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Relationship Between Functional Movement Screening Scores and Climbing Performance while Rock Climbing Indoors

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Abstract

Purpose: This study sought to determine if Functional Movement Screening (FMS) scores correlated with time to completion and perceived exertion when climbing an indoor rock wall.
Methods: Twenty college-aged individuals volunteered to participated in this study. Each participant was scored through a FMS test and completed a route on an indoor rock climbing wall. Each subject was timed and asked their Rate of Perceived Exertion (RPE) once they successfully completed the climb. One subject did not successfully complete the climbing portion of the study and therefore was not used for data analyses. A Spearman Correlation Coefficient analysis was used to compare the relationship between FMS scores and climbing variables.
Results: A Spearman Correlation Coefficient analysis revealed a moderate direct relationship between rating of perceived exertion and the time it took the participant to climb the wall ($r = 0.58$, $p = 0.009$). Also, a moderate negative relationship between the time to completion of the rock wall climb and the active straight leg raise test was revealed, as well as time to completion and the trunk stability test ($r = -0.60$, $p = 0.007$).
Conclusion: The main take away of this study is that FMS testing could serve as a forecasting measure for rock climbing performance and as a testing measurement to assist individuals in improving their performance and recording their progress. The active straight leg raise, and trunk stability scores could be used as indicators of an individual's rock climbing ability. In addition, rock climbing may be an ideal exercise for college-aged individuals to participate in.

Keywords: Functional Movement Screening, Rock Climbing, Rate of Perceived Exertion

1. Introduction

Rock climbing is a non-traditional form of exercise that has recently gained popularity in the past few decades. Indoor rock-climbing walls are becoming more easily accessible in gyms, contributing to its recent gain in popularity. Rock climbing is an activity that requires endurance, agility, balance, and mental determination; however, it can cater to a wide range of fitness levels. A previous study reporting on the activity level of college students indicate that anywhere from 30% to 50% of students do not participate in sufficient amounts of physical activity. A common reason for lack of physical activity reported in this study is a low perceived enjoyment of physical activity (Keating et al., 2005). Since indoor rock climbing has become a more prevalent and available activity for college students, it could be an enjoyable way for college students to become more active. A benefit to indoor rock climbing is access to a trained staff that can guide an individual on how to properly climb the wall, as well as options in climbing routes that allow climbers to work at different levels of difficulty. Rock climbing is a whole-body exercise targeting the abdominals, arms, legs, back, and glutes, while remaining a relatively low impact exercise. Results of a study done on the energy system contributions during indoor rock climbing found that the main energy systems utilized during rock climbing are the aerobic and anaerobic alactic systems (Bertuzzi, Franchini, Kokubun & Kiss 2007). This indicates that indoor rock climbing is an all-encompassing workout, utilizing both anaerobic and aerobic systems, but can still cater to

beginners. Thus, indoor rock climbing is an ideal activity to potentially help college students become more enthusiastic about exercising.

A recent study on college students found that around 40% of students expressed having mild to extremely severe symptoms of depression, and one of the main factors contributing to these depressive symptoms was physical inactiveness (Schofield, O'Halloran, McLean, Forrester-Knauss, & Paxton, 2016). A survey examining US college students found that 27% of students felt that they were so depressed that they felt like they couldn't function and 40% of students reported having an overwhelming amount of anxiety at a given time (Chow, Fua, Huang, Bonelli, Xiong, & Barnes, 2017). Studies have shown that rock climbing as a form of exercise can help improve these psychological symptoms. One study found that those with higher depression scores made more of an improvement with decreasing their depression after the three-month rock climbing/bouldering training sessions (Luttenberger, Stelzer, Forst, Schopper, Hornhubber, & Books, 2015). Therefore, rock climbing or bouldering could be an effective treatment for depression (Luttenberger et al., 2015). Another study found that state anxiety, which is a temporary response of anxiety in the presence of a threat or danger, decreased in a fitness training group as well as a rock climbing group after their last training session (Gallotta, Emerenziani, Monteiro, Iasevoli, Iazzoni, & Guidetti, 2015). As previously mentioned in the last study, although fitness training has been shown to help lower state anxiety, rock climbing training could provide a more enjoyable way to achieve this same goal. Ultimately, rock climbing could provide a way for college students to lower their psychological symptoms of depression and anxiety.

Recent research shows that increased heart rate, increased oxygen consumption, and muscular adaptations from rock climbing all contribute to an increase in heart rate variability in long-term climbers (Gomez et al., 2017). The study suggests that long term climbing can produce cardiac benefits so when compared to a sedentary group, long-term climbers had better "heart health". It has also been found that when comparing beginner and advanced climbers, there is significant variation in heart rate and rating of perceived exertion (RPE) prior to, during, and after a bout of indoor rock climbing (Janot, Steffen, Porcari, & Maher, 2000). This would suggest that skill, technique, and experience would have a significant influence on the physiological responses that the climbers experience. Therefore, one would expect a climber with little experience could expect to have a higher rate of perceived exertion and an increase in their mean heart rate during a climb session. When comparing rock climbing to a traditional exercise activity, like walking, research has found that rock climbing mimics similar physiological responses (Mermier, Robergs, McMinn, & Heyward, 1997). This would indicate that rock climbing is in fact an activity that could be used to increase cardiorespiratory fitness and muscular endurance. This activity is a rare form of exercise and since it has shown to have similar effects of activities, like brisk walking, it would be a reliable substitute that could potentially be more enjoyable for an individual. This enjoyment would also likely help to increase the likelihood of adhering to a workout prescription. Due to the research that found that college-aged students do not participate in appropriate amounts of physical activity, it could be assumed that, this non-typical, exciting form of exercise could inspire these students to exercise more frequently.

In a study examining the characteristics of elite climbers, the results indicated that elite rock climbers generally have the characteristics of great shoulder girdle endurance, finger strength, and hip flexibility (Grant, Hynes, Whittaker, & Aitchison, 1996). Another study indicated that flexibility is a key component of rock climbing when combined with sport-specific testing (Draper, Brent, Hodgson, & Blackwell, 2009). However, this study indicated that a lack of sport specific testing for rock climbing is an obstacle to testing climbing subjects. Since rock climbing requires a high level of mobility and technical skill, functional movement screening (FMS) could be used as a key tool in assessing asymmetries and weakness in movement patterns. As mentioned in Grant et al. (1996), shoulder girdle endurance and hip flexibility are important characteristics for rock climbers. FMS includes tests that not only assess these attributes, but also whole-body movement imbalances. FMS testing may allow participants to begin improving their movement patterns to become more adept rock climbers, thus encouraging individuals to pursue rock climbing as a regular form of physical activity.

The lack of sport specific testing for rock climbing needs further investigation and since no previous research has been conducted on the use of FMS screening as a test for rock climbing ability, this study seeks to investigate the association of FMS scores and a rock climber's performance. Previous studies report that flexibility and mobility are important characteristics of rock climbers. The hip and the shoulders have also been suggested to be the most important joints for rock climbers in which to have a good range of motion, which further indicates that FMS screening would be an appropriate test for rock climbers. This study sought to determine if FMS screening scores correlated with time to completion and perceived exertion when climbing an indoor rock wall. Based on evidence from the previous literature on rock climbing, we predicted that a strong relationship will exist between scores on the FMS screening and the climbing variables of time to completion and perceived exertion when climbing an indoor rock wall.

2. Methods

2.1 Participants:

The purpose of this study was to determine if participants' FMS scores related to RPE scores and time to completion of the climb after completing a rock climbing course. Participants, ages 19-25 years, were recruited from a Southeastern college campus. These participants were recruited via advertisements that were posted in approved locations around the campus and on various Facebook pages. If interested in volunteering, the volunteers contacted the investigators.

2.2 Data Collection:

Individuals interested in this study contacted the investigators based on the information provided on the advertisement. The interested participants were then emailed a copy of the *Physical Activity Readiness Questionnaire (PARQ+)* and a copy of the informed consent form; a hard copy of each of these was provided on the first day of data collection if the participant qualified for the study (Warbuton, Bredin, Gledhill, 2011). The applicants were asked to read over the informed consent document and complete the PARQ+ form. The PARQ+ was emailed back to the investigators prior to participating in the testing portion of the study. Upon completion of the PARQ+, the investigators examined the document for any major signs/symptoms/conditions that would not allow the individual to safely participate in this research study. If the participant answered "yes" to any of the initial seven PAR-Q+ questions, the participant was deemed ineligible to participate in the study. All experience levels of rock climbing were eligible to participate, and no previous climbing experience was screened for.

If the individual proved to be an eligible participant, the investigators contacted the participant to schedule a time for the participant to meet with the investigators in the testing lab and another day to meet at the indoor climbing wall facility. Individuals were asked to arrive at the testing location at the agreed upon time wearing loose, comfortable clothing and athletic footwear.

Once the participants arrived in proper clothing and footwear, the individuals were asked if they had any further questions or concerns in respect to the study and their role in the study. The investigators addressed any concerns and provided any further information on the study that was requested by the participant. Once the participant had all their questions and concerns addressed, they were given an informed consent document to sign. The investigator read through the form with the participant to ensure that they understood each component of the form. After the informed consent form was signed, the investigators assigned an identification code for the participant to ensure the participant's confidentiality on all data collection documents. Participants were then asked to complete a survey based on their knowledge and prior participation in the activity of rock climbing.

The participants were then asked to perform a series of standardized dynamic stretches as a warm-up for the FMS test. The participants were then introduced to the FMS board and the scoring sheets for the test. The participant was verbally explained the test, as to acquaint the individual with the guidelines and basic ideas of the test. Next, each subject was shown the movements that they would be asked to perform. The investigator performed a demonstration of the movement and then the participant was asked to perform the movement. For each of the seven FMS tests, the investigator assigned a score (0-3) to the participant and recorded it in the FMS scoring sheet. The participant was allowed three attempts to receive a three on the movement unless they scored a three on the first try. If the participant got multiple attempts, the investigator took the highest as the final score of the participant. After completion of all tests, the participant was dismissed and reminded of their second data collection day appointment.

On a separate, specified day, the participant met with the investigators once again. This day was 3-5 days after the FMS testing day and the participant was asked to meet the investigators at the indoor climbing wall facility. The participant was asked to wear athletic clothing and footwear on this day and was not allowed to participate without the proper attire. The participant was then asked to sign a waiver that all participants were required to complete prior to climbing on the wall, as enforced by the climbing facility. The individual was then taken through a safety briefing with the trained, professional climbing wall staff. This included the proper fit of equipment (shoes and harness), commands, and the process of the climb. Trained staff then fitted the participant into a harness and proper shoes. The climbing commands were reviewed by the belayer to the participant. The participants were shown the rate of perceived exertion (RPE) scale prior to scaling the wall to familiarize the participants with the scale and afford them the opportunity to ask any questions they might have (Borg, 1998). The participant was then instructed to place both hands on the wall and to keep two feet on the floor. The participant was then instructed to climb the wall as fast as safely

possible. The participant was also informed that the speed of the ascent depended on the belayer so if the belayer asked to slow down, the individual was to follow these directions.

The investigators instructed the participant to begin by saying "GO" and then started the stopwatch. Once the participant reached the top or got as far as they were willing to go, the researcher stopped the clock and the participant was asked to report what their RPE score was in that moment. The researchers recorded all measurements and the belayer let the climber down and released the individual from the equipment. The participants were then asked to fill out a questionnaire ranking the enjoyment of from the rock climbing experience (Mullen et al., 2011). The enjoyment scale is scored using a seven-point rating scale and the eleven items are reverse scored. The higher the Physical Activity Enjoyment Scale (PACES) score, the greater the level of enjoyment. The participant returned their safety equipment (harnesses and shoes) to the facility and was released for the day and the study.

2.3 Statistical Analysis:

Descriptive statistics (M±SD) were obtained for all dependent variables. A Spearman Correlation Coefficient analysis was used to compare the relationship between FMS scores and climbing variables (participants' time to completion and RPE scores). Statistical significance was set at $p \leq 0.05$, and all analyses were carried out using the Statistical Package for the Social Sciences version 22.0.

3. Results

A total of 20 Georgia College & State University students volunteered to participate in this study (n=20). Of these subjects, 65% were female (n=13) and 35% were male (n=7). Participants ranged in age from 19-23 years. The average (± SD) age in years of the participants was 21.1 ± 1.0. There were no adverse events during the testing portion of this study nor were there any individuals that were denied participation due to the predetermined testing eligibility criteria. However, one subject did not successfully complete the climbing portion of the study and therefore was not used for data analyses, thus the final sample size used in data analysis was 19.

The average time (in seconds) it took participants to climb the rock wall was 45.91 ± 19.43. A Spearman Correlation Coefficient analysis revealed a moderate direct relationship between RPE and the time it took the participant to climb the wall ($r = 0.58$, $p = 0.009$). See Figure 1 for a visual depiction of the results between time to climb the rock wall and RPE. No significant relationship was found between RPE and the FMS test. However, a Spearman Correlation Coefficient analysis revealed moderate negative relationship between the time to completion of the rock wall climb and the active straight leg raise test ($r = -0.60$, $p = 0.007$), as well as time to completion and the trunk stability test ($r = -0.60$, $p = 0.007$). See Figure 2 and Figure 3 for reports on the active straight leg raise and trunk stability scores in relation to time to climb a rock wall.

The participants were asked to score their enjoyment of rock climbing following the rock climb portion of the study. The measurement used was the Physical Activity Enjoyment Scale. The average (± SD) score reported by the participant was 110 ± 12. The highest score possible was a 126.

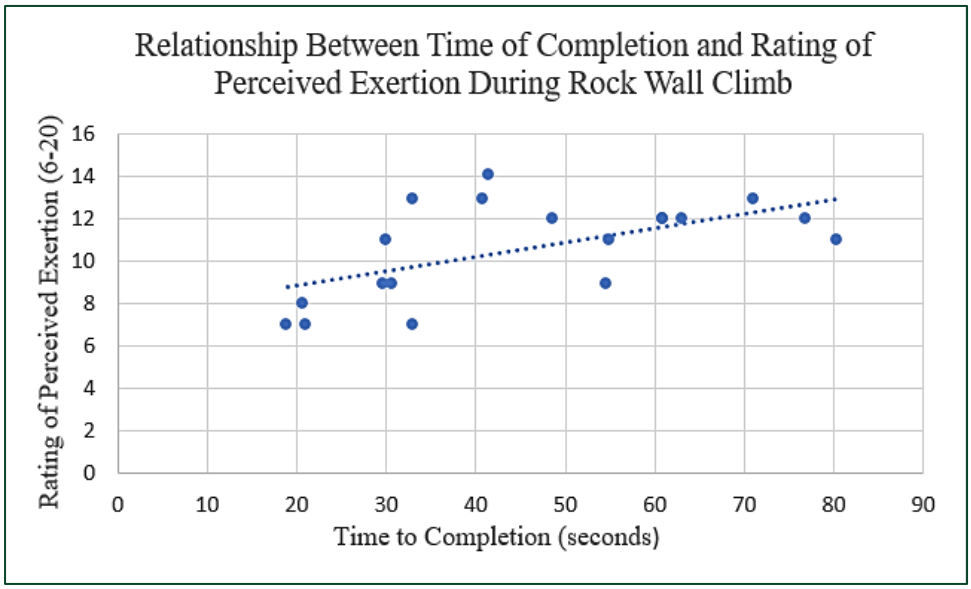

Figure 1: Relationship Between Time of Completion and Rating of Perceived Exertion During Rock Wall Climb (N=19)

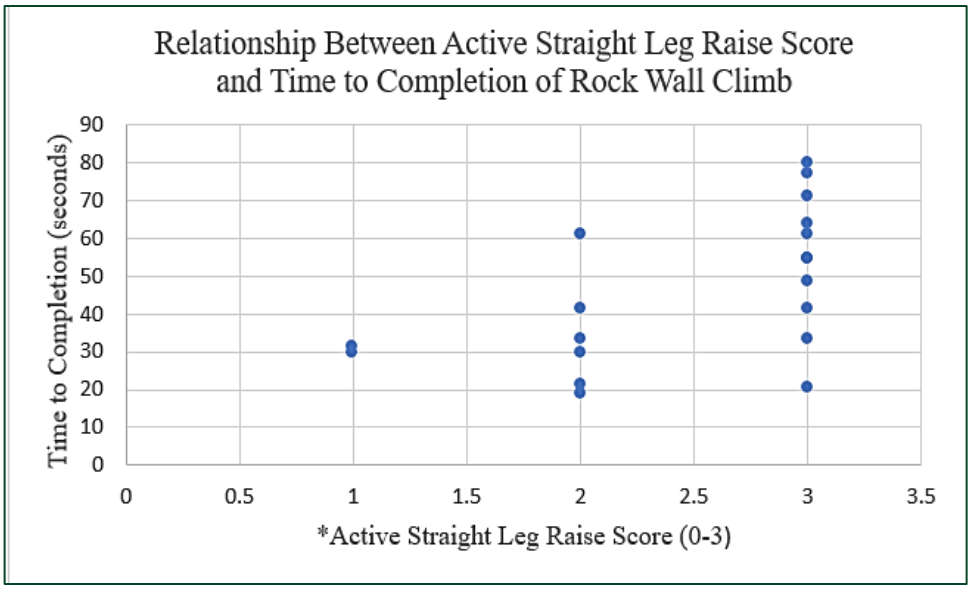

Figure 2: Relationship Between Active Straight Leg Raise Score and Time to Completion of Rock Wall Climb (N=19)

Figure 2. A score of "0" indicates that the participant felt pain during the test at some point. A score of "1" indicates that the vertical line of the malleolus was below the joint line. A score of "2" indicates that the vertical line of the malleolus was between the mid-thigh and joint line. A score of "3" indicates that the vertical line of the malleolus was between the mid-thigh and the anterior superior iliac spine.

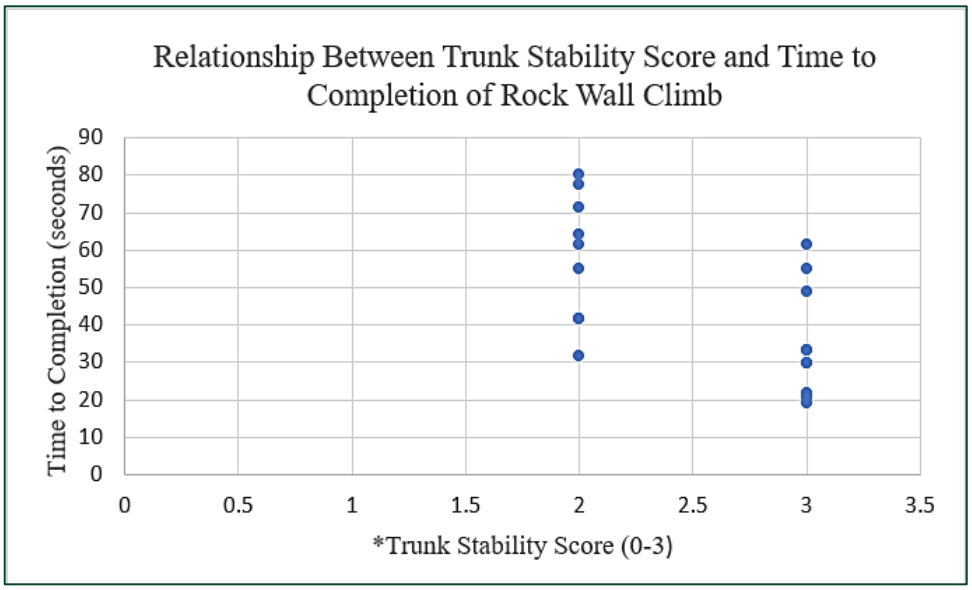

Figure 3: Relationship Between Trunk Stability Score and Time to Completion of Rock Wall Climb (N=19)

Figure 3. A score of "0" indicates that the participant felt pain during the test at some point. A score of "1" indicates that men cannot perform a repetition with hands aligned with the chin and women cannot perform a repetition with thumbs aligned with the clavicle. A score of "2" indicates that the entire body lifts as one unit with thumbs aligned with the chin for men and thumbs aligned with the clavicle for women. A score of "3" indicates that the body lifts as one unit with men performing a repetition with their thumbs aligned with their forehead and women performing a repetition with their thumbs aligned with their chin.

Table 1: Complete Results of FMS Test Scores (N=19)

COMPLETE RESULTS OF FMS TEST SCORES

	Total FMS Score	Deep Squat Score	Hurdle Step Score	Inline Lunge Score	Shoulder Mobility Score	Active Straight Leg Raise Score	Trunk Stability Score	Rotary Stability Score
MEAN	16.1	2.10	2.25	2.50	2.25	2.50	2.50	2.00
STANDARD DEVIATION	1.50	0.31	0.44	0.51	0.64	0.69	0.51	0.00

4. Discussion

The purpose of this study was to determine if a relationship exists between functional movement screening scores and the climbing variables of time to completion and perceived exertion of a rock wall climb. It was hypothesized that a strong relationship would exist between scores on the FMS screening and the climbing variables of time to completion and perceived exertion when climbing an indoor rock wall. Data collection and analysis revealed that no significant relationship was found when comparing FMS scores to RPE scores, however, a significant relationship was found between the time to completion of a rock wall and the active straight leg raise and trunk stability portions of the FMS test. Thus, it was concluded that the active straight leg raise, and trunk stability tests may be associated with rock climbing ability.

Our results indicated that the active straight leg raise, and trunk stability scores are correlated to the time it took participants to climb a rock wall. This is supported by previous research that indicated that hip flexibility was an important characteristic of elite rock climbers (Grant, Hynes, Whittaker, & Aitchison, 1996), as well as another study that suggested that flexibility was a key determinant of rock climbing performance (Draper, Brent, Hodgson, &

Blackwell, 2009). FMS testing may be a good sports-specific test for rock climbing, but the study would need to be reproduced on a larger scale to support our findings.

Our results found no significant relationship between FMS tests and RPE, which indicates that RPE may not be the best measurement to indicate rock climbing ability. One limitation that can be noted from this study is that many of the students that participated this study were exercise science or health science majors so the lack of relationship between RPE and FMS scores could be due to the fact that many of the exercise science majors had been exposed to the RPE scale before the study. These students may have already had knowledge of a reasonable RPE score to report prior to completing the rock wall whereas individuals without prior experience would have to base their results solely on the numbers presented on the scale. Comparatively, the same situation could have occurred with participants that were familiar with FMS testing. Since they had prior knowledge of what movements would produce the highest scores this could have allowed these participants to achieve a higher FMS score when compared to the other participants who did not have this knowledge. In future studies, it would be beneficial for researchers to diversify the participants by including students with several different majors. Time to completion may be a more accurate way to assess rock climbing ability, since it is an objective measurement, whereas RPE is subjectively reported by the participant. Another limitation of this study is that this sample size was relatively small. Increasing the number of participants would have greatly increased the reliability and possibly yielded more significant results to report. Also, most of the individuals participating in the study were already fairly fit, which represents a small population of college students. It may be more beneficial for future studies to diversify the participants by also including college-aged participants that do not partake in regular exercise. These factors should all be considered as limitations for the revealing the most accurate and best results from the study.

The Physical Activity Enjoyment Scale (PACES) scores were used as an indicator of how much the participant enjoyed rock climbing, as well as how likely they were to do it again. Since the average (± SD) score reported by the participant was 110.47 ± 12.46 out of 126, it can be concluded that overall the participants enjoyed their rock climbing experience. This is important because it suggests that rock climbing could be an enjoyable form of physical activity for college aged individuals. As previously mentioned, past research studies have shown that rock climbing as a form of exercise can help improve symptoms of depression and anxiety (Luttenberger, Stelzer, Först, Schopper, Hornhubber, & Books, 2015). The PACES scores from this study provides evidence that rock climbing may be an activity college students find pleasurable and therefore, would provide both a way to decrease symptoms of depression and anxiety among college students and increase their physical activity levels. This portion of the study would be useful information for universities that are considering making improvements to the campus. The addition of a rock wall may very well increase the success of some of their students.

The main take away of this study is that FMS testing could serve as a forecasting measure for rock climbing performance and as a testing measurement to assist individuals in improving their performance and recording their progress. More specifically, the active straight leg raise, and trunk stability scores could be used as indicators of an individual's rock climbing ability. In addition, rock climbing may be an ideal exercises in which college-aged individuals can participate in. These findings suggest that future research into FMS testing as a sports-specific tests for rock climbers may hold great potential, as well as the suggestion that rock climbing may be suitable a way to get college-aged individuals participating in physical activity.

5. Sources

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