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The Relationship between Aerobic Test Performance and Injuries in Police Recruits

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ABSTRACT

International Journal of Exercise Science 13(4): 1052-1062, 2020. Lower levels of fitness are associated with an increased risk of injury in police recruits. The aim of this study was to determine the relationships between initial aerobic performance assessments and injury risk during police recruit training. Retrospective data from 219 police recruits undergoing training program at a state police training academy, including 20-m Multistage Fitness Test (MSFT) and 30-15 Intermittent Fitness Test (IFT) scores and injury data, were collected. Spearman's correlation analysis revealed a significant negative correlation between levels of fitness (MSFT rs = - 0.292, $p < 0.001$: 30-15 IFT rs=- 0.315, $p < 0.001$) and rates of injury. Furthermore, a Pearson's correlation showed a strong correlation between MSFT and the 30-15 IFT scores (r = 0.877, $p < 0.001$). Police recruits with lower fitness were at a higher risk of injury than those with higher fitness over the duration of a recruit training program. These findings indicate that aerobic performance assessments may be used by law enforcement agencies to estimate the relative risks of injury among cadets.

KEY WORDS: Tactical, law enforcement, police recruit, 20-m progressive shuttle run test, 30-15 intermittent fitness test

INTRODUCTION

Tactical occupations require their personnel to maintain a standard of physical fitness in order to perform required job tasks in an efficient and effective way, particularly during emergency events (18). Training programs are typically designed to prepare recruits to withstand the physical demands of their occupation and are often intense in nature, such as the 9-week US Army Basic Combat Training course (18) and the 80-day Australian Army recruit training course (13). Given the high levels of physical training required, and the short duration of these courses, recruit training is often associated with a high number of musculoskeletal injuries (37). A major risk factor for both injury and attrition during basic training is poor fitness, with previous research highlighting that recruits in tactical populations who scored lower on aerobic

performance measures were more likely to not complete recruit training than those who scored higher in these measures (16, 31). At this time, injury and attrition rates associated with poor performance on aerobic assessments have not been thoroughly investigated among police recruits. This information may be of significant interest to law enforcement agencies during the recruit selection process.

In police officers specifically, the physical demands of the occupation may include occasions where an officer is required to crawl, balance, climb, lift, carry, push and pull during their shift (6). These periods of physical activity are often spontaneous in nature and may be interspersed by long periods of sitting, which can be up to half of the duration of a shift (15). This requirement for rapid exertion of potentially maximal effort highlights the importance of physical fitness amongst this population in order to cope with the typical stresses of the job (17) and as such physical training is often incorporated into police recruit academy programs (10).

Due to the associations between injury risk, low levels of physical fitness and the job requirements, the assessment of physical fitness is routine in many tactical populations especially during initial training (36). These assessments are usually in the form of field based measures, such as push-ups, sit-ups, the 20-m Multistage Fitness Test (MSFT) or the 30-15 Intermittent Fitness Test (IFT) (31). The 20-m MSFT and 30-15 IFT are two aerobic performance assessments preferentially used over traditional laboratory-based aerobic capacity assessments due to the time, cost and the logistical constraints of conducting these assessments (1).

Despite measures of aerobic performance being used for both the determination of fitness levels and as a means of predicting injury risk in military populations (24, 31), such research on police recruits is scarce. Given that low levels of aerobic performance appear to be a risk factor for future injury and attrition, the aim of this study was to determine the relationships between initial aerobic performance assessments and injury risk during police recruit training. The hypothesis for this study was that recruits with lower aerobic performance assessment scores, as measured by the 20-m MSFT and 30-15 IFT, would be more likely to suffer an injury.

METHODS

Participants

A retrospective cohort study was designed utilising data obtained from an initial recruit training course at a state police training academy. The initial recruit training course ran for 12 weeks with multiple courses held throughout the year. Variables of interest were aerobic performance assessment results (20-m MSFT and a 30-15 IFT), assessed at the commencement of training, and subsequent occurrences of injury during the training program.

Data from a total of 219 police recruits were included in this study. For security reasons, no demographic information was provided to the researchers. However, all participants were at least 18 years of age - an entry requirement to the state police training academy - and the sample did include both male and female recruits. Each participant had completed a health clearance from a General Practitioner and had a full medical assessment completed by an external

provider prior to entry into the academy. This limitation on participant demographics has been reported in previous literature (27). Data were included if they: a) pertained to a recruit who was completing the 12-week training course, and b) if the recruit completed all physical fitness measures. Data were excluded if: a) the recruit had suffered an injury prior to admission to the state police training academy, or b) the recruit was re-entering the training program. Ethical approval for this study was obtained from the Bond University Human Research Ethics Committee (RO1898). This research was carried out full in accordance to the ethical standards of the International Journal of Exercise Science (25).

Protocol

Both aerobic assessments were performed during the first week of the training program by Physical Training Instructors, who were blinded to the research study. The first fitness assessment was the 20-m MSFT, which is a maximal, multistage fitness test. Its validity (r = 0.90) and reliability (r = 0.95) have been demonstrated in previous research (21), and it has been used in police (12) and military (1) populations. The test requires recruits to run between two parallel lines placed 20 metres apart. The running speed was standardized using pre-recorded auditory beeps played from an iPad device (Apple Inc., Cupertino, CA) connected to a portable speaker. The starting speed is 8.5 km/h and is progressively increased at each successive level by 0.5 km/h, at approximate one-minute intervals (21, 31). If the recruit does not reach the line before the audible beep then a warning is given, and on the second occasion the test is stopped. An overall level and stage score is assigned to each recruit (e.g. Level 12.3), based upon the corresponding total number of shuttles completed. Only one attempt at the 20-m MSFT was allowed.

The second aerobic fitness measure used was the 30-15 IFT (7) which was conducted 2 days later. The 30-15 IFT has been used extensively in sports, where its reliability has been demonstrated (34, 39). The test is performed over a marked out 40-m track, with a 20-m midpoint and 3-m tolerance zones at each line. Participants complete 30-second shuttle runs followed by 15-seconds of passive recovery. Initial running speed is 8 km/h and increased by 0.5 km/h every 45-seconds. Audible beeps are used to help recruits pace themselves (8). The test is concluded when the participant is not able to reach the tolerance zone on three occasions. The speed of the test corresponds with a level, and the final level reached is assigned to each recruit.

Data regarding injury incidents were collected using the Charles Sturt University Accident and Incident Form which records injuries that occurred during training in accordance with normal police processes (27). Under this system, an injury was considered to be any physical damage to the musculoskeletal system determined by the medical staff who, given the retrospective nature of the study, were also blinded to the study. Only injury data provided was a 'yes' classification if a recruit had reported an injury during training. Upon collection, data were entered into an Excel spreadsheet and manually cleaned and sorted into bins for further analysis. Bins (categories) for the 20-m MSFT were based on the total number of shuttles completed, grouped as every 5 shuttles completed. Bins for the 30-15 IFT were based on the number of levels completed, rounding half levels down to a whole number (i.e., Level 12.5 is included in the Level 12 bin). This approach to categorising data by bins has been used previously in this population

and ensures there are adequate participants and outcome events underpinning each point estimate derived from the data analysis (28). In both measures, bins at both extremes on the respective scales represented small numbers of recruits, and therefore counts from two or more bins at each of these extremes were combined within a replacement bin covering a wider range of fitness levels, in order to ensure at least 5 recruits were represented in each bin and so enable more accurate analysis of injury risk associated with these more extreme fitness levels.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) software version 23 was used for statistical analysis. The proportion of recruits in each fitness 'bin' that were injured was calculated as (count of injured recruits within bin)/ (number of recruits within bin) x 100%, and 95% confidence intervals around these proportions were also calculated. The method used to calculate the confidence intervals for the proportions injured or uninjured within each bin was the Wilson score method without continuity correction (26). An independent samples student t-test was performed to determine whether there were any significant differences between the mean fitness scores of recruits who were, and were not, injured. In addition, Spearman's correlation analysis was performed to determine the relationship between fitness scores from each measure and recruit injury risk. Pearson's correlation analysis was used to determine the relationship between the two fitness assessments with alpha set at 0.05 a priori. With 219 subjects, an effect size (ES) of 0.3 (i.e., small-moderate ES) and alpha level at 0.05, the calculated statistical power was 0.993 for the t-tests, and 0.996 for the correlations.

RESULTS

Of the 219 police recruits from which data were collected, injuries were reported by 56 recruits (26%). Table 1 shows the results of the 20-m MSFT along with the incidence of injuries among participants at each aerobic performance level. The mean score in the 20-m MSFT for recruits who suffered an injury was significantly lower (t [108.19] = 4.617, $p < 0.01$) than that for those who were not injured (55.05 ± 14.20 vs 65.60 ± 16.25 shuttles respectively). Table 2 shows the results of the 30-15 IFT along with the incidence of injuries among participants at each fitness level. Again, the mean 30-15 IFT score of injured recruits was significantly (t[115.19] = 5.25, $p = 0.001$) lower than that for non-injured recruits (Level 15.68±1.41 vs Level 16.89±1.71, respectively). Spearman's correlations were considered 'weak' (9) but significant for the relationships between both measures and injury risk (20-m MSFT and injury, rs = -0.292, $p < 0.001$; 30-15 IFT and injury, rs = -0.315, $p < 0.001$).

Table 1. Injury rates by 20-m MSFT score bin

# of Shuttles	Injury	%	95% CI	Not Injured	%	95% CI
25 – 39*	9	53	30.96 – 73.83%	8	47	26.27 – 69.04%
40 – 44	3	23	8.91 – 50.26%	10	77	49.74 – 91.82%
45 – 49	3	43	15.82 – 74.95%	4	57	25.05 – 84.18%
50 – 54	13	36	22.48 – 52.42%	23	64	47.58 – 77.52%
55 – 59	13	46	29.53 – 64.19%	15	54	35.81 – 70.47%
60 – 64	6	17	7.87 – 31.89%	30	83	68.11 – 92.13%
65 – 69	2	17	4.70 – 44.80%	10	83	55.20 – 95.30%
70 – 74	2	12	3.29 – 34.34%	15	88	65.55 – 96.71%
75 – 79	0	0	0.00 – 24.25%	12	100	75.75 –100.00%
80 – 84	3	15	5.24 – 36.04%	17	85	63.96 – 94.76%
85 – 89	1	14	2.57 – 51.31%	6	86	48.69 – 94.76%
90 – 94	1	14	2.57 – 51.31%	6	86	48.69 – 94.76%
95 – 99	0	0	0.00 – 43.35%	5	100	56.55 –100.00%
100 – 109*	0	0	0.00 – 65.76%	2	100	34.24 –100.00%

* Counts for several bins were pooled to form a replacement bin, due to small numbers of participants and injuries, in order to provide more accurate analysis.

Table 2. Injury rates by 30-15 IFT score bin participants

30-15 Level	Injury	%	95% CI	Not Injured	%	95% CI
12 – 13.5*	4	50	21.52 – 78.48%	4	50	21.52 – 78.48%
14 – 14.5	10	38	22.43 – 57.47%	16	62	42.53 – 77.57%
15 – 15.5	16	40	26.35 – 55.40%	24	60	44.60 – 73.65%
16 – 16.5	19	38	25.86 – 51.85%	31	62	48.15 – 74.14%
17 – 17.5	2	5	1.35 – 16.14%	39	95	38.60 – 98.65%
18 – 18.5	3	12	4.00 – 28.98%	23	88	71.02 – 96.00%
19 – 20.5*	2	7	2.02 – 29.27%	26	93	77.35 – 98.02%

* Counts for several bins were pooled to form a replacement bin, due to small numbers of participants and injuries, in order to provide more accurate analysis.

For both the 20-m MSFT and the 30-15 IFT, higher proportions of police recruits who suffered an injury were reported in the lower score bins, and a trend existed between increasing scores and decreasing proportions of recruits who suffered injuries. Of note however, some injuries were still reported among those who achieved higher scores. In the 20-m MSFT, injury rates appeared to decline as participants surpassed 55-59 shuttles (Figure 1) with 73% of all injuries reported occurring in those scoring between 25 and 59 shuttles. On the 30-15 IFT, the relationship between injury and performance was more pronounced. Initially, as scores improved, injury rates remained relatively unchanged (Figure 2). However, once participants reached Levels 16 and 16.5, injury rates dramatically declined. Of the injuries reported, 88% occurred between levels 12 and 16.5.

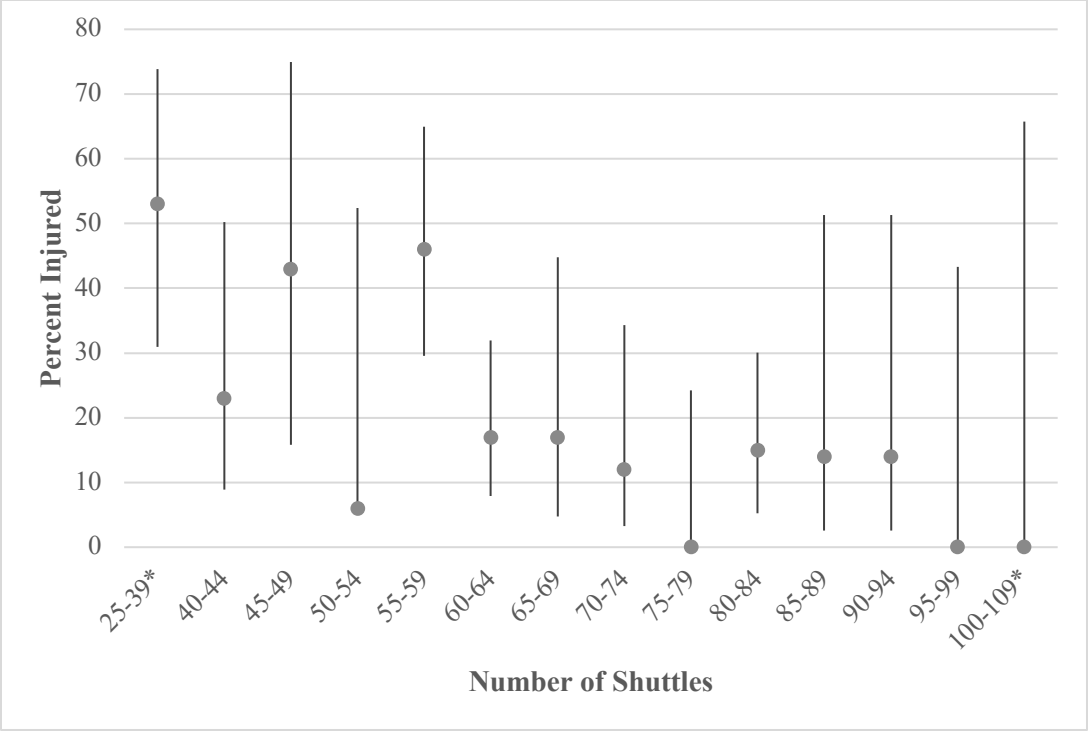

Figure 1. Percentage of recruits injured (95% CI) by 20-m MSFT fitness score bin

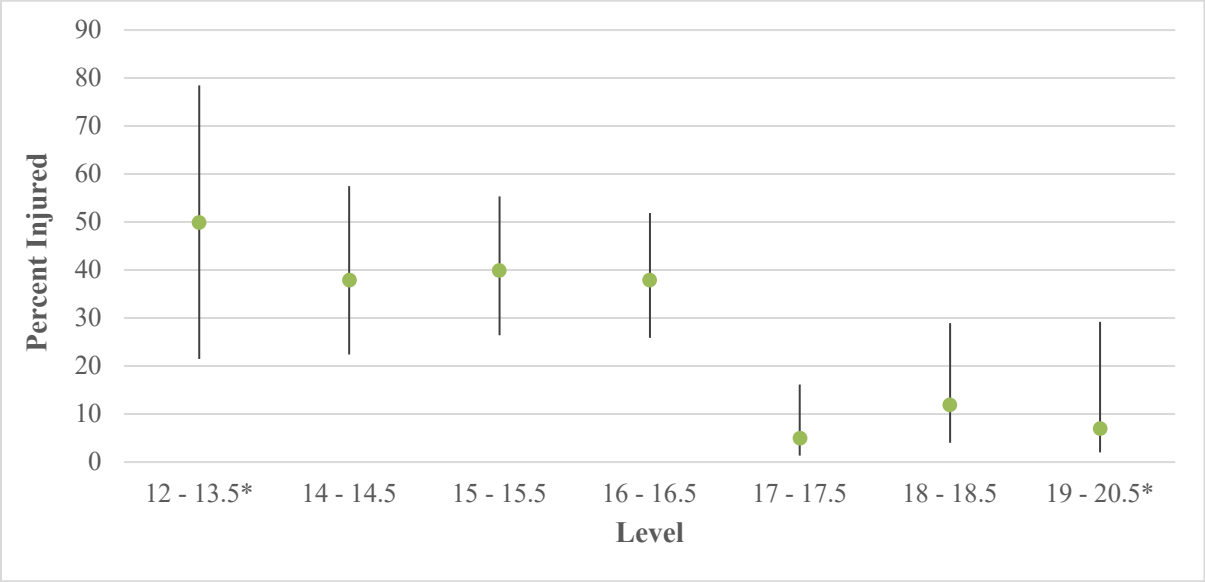

Figure 2. Percentage of recruits injured (95% CI) by 30-15 IFT fitness score bin

DISCUSSION

The aims of this study were to determine the relationships between initial aerobic performance assessments (20-m MSFT and 30-15 IFT) and injury risk during police recruit training.The investigation found that significantly greater proportions of participants who scored lower on either aerobic performance assessment were injured when compared with those who scored

higher. Lower levels of aerobic performance for both assessments were indicative of identify police recruits that were at an increased risk of injury during initial academy training.

In this study, those who were injured scored, on average, significantly lower on the 20-m MSFT than those who did not suffer an injury (injured 55.05±14.20 shuttles or Level 7-4 vs non-injured 65.50±16.25 shuttles or Level 8-4). The findings of MSFT performance and injury risk in this study is in line with previous research in military recruits, in which Pope et al. (31) showed that those recruits who scored less than 52 shuttles (Level 7-1) were five times more likely to sustain an injury than those who scored 105 shuttles (Level 11-11) or more. Lower limb injury risk is much higher in recruits with lower fitness levels (when compared to their cohort), highlighting that fitness may be a modifiable risk factor for injury reduction (32).

The results of the 30-15 IFT were also associated with injury risk in this study, and scores on this assessment were slightly more related to injury risk than scores on the 20m MSFT. On average, injured recruits scored 15.68 ± 1.41 levels on the 30-15 IFT, compared to 16.89 ± 1.71 levels in the non-injured group. Despite the 30-15 IFT being used extensively in sports including ice hockey, soccer and rugby league (5, 34, 38), to the researchers' knowledge it has not been utilised as a tool for evaluating injury risk. The typical use of the 30-15 IFT in these sports is for monitoring changes in fitness in season (7), making comparison of results difficult. Further to this, the use of the 30-15 IFT in these sports may be due to these athletes typically performing repetitive bouts of maximal exercise, as opposed to continuous sub-maximal exercise (7). Therefore, the 30-15 IFT may be well suited to a police population due to their potential requirement to perform spontaneous, maximal effort, movements which may be repetitive in nature. It should be noted that injuries still occurred in those who possessed high levels of fitness in both fitness assessments, but at lower rates than in those with lower levels of fitness. Accordingly, any program implemented to address injuries should be termed *'injury minimisation'* as opposed to '*injury prevention*'.

Despite weak relationships (14) between both aerobic performance assessments and injury occurrence, the cumulative effect of injury risk associated with poor performance on these assessments should be considered. This phenomenon of cumulative risk accrual over repeated exposures to physical activity events across a training program, is discussed in detail by Pope (30). Furthermore, from a more pragmatic level, officers are expected to continue physical activity throughout their careers. Thus, the greater number of exposures an officer or recruit has to these stressors (i.e., continues running) the more likely they are to experience an injury (31). Thus, across the span of a career, the downstream impact of low aerobic fitness on injury counts may be magnified. Low levels of fitness may also lead to an earlier onset of fatigue. The effects of fatigue include compensation patterns in motor control and negative effects on balance. The subsequent alteration in biomechanics in tasks such as walking, running and sprinting may also affect injury risk (2, 20, 22, 29, 33). This should be of significant importance to law enforcement agencies as injuries suffered during training are costly and detract from force readiness (22, 24, 35).

A very strong correlations was found between the 20-m MSFT and the 30-15 IFT outcome measures. With change of direction tasks of 30° or greater potentially placing a higher load through the knee joints (4), the greater number of changes of direction in the 20-m MSFT could place more stress through the knees than the 30-15 IFT. If a measure of aerobic performance is required in a population of older police officers at risk of age-related deterioration of cartilage in the knee joint (9, 19, 23) then the 30-15 IFT may be more appropriate.

A final consideration lies in the setting of standards by law enforcement agencies. If the state police force from which these recruits were drawn were to set a standard for the MSFT of 48 shuttles (i.e., Level 6.8), our findings suggest that 41% (n = 15) of recruits would fail to reach this level (n = 37) and would suffer an injury, accounting for 27% of all injuries in the total recruit cohort. However, the remaining 59% (n = 22) of recruits who did not reach this standard successfully would go on to successfully complete training, representing 13% of the passing cohort. If the standard were to be raised to Level 7.7, 34% (n = 41) of recruits would fail to reach this standard (n = 101) would represent 73% of all recruits who suffered an injury. However, considering that 60 recruits who did not reach this standard were in the passing cohort, adoption of this standard would result in a loss of 37% (n = 60) of the passing cohort. On this basis, any setting of a given entry standard by a law enforcement agency would need to consider the level of injury risk the agency is willing to accept and the reduction in the net training success rate it can afford to entertain, which will depend in part on both the size of the applicant pool and the cost of recruiting each individual, up to the testing stage, relative to overall recruitment budgets of the organisation. An alternative to using the test as a barrier test for entry is to use it as a screening tool and basis for tailoring training to individual starting fitness levels, in order to reduce injury risks in those less fit.

There are some limitations to this study which should be acknowledged. The data captured was from a limited number of recruits who were enrolled in initial training at the state police training academy. Additionally, all demographic information was omitted for security reasons. Considering this, while sex related data were omitted, research suggests that the relationship between aerobic performance and injury risk in tactical forces trainees is independent of sex (3) and so the lack of sex data is unlikely to have affected the findings of this study or its implications for recruit cohorts. The database only allows for capture of the number of injuries sustained, without reference to the type, nature, location or severity of the injury. Future studies could aim to capture this information to further explore injury minimisation strategies. Furthermore, anthropometric information (i.e., height, body mass, body mass index, body composition) was not provided for the recruits in this study. This may have a significant impact on aerobic performance as the physiological burden of carrying additional mass ,especially non-functional mass (i.e., body fat), increase joint stress and the overall amount of relative work that must be performed to do the same task (11). Nonetheless, the results from this study indicate that overall both fitness assessments are capable of predicting injury risk amongst a population of police recruits undergoing initial training. However, based on the potentially greater specificity to police requirements when performing spontaneous, maximal effort, movements which may be repetitive in nature, the 30-15 IFT, may be of greater benefit as an assessment when compared to the 20 m MSFT.

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