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The Functional Movement Screen as a Predictor of Police Recruit Occupational Task Performance

Running Title: The FMS as a Predictor of Police Task Performance

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Accepted

ABSTRACT

Aim: The aim of this study was to determine whether poor movement patterns impact on police recruit task performance. Methods: Fifty-three volunteers were randomly selected from a pool of 173 police recruits attending basic recruit training. Relationships between movement performance, as measured by the Functional Movement Screen, and four occupational tasks were investigated. Results: Eleven percent failed the marksmanship and baton strike assessments, 21% failed defensive tactics and 36% failed the tactical options assessment. Mean Functional Movement Screen score was 13.96 points (± 1.99 points). Only the tactical options assessment approached a significant difference ($p = 0.077$) between pass/fail recruits. When Functional Movement Screen scores when graded as pass (14+) or fail (<14) again only the tactical options assessment approached significance ($p = 0.057$). Conclusion: The results of this study suggest that a relationship between an officer's movement patterns and occupational performance, most notably choice of tactical options, may exist.

Key words:

FMS; recruit; marksmanship; tactical athlete; basic training

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INTRODUCTION

Occupational demands of tactical personnel, such as police officers, require the performance of daily duties that consist of dynamic tasks. These dynamic tasks can require movements like running, jumping, crawling, balancing, climbing, lifting, carrying, pushing, pulling, fighting and dragging, in unpredictable environments (such as rugged and hash terrains) often while the officer is wearing external loads (Blacker et al., 2013; Orr, 2007; Petersen & Smith, 2007). These external loads, which for a general police officer can equate to a weight of 10 kg and a specialist police officer over 20 kg (Blacker et al., 2013; Carlton, Orr, Stierli, & Carbone, 2013), can consist of items such as protective armour, personal weapons and communication devices (Dempsey, Handcock, & Rehrer, 2013).

Performing these dynamic occupational duties can affect a police officer in a number of ways through imposing significant physiological stress like causing elevations in heart rate, oxygen consumption and heat production (Blacker et al., 2013; Sharkey & Davis, 2008). The addition of external load further influences the impact of dynamic occupational task performance, from reducing their physiological function (Perry & Koehle, 2013), task performance capability (Larsen, Netto, & Aisbett, 2011) and ability to tolerate heat (Larsen et al., 2011), to increasing their energy expenditure while performing a given task (Hasselquist, Bensel, Corner, Gregorczyk, & Schiffman, 2008). The results of these impacts can in turn lead to decreases in the ability of the officer to mobilise over short explosive tasks (Treloar, Alison, & Billing, 2011) and over tasks of longer durations (Drain, Orr, Billing, & Rudzki, 2010). In addition, external load carriage is known to impair balance (Park et al., 2014), change gait patterns (running and walking) (Hasselquist et al., 2008; Park et al., 2014; Perry & Koehle, 2013), and influence postural stability (Park et al., 2014; Sell et al., 2013). Considering these occupational demands, it

Accepted

has been suggested that poor movement quality has the potential to impede occupational performance to the point of reducing performance or causing injury (Orr, 2007).

One means of identifying poor movement patterns is through the use of the Functional Movement Screen (FMS) tool. The FMS is an evaluation tool used to assess the fundamental movement patterns of an individual in a dynamic and functional capacity (Cook, Burton, & Hoogenboom, 2006). The FMS consists of seven movement patterns that require elements of muscle strength, flexibility, range of motion, coordination, balance, and proprioception for successful completion (Cook et al., 2006; Kiesel, Plisky, & Voight, 2007). With poor execution of these elements associated with an increased risk of musculoskeletal injury (Cook et al., 2006), the FMS tool offers an approach to injury prevention and performance predictability by identifying an individual's functional limitations and / or asymmetries (Cook et al., 2006; Gribble, Brigle, Pietrosimone, Pfile, & Webster, 2013; Kiesel, Plisky, & Butler, 2011; Kiesel et al., 2007; Perry & Koehle, 2013).

The use of the FMS as a predictor of injury forms one of the key tenants for its use within physically active populations (Cook et al., 2006). Previous studies have suggested that low FMS scores of $\leq$14 (out of a possible 21) have an association with musculoskeletal injuries in athletic (Chorba, Chorba, Bouillon, Overmyer, & Landis, 2010; Kiesel et al., 2007), general (Perry & Koehle, 2013; Schneiders, Davidsson, Hörman, & Sullivan, 2011) and tactical (Dempsey et al., 2013; Gribble et al., 2013; Lisman, O'Connor, Deuster, & Knapik, 2012; O'Connor, Deuster, Davis, Pappas, & Knapik, 2011) populations. Kiesel, et al. (2007) conclude that National Football League players with FMS scores $\leq$14 had an 11-fold increase in chance of injury in comparison with players with scores >14. These results were supported by Chorba, et al. (2010). Schneiders, et al.

Accepted

(2011) and Perry and Koehle (2013) both confirmed that a FMS score of ≤14 indicated an increased risk of injury within the general population while O'Connor, et al. (2011) and Lisman, et al (2012) validated the use of the FMS score of ≤14 as a predictor of injury within tactical populations.

While evidence is available for the use of the FMS as a predictor of injury there is limited evidence that the FMS can predict performance. As the FMS assesses fundamental movement patterns of an individual in a dynamic and functional capacity, movement patterns typical of the occupational nature of police officers (Blacker et al., 2013; Carlton et al., 2013), the question arises whether this tool could be employed to assess occupational capability in tactical personnel. Therefore, the aim of this study was to investigate the relationship between (a) the quality of functional movement patterns (the independent variable assessed via the Functional Movement Screen instrument) and (b) each of four occupational police tasks (the four dependent variables) as demonstrated by police recruits. .

METHODS

Participants

A sample of 53 recruits, drawn from a pool of 173 police recruits, attending a police recruit training course provided the sample pool for this study. These recruits were undergoing fulltime training at the New South Wales (NSW) Police Academy. No demographic information on these recruits was available, however all recruits did meet the necessary entry requirements for age (a minimum of 18 years and 4 months of age), completed a health clearance from a General Practitioner and had a full medical assessment completed by an external provider. Inclusion criteria were a) the recruit was attending Session 2, police recruit training, b) the recruit had not attempted Session 2

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previously and c) the recruit was able to complete the FMS and all occupational measures. The exclusion criterion for this study was a recruit currently suffering an injury.

Procedures

As part of their training process, 173 police recruits were divided into tutor groups by Academy staff who were blinded to the study. These tutor groups are smaller groups of approximately 20 to 30 recruits (depending on intake size) created for improved logistic coordination. Due to timetable limitations, two tutor groups were randomly selected by the researchers (via a hat draw) to complete the FMS, leading to a total of 53 police recruits completing the FMS. All recruits gave informed consent to study participation. Ethics approval for this research was granted by the Bond University Human Research Ethics Committee (RO1596).

Functional Movement Screen

The FMS is a comprehensive evaluation tool used to assess the fundamental movement patterns of an individual in a dynamic and functional capacity (Cook et al., 2006). The FMS consists of seven movement patterns that include an overhead squat, hurdle step, in line lunge, shoulder mobility, active straight leg raise, push-up, and rotary stability (Cook et al., 2006).

Each component of the FMS is scored on a zero to three scale. A score of zero was assigned if the participant experienced pain with any portion of the movement pattern regardless of movement pattern quality. A score of one identified that the participant could not complete the movement pattern as instructed while a score of two identified that the participant could complete the movement pattern pain-free but with some level of

Accepted

compensation. Finally, a score of three identified that the participant's movement pattern was completed as instructed with no movement compensation noted and was performed pain-free (Cook et al., 2006). The overall FMS score can range from zero to a total score of 21 (Cook et al., 2006).

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The validity of the FMS has been established by Kiesel, et al. (2007)when they considered the relationship of football participants' pre-season FMS scores and serious injuries occurring during one football season. Their results showed that a score of 14 or less on the FMS predicted serious injury with specificity of 0.91 and sensitivity of 0.54. Inter-rater reliability of the FMS has been established by Minick, et al. (2010)whose study showed excellent agreement between both expert and novice testers for all test components of the FMS. The intra-rater reliability has been established by Gribble, et al. (2013) when they compared participants with varying FMS experience and their ability to repeat test scores a week apart. The study's results showed student scorers had poor intra-rater reliability, trainers had moderate intra-rater reliability and experts had the strongest intra-rater reliability. As such, the current study took into consideration previous validity and reliably of FMS studies and allocated a single NSW Police Physical Training Instructor (PTI) to assess a given FMS movement pattern for all recruits completing that movement pattern station. These PTI were trained in the conduct of the FMS at their annual PTI training conference prior to the conduct of the study.

Occupational measures

The selected occupational measures were derived from the assessable occupational task requirements of new police recruits. These occupational measures, considered to be those required as serving police officers, were completed as part of standard recruit training.

Accepted

Marksmanship

Police recruits were required to engage a standard police Z-4 target with a 9mm Glock pistol firing a total of 30 scoring rounds over several serials. Pass score requirement was 80 points with points awarded depending on figure strike zone (zero points for a miss, one to four points per round on target).

Defensive tactics

Police recruits were required to perform basic tactics of defence including restraining belligerent assailants and handcuffing. The recruits were scored as a pass or fail by the police instructor based on their technique and performance.

Baton strikes

In addition to portraying an understanding of the nature of the baton and its use, police recruits were required to perform baton strikes to precise areas of designated static targets. The recruits were scored as pass or fail by the police instructor based on knowledge, technique and performance.

Tactical options

Police recruits were required to respond to given scenarios and employ the most appropriate tactical options (TAC OPS) to resolve the situation with as minimal force as possible to neutralize the situation. The recruits were scored as pass or fail by the police instructor based on the tactical options they selected and their application of these options.

Statistical analysis Descriptive statistics were used to describe the data. Before any comparative analyses were conducted, consideration was given to the assumption of

Accepted

normality by using the Kolmogorov-Smirnov test and the assumption of homogeneity of variances by using Levene's test. Independent sample t-tests were conducted to detect differences in FMS scores between pass/fail groups across all assessed occupational tasks. Post-hoc Pearson's Chi-square tests of independence were used to examine the relationship between the FMS scores, when categorised into pass (>14) and fail (≤14) scores, and occupational measures expressed in contingency tables. Analysis was conducted using SPSS v.20 (SPSS Inc., 2010) with alpha level set at 0.05.

RESULTS

A total of 53 recruits completed the FMS and occupational measures. FMS scores ranged from 8 to 18 points (mean = 13.96 ± 1.990 points). Of the occupational measures 11% (n = 6) failed the marksmanship and baton strike assessments, 21% (n = 11) failed defensive tactics (DEF TAC) and 36% (n = 19) failed TAC OPS (Table 1).

INSERT TABLE 1 HERE

No significant difference (t (51) = -0.601, p = 0.551) for marksmanship performance was found in FMS scores between passing (mean = 14.02±2.00) and failing (mean = 13.50±2.07) recruits. Similar results were found with the DEF TAC assessment (mean pass = 14.07±2.06: mean fail = 13.55±1.97: t (51) = -0.777, p = 0.441) and the baton strikes assessment (mean pass = 13.98±2.05: mean fail = 13.83±1.60: t (51) = -0.167; p = 0.868). Only the TAC OPS assessment approached a significant difference (mean pass = 14.32±1.71: mean fail = 13.32±2.30: t (51) = -1.806, p = 0.077).

Following review of the literature, a post hoc analysis was conducted whereby scaled FMS scores were converted to categorical 'pass' (FMS score of >14 points) or 'fail'

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(FMS score of ≤14 points) using scoring system associated with injury prediction (O'Connor et al., 2011). Of those failing to meet the FMS standard, 4 % (n = 2) failed the baton strikes assessments, 6% (n = 3) failed marksmanship performance and DEF TAC assessment and, 19% (n = 10) failed TACOPS. No significant relationship was found between the FMS pass/fail categories and the baton strikes assessment (x^2 (1) = -0.019, p = 0.891), marksmanship performance (x^2 (1) = -0.589, p = 0.443) or DEF TAC assessment (x^2 (1) = -0.444, p = 0.505). Again, only the TAC OPS assessment approached a significant relationship (x^2 (1) = -3.627, p = 0.057) with FMS pass/fail categories (Table 2 and Figure 1). False positives errors, whereby recruits failed the FMS (≤14 points) but passed the occupational assessments were: 32% (n=17) of baton strike assessments, 30% (n = 16) of marksmanship performance and the DEF TAC assessment and 17% (n = 9) of TACOPS assessment.

INSERT TABLE 2 HERE

INSERT FIGURE 1 HERE

DISCUSSION

The aim of this study was to utilize the FMS tool to assess whether poor movement patterns were associated with reduced performance of police occupational tasks. Of the four occupational tasks investigated, no significant differences were found in FMS scores between recruits passing and recruits failing marksmanship, DEF TAC and baton strikes assessments. Only the TAC OPS assessment approached a significant difference.

The results of our study indicate a possible association was found between FMS scores and the TAC OPS occupational measure of police recruits. While no current literature

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compares outcomes on the FMS tool to occupational task performance in police officers, previous research in other population groups does suggest a relationship between lower FMS and poorer performance (Chapman, Laymon, & Arnold, 2013; Petersen & Smith, 2007).

Chapman, et al. (2013) supported a relationship between FMS scores and longitudinal performance changes in elite track and field athletes. Their study consisted of 121 elite track and field athletes with corrective exercise prescribed following FMS screening. The FMS scores were compared to best performance achieved over two calendar years. While compliance with the corrective exercises were considered problematic and no results were provided, athletes with FMS scores of 14 points or less did not improve in performance to the same extent that athletes with a score of higher than 14 (-2.3% versus 2.5% respectively) points. These results suggest that for athletes with low initial FMS scores or an identified asymmetry, performance ability may be reduced (Chapman et al., 2013).

Petersen and Smith (2007) investigated functional movements of solider recruits and noted that physical restrictions limited soldier's participation and performance of entry level training. Medical screening examination consisted of participants completing a questionnaire and 10 functional movements. The study consisted of 1,013 soldiers reporting for individual entry training, of which 10.4%, (105) reported for medical screening due to injuries or not passing a physical fitness test. Physical restrictions that limited participation and performance were noted in 76 out of the 105 (72%) participants that reported for medical screening. Petersen and Smith (2007) concluded that their study documents the use and benefits of a musculoskeletal screening examination for individual entry training soldiers.

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Several differences between our study and the studies of Chapman, et al. (2013) and Peterson and Smith (2007) were identified. Apart from the population differences in the study of Chapman, et al. (2013) who used athletes and this study within a tactical population, Chapman, et al. (2013) based performance over a longitudinal period. Conversely, this study compared the officer's movement pattern scores to occupational performance tasks conducted within a few weeks. When compared to the study by Peterson and Smith (2007), the notable difference was in the classification of functional movements used to evaluate the participant's movement patterns. Where Peterson and Smith (2007) used functional movements that stressed different parts of the body for medical screening this study used a standardised assessment tool (FMS) to predict performance. Given these differences, all studies have suggested potential associations between poor movement patterns and a potential for reduced performance, be it of athletic movement or of occupational tasks.

Finally, while studies have suggested that low FMS scores of ≤14 are associated with an increased risk of musculoskeletal injuries in tactical populations (Dempsey et al., 2013; Gribble et al., 2013; Lisman et al., 2012; O'Connor et al., 2011), the results of this study would not advocate for a similar 'cut score' to be used in relation to occupational tasks. Apart from failing to find an association between poor movement patterns and reduced performance of police occupational tasks, this study did observed a notable number of false positives errors using a FMS 'passing' score of >14. This is clearly seen in Figure 1 where a notable number of police recruits who may have been removed from training having failed to meet FMS standards (up to 32%) would have passed their occupational assessments.

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Limitations and future research

Four main limitations of this study should be considered; these being the limited number of failures in some occupational measures, further lack of demographic detail of the participants, including gender and age, the use of categorical rather than continuous data, and inability to confirm that the two selected groups of recruits were a fair representation of the general police recruit population. The number of failures in three of the occupational measures were very low. On this basis, further research would benefit from larger cohorts to increase the power of relationship findings. The current study was not able to investigate factors like age and gender differences within the FMS data collection of the police cohort. The low number of failures notwithstanding, gender differences, for example, in individual FMS item scores have been identified by Schneiders et al. (2011) when investigating normative values for the FMS in a population of active, healthy individuals. Future studies should consider the effect of age and gender within their data collection to further establish the use of the FMS within the police cohort. As the occupational data were only provided as pass or fail, the sensitivity of the data was limited and there was no ability to distinguish the degree of failure or success. For example, a police recruit may have failed the marksmanship task by one point or fifteen. Considering this, tasks performance is viewed in light of competent or not yet competent and recruits either pass or fail a competency, the degree of which is considered irrelevant. As such, the approach taken by this study is more applicable to the current assessment process. As only data for the

CONCLUSION

Completion of tasks containing dynamic and functional movement patterns is an occupational requirement for police officers, with poor movement patterns possibly leading to decreased performance and injury in some of these tasks. Previous research has

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indicated that the FMS is a reliable tool for identifying poor movement patterns. The current study suggests that poor movement patterns, as measured by the FMS may not predict poor occupational performance in marksmanship, DEF TAC and baton strikes assessments, but may in TAC OPS assessments.

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Accepted

Table 1: Descriptive statistics for occupational measures.

Variables	Pass Occ Measure	FMS Mean SD (Points)	Fail Occ Measure	FMS Mean SD (Points)	Significance T (Degrees Freedom), p value
Marksmanship	47	14.02 ± 1.994	6	13.50 ± 2.074	-0.60 (51), p=.55
DEFTACT	42	14.07 ± 2.005	11	13.55 ± 1.968	-0.78 (51), p=0.44
Baton	47	13.96 ± 2.048	6	13.83 ± 1.602	-0.17 (51), p=.87
TACOPS	34	14.32 ± 1.718	19	13.32 ± 2.311	-1.81(51), p=.08

Occ = Occupational: DEFTACT = Defensive tactics: TACOPS = Tactical options

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Table 2: Occupational results grouped by FMS Fail (≤14) or Pass (>14) results.

Occupational Assessment	FMS Groups	Occupational Assessment Outcome		Significant difference between groups
		Fail	Pass	X^2 (Degrees Freedom), p value
Marksmanship	≤14	3	16	
	>14	3	31	0.589 (1), p= 0.44
DEFTACT	≤14	3	16	
	>14	8	26	0.444 (1), p= 0.51
Batons	≤14	2	17	
	>14	4	30	0.02 (1), p= 0.89
TACOPS	≤14	10	9	
	>14	9	25	3.627 (1), p= 0.57

DEFTACT = Defensive tactics: TACOPS = Tactical options

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Figure 1. A box plot of the distribution of Tactical Options results grouped by FMS pass / fail scores. The dissect line at the FMS total score of 14 displays the number of participants provides a representation of false positive scores.

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