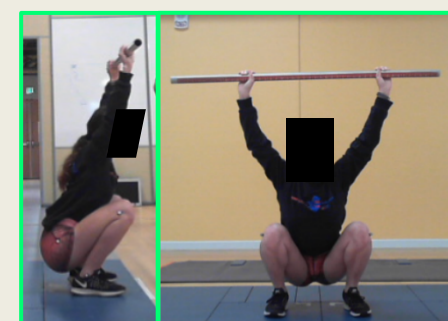


Figure 2 : FMS Score of a 3. Met All criteria

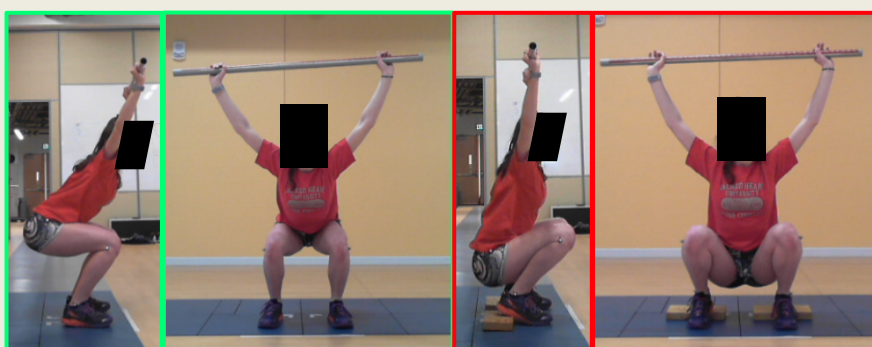


Figure 3: FMS Score of a 2 (with and without 2x6 blocks)

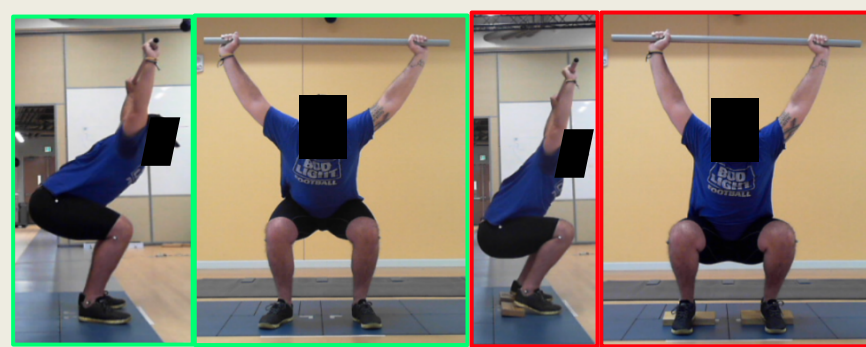


Figure 4: FMS Score of a 1 (with and without 2x6 blocks)

RESULTS

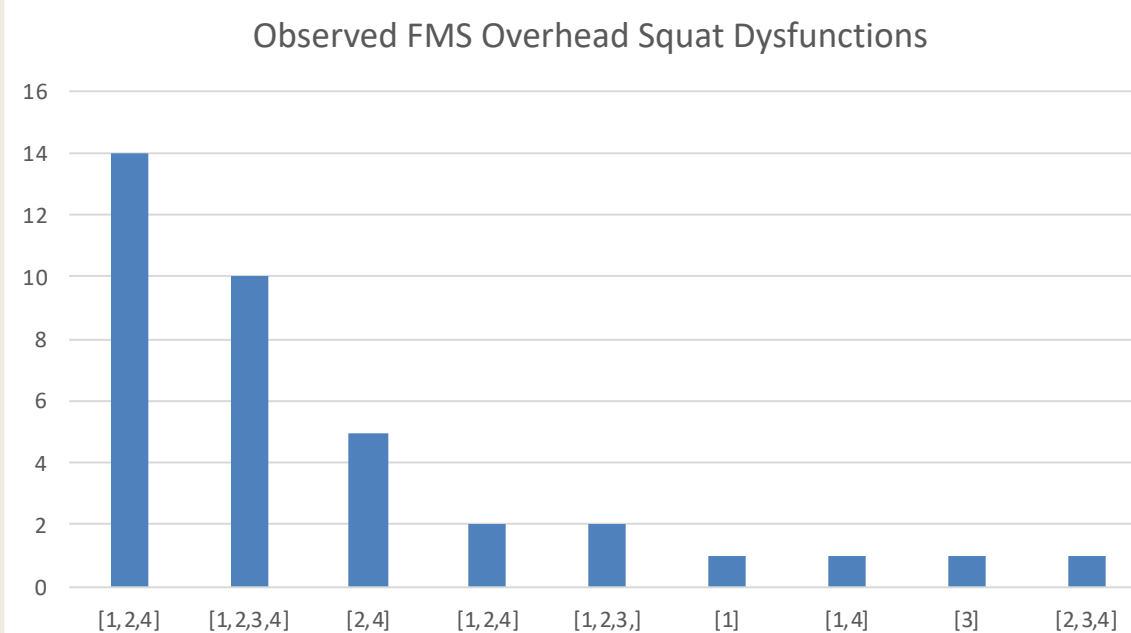


Figure 5: Frequency of Common Overhead Deep Squat Dysfunctions.

- No association between gender and observed dysfunctions ($\chi^2 = 6.122$, $df = 8$, $P = .634$)
- Combination of torso/tibia angle, femur angle, and dowel traveling past toes is most frequently observed dysfunction (Figure 5)
- Only 2 subjects present with a singular dysfunction

Key

- Torso parallel to tibia or toward vertical
- Femur below horizontal
- Knees aligned over feet
- Dowel does not extend past feet

DISCUSSION

- Dysfunctions in the ODS are more likely to occur in combinations rather than singularly which is consistent with the concept that dysfunction in one part of the kinetic chain will result in dysfunction in another area.
 - 35/37 subjects demonstrated a combination of dysfunctions as opposed to an individual dysfunction.
 - It is not clear what the cause is for the noted common combinations of dysfunction
- No association was noted between gender and observed dysfunction which differs from other studies that have identified differences between males and females during squat movement patterns.
- Limited dorsiflexion has been shown to be associated with medial knee displacement during the ODS and may also present an increased risk of musculoskeletal injuries.⁵
 - It is unclear which limitations in the kinetic chain result in the dysfunctions that were most commonly identified in this study.
 - Thus mobility/stability limitations at the ankle could inhibit performance of the proximal joints.³
- The ODS requires multiple joints to work in conjunction and the combination dysfunctions occurred from limitations in certain joints that gave rise to other joints compensation.

Conclusion

Individuals are more likely to show ODS dysfunctions in combinations rather than individually and based on the current results, there is no association between gender and observed dysfunctions. It is unknown which biomechanical limitations lead to these dysfunctions. Therefore, future work should explore the biomechanical limitations that led to these common combinations of dysfunction.

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