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# LOAD-ENHANCED MOVEMENT QUALITY SCREENING AND TACTICAL ATHLETICISM: AN EXTENSION OF EVIDENCE

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## ABSTRACT

***Background:*** Military organizations use movement quality screening for prediction of injury risk and performance potential. Currently, evidence of an association between movement quality and performance is limited. Recent work has demonstrated that external loading strengthens the relationship between movement screens and performance outcomes. Such loading may therefore steer us toward robust implementations of movement quality screens while maintaining their appeal as cost effective, field-expedient tools.

***Purpose:*** The purpose of the current study was to quantify the effect of external load-bearing on the relationship between clinically rated movement quality and tactical performance outcomes while addressing the noted limitations.

***Study Design:*** Crossover Trial.

***Methods:*** Fifty young adults (25 male, 25 female, 22.98 ± 3.09 years, 171.95 ± 11.46 cm, 71.77 ± 14.03 kg) completed the Functional Movement Screen™ with (FMS™W) and without (FMS™C) a weight vest in randomized order. Following FMS™ testing, criterion measures of tactical performance were administered, including agility T-Tests, sprints, a 400-meter run, the Mobility for Battle (MOB) course, and a simulated casualty rescue. For each performance outcome, regression models were selected via group lasso with smoothed FMS™ item scores as candidate predictor variables.

***Results:*** For all outcomes, proportion of variance accounted for was greater in FMS™W ($R^2 = 0.22$ [T-Test], 0.29 [Sprint], 0.17 [400 meter], 0.29 [MOB], and 0.11 [casualty rescue]) than in FMS™C ($R^2 = 0.00$ [T-Test], 0.11 [Sprint], 0.00 [400 meter], 0.19 [MOB], and 0.00 [casualty rescue]). From the FMS™W condition, beneficial performance effects ($p < 0.05$) were observed for Deep Squat (sprint, casualty rescue), Hurdle Step (T-Agility, 400 meter run), Inline Lunge (sprint, MOB), and Trunk Stability Push Up (all models). Similar effects for FMS™C item scores were limited to Trunk Stability Push Up ($p < 0.05$, all models).

***Conclusions:*** The present study extends evidence supporting the validity of load-enhanced movement quality screening as a predictor of tactical performance ability. Future designs should seek to identify mechanisms explaining this effect.

***Level of Evidence:*** 3

***Key Words:*** Movement quality, tactical athlete, talent identification, screening

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## INTRODUCTION

Recent recruiting cycles have been remarkably successful for the U.S. military.[1,2] Accession goals with respect to quantity and quality were exceeded, in many cases by substantial measure. Such a favorable recruiting environment largely eliminated the need for consideration of pre-accession performance screening systems.[3] However, the same reports that extol the recruiting successes of recent years also express concern about potential future challenges.[1,2] Owing to a combination of defense budget cuts and economic alternatives for the recruitment population, it will likely be more difficult for the military to meet its accession goals over the next decade. This prospect of future austerity has accordingly renewed focus on the discussion of minimizing preventable attrition due to substandard fitness or injury. Because multi-faceted performance batteries can be cumbersome, consideration is warranted for efficient clinical tools that can identify at-risk military candidates in pre-accession settings.

One solution that may hold promise as a cost effective and field-expedient option for preventing performance-related personnel loss is movement quality screening. The use of such screens has increased substantially in recent years.[4-7] In addition to classifying individuals by injury risk, movement screens have also been applied as a method of predicting performance in tactical athletes[8,9] and other populations.[10-12] In this endeavor, most research has failed to show a relationship between clinically rated movement scores and performance outcomes[9-13]—a lack of association which likely stems from two sources. First, relatively undemanding movement tests may not present a challenge sufficient to highlight deficiencies relevant to athletic performance. Accordingly, it has been suggested that adjusting screening practices to increase specificity or difficulty may increase the likelihood of detecting deficiencies clinically.[9,13,14]

The second limitation of movement screening as a correlate of physical performance relates to current methods for scoring and analyzing data. Item scores are most commonly rated on an ordinal scale and summed into a total. While a composite representation of test performance has its appeal, this practice is appropriate only if the construct underlying the total score is unidimensional. In the case of clinical movement screens, a growing body of evidence would suggest this is not the case.[15-17] More detailed information can be found in the item scores themselves, although certain considerations must be addressed concerning their analysis. In addition to a rank order structure which is difficult to accommodate in linear or logistic regression,[18] direct analysis of component score data in existing clinical movement screens would substantially increase the dimensionality of a prediction model.

A recent investigation in young, recreationally active non-service members demonstrated that Functional Movement Screen™ (FMS™) tests under load show increased predictive validity with respect to criterion performance measures specific to the tactical athlete.[14] In the same context, that study also demonstrated the utility of regularization techniques designed to accommodate high-dimensional regression problems with ordered predictors. The intention in combining these two modifications in approach was to help bring the sports medicine community closer to a field-expedient, feasible means of conducting pre-accession screening for performance deficits.

While the above-mentioned study showed promising results, certain factors limit the generalizability of their findings. First, it was conducted using a relatively small sample size (n = 19). Second, this sample did not contain an even balance of men and women. The purpose of the current study was to quantify the effect of external load-bearing on the relationship between clinically rated movement quality and tactical performance outcomes while addressing the noted limitations.

## METHODS

Data were collected in a laboratory setting by a single investigator experienced in the required measurement techniques. Participation was limited to individuals between 18-34 years of age in order to reflect the recruitment pool for military and tactical occupations. Subjects were additionally required to be free from recent (< six months) injury and to accumulate a minimum of 90 minutes/week of physical activity. All subjects provided written consent to participate and completed a physical activity readiness questionnaire (PAR-Q) before data collection.

## Procedures

This study was approved by the Institutional Review Board at The University of North Carolina at Greensboro. A total of fifty recreationally active adults participated in the study (25 female: 22.00 ± 2.02 years, 165.40 ± 10.24 cm, 63.98 ± 11.07 kg; 25 male: 23.96 ± 3.74 years 178.82 ± 7.51 cm, 79.66 ± 12.66 kg). Subjects reported to the laboratory for a single data collection session. Following consent and completion of the PAR-Q, the Functional Movement Screen™ was administered under two conditions (wearing a weight vest: $FMS_W$, and not wearing a weight vest: $FMS_C$) in randomized order. Finally, participants completed a battery of physical performance tests.

## Functional Movement Screen™

Following a familiarization round, the FMS™ [19,20] was administered both with and without an 18.10 kg weight vest (MiR Vest Inc., San Jose, CA). This is comparable to loads used in previous investigations on the topic of tactical athleticism,[21,22] as well as those used in clinical screens designed to predict physical performance.[6] Testing conditions were administered back-to-back in randomized order by an investigator proficient in the use of FMS™ testing. Scores for component tests were assigned based on a 1-3 scale according to the criteria outlined in the FMS™ protocol.[19,20]

## Physical Performance Tests

Following completion of the FMS™ in both testing conditions, participants performed a 10-minute cycle ergometer warm up during which they were instructed to target an RPE of 13 ("Somewhat Hard"). They then began a series of five performance tests comprising assessments from previous tactical performance work.[22,23] Instructions were to complete each individual test as quickly as possible. Physical performance tests were administered in the following order for all subjects: 1) T-Agility test, 2) 27.43 meter sprints, 3) 400 meter run, 4) Mobility for Battle (MOB), and 5) simulated casualty rescue.

Completion time for both the Agility T-Test and sprints was recorded using an infrared timing gate (Brower Timing Systems, Draper, UT). Subjects began on the starting mark with one foot positioned on a start-on-release trigger. When directed, subjects performed the following sequence: forward sprint 9.14 m (10 yds), right side-shuffle 4.57 m (5 yds), left side-shuffle 9.14 m (10 yds), right side shuffle 4.57 m (5 yds), back peddle 9.14 m (10 yds). The timing gates were applied similarly in the 27.43 m sprints. For both the Agility T-Test and the 27.43 sprint, each effort was followed by approximately 60 seconds of rest regardless of whether performing another trial of the same test or proceeding to the next task.

Because of logistical restrictions, completion time for the remaining tests was recorded using a handheld stopwatch. Courses for the 400 m run and Mobility for Battle[23] (MOB) were mapped with cones in an indoor gymnasium. The 400 m run was administered as a series of 4.5 laps around the periphery of the gym space. The MOB, designed as a multifaceted test incorporating several soldier-relevant field maneuvers, was organized in stations according to the methods described in Crowder et al.[23] Participants were allotted up to five minutes of recovery time upon finishing each of the 400 m and MOB tests.

The final test was a simulated partner rescue, in which subjects were required to drag a 68.04 kg (150 lbs.) dummy across a distance of 45.72 m (50 yds). The dummy was fashioned from sandbags wrapped in carpet with a handle attached to one end. Completion time was recorded after the final bag crossed the finishing line.

## Statistics

Several researchers have noted the limitations of analyzing the FMS™ composite score.[14-16] The item scores themselves are likely the better source of information, although extra care must be taken to select appropriate prediction models from a multitude of candidate predictor variables. Further, more of the information contained in the item scores can be preserved by using methods that account for their ordinal structure. Each of these challenges can be addressed via penalization. Application of regression penalization algorithms is common in, for example, genome-wide association studies (GWAS),[24] in which the number of predictors often greatly exceeds the number of observations. The effect of penalization is to shrink large coefficients and thereby reduce bias toward data characteristics, which are unique to a given sample. Additional penalization can be applied to smooth the differences between successive levels of a predictor.[18] Thus, these techniques offer an attractive solution to the problems that arise when analyzing FMS™ item score data.

In the current analyses, a group lasso penalty was first applied to select an appropriate model. Differences between neighboring levels within the retained predictors were then smoothed using a second penalization algorithm. The same penalty parameter (Λ) was used in each step, identified as the value of Λ, which minimized cross-validation error in the group lasso. The final step after model selection and smoothing was to construct bootstrap 95% confidence intervals of the estimated coefficients using the bias-corrected and accelerated method. Each of these steps was completed using R v3.1.0 with ordPens 0.3-42[18] and grpreg 2.8[25] packages.

## RESULTS

Descriptive statistics regarding physical performance outcomes are presented in Table 1. Model summaries are presented in Table 2 while smoothed and unsmoothed coefficients, along with their respective bootstrap confidence intervals, are presented in Tables 3 (Agility T-Test, Sprint, and 400 meter outcomes) and 4 (MOB and Partner Rescue outcomes). A non-zero $R^2$ was observed in only three of the models corresponding to the unweighted condition. The first of these was the Sprint model, in which penalized FMS™ item scores accounted for 11% of the variance in time to completion. The second and third were the penalized and unpenalized MOB models which, respectively, accounted for 19% and 9% of the variance in time to completion. In contrast, non-zero $R^2$ values were observed in all models featuring scores from the weighted condition, with variance explained ranging from 11% - 29%.

In the unweighted condition, higher Trunk Stability Push Up scores were predictive of faster completion times for the Sprint and MOB tests. A similar influence was observed for the remaining three performance outcomes, though variation in scores was not

**Table 1.** *Descriptive Summary of Performance Outcomes.*

| Test | Time (s) |
|---|---|
| T-test | 12.81 ± 1.55 |
| Sprint | 3.98 ± 0.54 |
| 400m | 93.88 ± 16.60 |
| MOB | 145.74 ± 28.39 |
| RSQ | 23.17 ± 9.48 |

T-test = T-Agility test
Sprint = 27.43 meter sprint
400m = 400 meter run
MOB = Mobility for Battle assessment
RSQ = simulated casualty rescue

**Table 2.** *Summaries of Penalized and Unpenalized Model Solutions. FMS™C (unweighted) models are shown on the left and FMS™W (weighted) models are shown on the right. Each is presented both with optimized penalization (top) and no penalization (bottom) in adjacent rows. The "Features" column indicates the number of predictors retained at the given level of penalization.*

| | Unweighted | | | | Weighted | | | |
|---|---|---|---|---|---|---|---|---|
| | Λ | CVE | $R^2$ | Features | Λ | CVE | $R^2$ | Features |
| Agility | 0.31 | 2.48 | 0.00 | 1 | 0.16 | 1.84 | 0.22 | 3 |
| | 0.00 | 3.14 | 0.00 | 7 | 0.00 | 2.22 | 0.05 | 7 |
| Sprint | 0.09 | 0.25 | 0.11 | 2 | 0.02 | 0.20 | 0.29 | 7 |
| | 0.00 | 0.29 | 0.00 | 7 | 0.00 | 0.21 | 0.27 | 7 |
| 400m | 4.12 | 285.68 | 0.00 | 1 | 1.01 | 223.15 | 0.17 | 6 |
| | 0.00 | 294.19 | 0.00 | 7 | 0.00 | 227.78 | 0.16 | 7 |
| MOB | 4.46 | 637.21 | 0.19 | 1 | 2.99 | 559.84 | 0.29 | 3 |
| | 0.00 | 720.13 | 0.09 | 7 | 0.00 | 606.77 | 0.23 | 7 |
| RSQ | 1.27 | 90.06 | 0.00 | 3 | 1.46 | 78.21 | 0.11 | 3 |
| | 0.00 | 93.32 | 0.00 | 7 | 0.00 | 95.79 | 0.00 | 7 |

Agility = T-Agility test, Sprint = 27.43 meter sprint, 400m = 400 meter run, MOB = Mobility for Battle assessment, RSQ = simulated casualty rescue, Λ = regression model penalty parameter, CVE = Cross-validation error

**Table 3.** *Coefficients and bootstrap (BCa method) 95% confidence intervals for retained predictors of time to completion of Agility, sprint, and 400 meter. Level indicates the FMS™ item score, for which the reference condition ("1") is not shown.*

| | | Agility | | Sprint | | 400m | |
|---|---|---|---|---|---|---|---|
| Test | Level | *Coef* | 95% CI | *Coef* | 95% CI | *Coef* | 95% CI |
| DS | 2 | -- | -- | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- | -- | -- |
| HS | 2 | -- | -- | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- | -- | -- |
| ILL | 2 | -- | -- | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- | -- | -- |
| SM | 2 | -- | -- | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- | -- | -- |
| ASLR | 2 | -- | -- | -0.01 | (-1.63, 0.53) | -- | -- |
| | 3 | -- | -- | 0.21 | (-0.26, 0.94) | -- | -- |
| TSPU | 2 | 0.41 | (-0.91, 4.27) | 0.00 | (-0.63, 1.10) | -1.21 | (-12.10, 8.57) |
| | 3 | -1.40 | (-1.97, -1.78)* | -0.64 | (-0.94, -0.94)* | -11.62 | (-30.41, -12.86)* |
| RS | -- | -- | -- | -- | -- | -- | -- |

Weighted Condition

| | | Agility | | Sprint | | 400m | |
|---|---|---|---|---|---|---|---|
| Test | Level | *Coef* | 95% CI | *Coef* | 95% CI | *Coef* | 95% CI |
| DS | 2 | -- | -- | -0.23 | (-1.12, -0.02)* | -1.95 | (-16.19, 7.51) |
| | 3 | -- | -- | -0.15 | (-0.95, 0.32) | -6.02 | (-28.49, 3.61) |
| HS | 2 | -1.13 | (-6.49, 0.00)* | -0.04 | (-2.54, 0.34) | -28.84 | (-50.70, -29.29)* |
| | 3 | -1.95 | (-5.96, -1.51)* | -0.35 | (-3.00, 0.08) | -37.03 | (-49.89, -42.12)* |
| ILL | 2 | -- | -- | -0.29 | (-2.53, 0.15) | -- | -- |
| | 3 | -- | -- | -0.43 | (-2.69, -0.02)* | -- | -- |
| SM | 2 | 0.43 | (-0.26, 1.96) | 0.25 | (0.03, 1.16)* | 6.74 | (1.75, 19.52)* |
| | 3 | -0.20 | (-2.90, 1.89) | 0.21 | (-0.28, 2.49) | 16.89 | (6.47, 51.08)* |
| ASLR | 2 | -- | -- | 0.12 | (-0.66, 1.12) | -- | -- |
| | 3 | -- | -- | 0.15 | (-0.63, 1.25) | -- | -- |
| TSPU | 2 | -1.62 | (-2.08, -2.06)* | -0.43 | (-0.95, -0.36)* | -12.67 | (-24.17, -13.18)* |
| | 3 | -1.57 | (-2.49, -1.79)* | -0.50 | (-1.51, -0.46)* | -11.19 | (-25.65, -7.67)* |
| RS | -- | -- | -- | -- | -- | -- | -- |

DS = Deep Squat, HS = Hurdle Step, IL = Inline Lunge, SM = Shoulder Mobility, ASLR = Active Straight Leg Raise, TSPU = Trunk Stability Push Up, RS = Rotary Stability

explained at the model level. Higher Trunk Stability Push Up scores from the weighted condition were predictive of faster completion times for all measures. Additionally in the weight vest condition, a Hurdle Step score of 3 was predictive of faster Agility T-Test times while a score of 2 or 3 was predictive of faster 400 meter run times. Higher weighted Inline Lunge scores were also associated with performance, with a score of 3 predicting faster Sprint times and a score of 2 or 3 predicting faster MOB times. Interestingly, a weighted Inline Lunge score of 3 was also predictive of slower time to completion on the partner rescue simulation. A similar inverse relationship was observed between 400 m times and scores of 2 or 3 in the weighted Shoulder Mobility test. Finally, a weighted Deep Squat score of 2 was predictive of faster sprint times while a score of 2 or 3 was predictive of faster partner rescue times.

## DISCUSSION

This study sought to quantify the effect of external load-bearing on the relationship between cost-efficient movement quality screens and tactical performance outcomes. The current findings support the conclusion that external load-bearing strengthens the relationship between movement quality and tactical athleticism. The vast majority of these results demonstrate that better movement quality on the weighted Trunk Stability Push-up, Hurdle Step, Inline Lunge, and Deep Squat tests is predictive of faster completion of the physical performance tests. Very few predictive relationships exist

**Table 4.** *Coefficients and bootstrap (BCa method) 95% confidence intervals for retained predictors of time to completion of MOB and Partner Rescue. Level indicates the FMS™ item score, for which the reference conditions ("1") is not shown.*

| | | MOB Obstacle | | RSQ | |
|---|---|---|---|---|---|
| Test | Level | *Coef* | 95% CI | *Coef* | 95% CI |
| DS | 2 | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- |
| HS | 2 | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- |
| ILL | 2 | -- | -- | 0.00 | (0.00, 0.00) |
| | 3 | -- | -- | 3.54 | (1.50, 9.01)* |
| SM | 2 | -- | -- | -1.36 | (-34.51, 6.22) |
| | 3 | -- | -- | 2.98 | (-7.19, 12.92) |
| ASLR | 2 | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- |
| TSPU | 2 | -6.30 | (-37.33, 3.88) | -1.39 | (-10.34, 6.52) |
| | 3 | -31.05 | (-52.60, -52.60)* | -6.01 | (-14.65, -4.63)* |
| RS | -- | -- | -- | -- | -- |

Weighted Condition

| | | MOB Obstacle | | RSQ | |
|---|---|---|---|---|---|
| Test | Level | *Coef* | 95% CI | *Coef* | 95% CI |
| DS | 2 | -- | -- | -4.40 | (-16.25, -2.37)* |
| | 3 | -- | -- | -4.57 | (-17.39, -1.03)* |
| HS | 2 | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- |
| ILL | 2 | -25.34 | (-78.57, -14.32)* | -- | -- |
| | 3 | -29.59 | (-80.03, -21.00)* | -- | -- |
| SM | 2 | -- | -- | -- | -- |
| | 3 | -- | -- | -- | -- |
| ASLR | 2 | -- | -- | -- | -- |
| | 3 | -- | -- | | |
| TSPU | 2 | -28.81 | (-28.88, -28.88)* | -9.39 | (-9.90, -9.90)* |
| | 3 | -30.54 | (-28.88, -28.88)* | -10.83 | (-11.54, -11.54)* |
| RS | -- | -- | -- | -- | -- |

MOB = Mobility for Battle assessment, RSQ = simulated casualty rescue, DS = Deep Squat, HS = Hurdle Step, IL = Inline Lunge, SM = Shoulder Mobility, ASLR = Active Straight Leg Raise, TSPU = Trunk Stability Push Up, RS = Rotary Stability

between unweighted movement quality and performance tasks. These observations parallel previously reported increases in the predictive validity of FMS item scores related to testing under a standardized external load.[14] The combination of the present findings with similar results derived from an unrelated sample establishes strong evidence in support of this effect. Before continuing the discussion of the present findings, it should be noted that the authors consider the correlation between movement quality and performance as a function of the common factors that underlie both outcomes. The factors in question are derived from physical fitness models found in the U.S. Army Physical Fitness School doctrine.[26] As will be detailed later, this conceptual framework may have implications for how movement quality assessments are applied.

In this protocol, the expected finding was that external loading during movement quality assessments would improve prediction of physical performance. While this improvement in prediction was observed, it is interesting to note that the test items driving that improvement were not necessarily the same as those observed previously. Among the items that overlap, weighted Trunk Stability Push Up predicted better performance in all outcomes, as did the unweighted Trunk Stability Push Up for the Sprint.

Also common to both datasets, weighted Hurdle Step predicted faster 400m run times. The previously published data[14] contains several unique effects in the weighted condition. These include relationships between the Deep Squat and 400m run, the Deep Squat and MOB, and the Hurdle Step and MOB. Two unique performance-inhibiting effects were also noted. Specifically, a 3 on the Inline Lunge or Shoulder Mobility tests predicted slower times in the Partner Rescue task.

Several unique effects were also observed in the current data set. These included the relationships between weighted Inline Lunge and sprint speed, weighted Inline Lunge and MOB times, and weighted Deep Squat and Partner Rescue times. Each of these positive effects might be explained by qualities like muscular strength and balance, which arguably become more critical to movement execution in the weighted condition. Additional beneficial effects specific to the present analysis were observed in the relationships between unweighted Trunk Stability Push Up and all outcomes other than sprint speed. Again, muscular strength is likely a factor, as this test requires a high degree of upper body strength even in the unweighted condition.

Apparently detrimental effects of movement quality in the current dataset included those between weighted Shoulder Mobility and sprint speed, weighted Shoulder Mobility and 400 m times, and unweighted Inline Lunge and Partner Rescue times. In those effects related to the weighted Shoulder Mobility test, it is possible that certain qualities that enable an individual to achieve a high score are beneficial only to a point. For example, an individual who is able to touch fists behind his/her back despite wearing a weight vest might be hypermobile to an extent that interferes with performance. Alternatively, this degree of mobility might reflect a lack of movement restriction associated with typical muscle development. The negative association between unweighted Inline Lunge scores and Partner Rescue times is more difficult to explain and may require further consideration. One possibility is that this reflects a tradeoff between muscular strength/power and coordination in performing this relatively novel movement. In any case, because the current results are based on a larger sample size that is split evenly between men and women, these findings may be more generalizable than previous work.

In many cases, the hypothesized relationship between clinically rated movement behaviors and physical performance has eluded investigators.[9-11,13] The difficulty in demonstrating this association may be rooted in the relatively low demand of most screening tools or improper analysis. Steps were taken in the present study to address these concerns. Specifically, we incorporated an external loading condition and modeled the effects of item scores on performance outcomes with well-suited statistical techniques. The current results suggest that the relationship between movement and performance can be observed under the proper conditions. These findings may have considerable implications for pre-accession screening strategies in a time during which the cost of performance failure has the potential to increase substantially. Specifically, an inexpensive and easily administered movement assessment could help prevent attrition and washback by complementing existing accession standards.

A natural follow-up question might seek to explain the mechanisms driving this relationship between movement patterns and performance outcomes. Different interpretations of the present findings could be taken to support vastly different approaches to training. Proponents of movement screening frequently consider movement behaviors themselves to be a kind of stand-alone functional criterion.[5,27] This understanding has recently inspired efforts to identify intervention protocols capable of improving screening scores.[28,29] An alternative interpretation proposed here would suggest that the utility of clinical screens in this context is that they allow us to see evidence of performance-relevant attributes using a convenient, field-expedient test. Understanding which attributes mediate the relationship between movement and performance may therefore be the more appropriate focus of training and is the subject of ongoing research in our laboratory.

Two limitations should be noted regarding this study. First, participants were recruited primarily from a civilian undergraduate population without regard to tactical occupational experience or aspirations. As such, it is possible that this sample failed to represent certain characteristics of individuals likely to pursue such careers. Second, as has been noted by other researchers,[30] an individual's behavior in response to standardized FMS™ instructions is not necessarily a reflection of his/her preferred technique. To the extent that the latter is a better indicator of movement quality, the FMS™ may be limited in its ability to capture this quantity.

## CONCLUSION

In conclusion, the results of this study support previously observed increases in the validity of clinically rated movement as a predictor of tactical athlete performance outcomes, specifically when movement quality is rated in conjunction with external loading. Clinicians and recruiters might consider screening for performance-relevant movement dysfunction using adjunct weight. Future research should focus on refining testing methods to increase feasibility and information gained, as well as identifying modifiable factors that best explain this relationship.

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