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A Preliminary Analysis of the Relationship between the Multistage Fitness Test and 300-m Run in Law Enforcement Officers: Implications for Fitness Assessment

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ABSTRACT

International Journal of Exercise Science 11(4): 730-738, 2018. Law enforcement agencies (LEAs) often use fitness tests to assess recruits and incumbents. One fitness test that is gaining popularity is the 20-meter multistage fitness test (20m-MSFT). However, the potential length of this assessment, in addition to the repeated direction changes, means this test may not be appropriate for all officers (e.g. older officers, or those with physical impairments). The 300-m run is shorter, features no direction changes, and could provide an indication of fitness. The study purpose was to investigate the relationship between the 20m-MSFT and 300–m run. Retrospective analysis of data from a convenience sample of 15 incumbents from one LEA were used. Incumbents completed the 20m-MSFT and 300-m run one week apart. Pearson's correlations ($p \leq 0.05$) calculated the relationships between the descriptive data of the incumbents, 20m-MSFT shuttle score and 300-m run time. Linear regression plots were also constructed to determine the predictive relationship between the two assessments. The results indicated a large negative relationship ($r=-0.61$) between number of shuttles completed on the 20m-MSFT and the 300-m run time. However, there was a low predictive relationship shown by the regression between the 20m-MSFT and 300-m run ($R^2=0.3728$). Although the 300-m run and the 20m-MSFT both provide some measure of general fitness and high-intensity running performance, each assessment generally provides a measure of different physiological qualities. Nonetheless, given the significant correlation between the assessments, the 300-m run could still be a useful assessment for those officers for whom the 20m-MSFT is inappropriate, such as officers with physical limitations.

KEY WORDS: Aerobic capacity; job-related fitness; physical ability; police; tactical strength and conditioning

INTRODUCTION

The tasks required by law enforcement officers (LEOs) may range from relatively sedentary functions such as passive observation and driving a vehicle, to tasks potentially requiring maximal exertion, such as maximally sprinting while chasing a suspect, grappling with a suspect, lifting heavy objects, and crowd control (1, 10, 14, 18). These incidents may require brief or sustained periods of high and low physical exertion with minimal rest during the event, which places high demands on a LEO's aerobic and anaerobic capacity (7). An example of such an event would involve a chase through urban terrain followed by grappling with an uncooperative suspect. As a result, aerobic fitness is important for LEOs (1, 7, 10, 14, 18), as low levels of fitness in these areas may negatively impact job performance or put the officer and public in significant peril should a critical incident occur.

Specific to the need for aerobic fitness in a variety of essential job tasks, law enforcement agencies often administer aerobic capacity tests to both recruits and incumbents (1, 14). Some examples of tests or assessments that are commonly used include the 1.5 mile or 2.4 kilometer (km) run (12) , and the 20-meter multi-stage fitness test (20m-MSFT). The 20m-MSFT in particular is a widely utilized fitness test that has been shown to be a reliable and valid measure of maximal aerobic capacity (30). As a result, the 20m-MSFT has been used to assess aerobic capacity and general physical fitness in athletes (13), the general population (25) and in tactical populations (6, 11, 29). The 20m-MSFT is often chosen for its efficiency as large groups of participants can all be assessed at once with relatively minimal equipment (e.g. a tape measure to measure the distance, cones to mark the area, a tablet computer with a 20m-MSFT application, and a portable speaker).

Nonetheless, the 20m-MSFT is not without limitations. The test can have an unpredicatable duration (e.g. 16 seconds [s]-~20 minutes) (21), based upon the abilities of the participants. In addition to this, one of the core components of the test is the need for 180° changes of direction every time a 20-meter (m) shuttle is completed. Change of direction tasks of 30° or greater can place a high load on the knees (5). These multiple changes of direction could also be stressful for officers with physical impairments or older officers who are at increased risk for age-related deterioration of cartilage in the knee joint (8, 17, 24). Gait adaptations to the joint deterioration may also present a risk for older officers or officers with physical impairments (e.g. previous knee injuries) if they are forced to complete a great volume of high intensity direction changes during a maximal running test (27).

What could serve as an appropriate compromise is a shorter duration fitness test that provides a measure of physical fitness, features minimal changes of direction, and has a shorter duration to decrease stress to incumbent officers. The 300-m run could fit these requirements, as it is a shorter duration test that takes approximatelty 60-70 s to complete by healthy individuals (9), and features no 180° changes of direction. While assessing a larger amount of recruits or incumbents might take objectively more time to complete, the duration that each recruit or incumbent is expected to run for is far less in the 300-m run than the 20m-MSFT. This would mean that each recruit or incumbent is exposed to less stress during the 300-m run. The 300-m run requires relatively little preparation and minimal resources (i.e. a timing device and an unobstructed 300-m distance). While typically used as a measure of anaerobic power (31, 34), better performance on anaerobic power tests have been linked to higher levels of aerobic capacity (34, 35). The 300-m could potentially be a multipurpose assessment (20), by concurrently providing a measure of aerobic and anaerobic capacity. Reducing the number of assessments performed, while gaining similar fitness information, could be useful for a law enforcement agency as they can be time-poor with regards to their ability to conduct fitness assessments for their incumbent staff. However, before law enforcement agencies apply the 300-m run as a potential measure of aerobic capacity and general fitness, it must be determined whether this assessment measures similar qualites to a maximal aerobic test such as the 20m-MSFT.

Therefore, the purpose of this study was to investigate the relationship between the 20m-MSFT and the 300-m run in incumbent LEOs. This would demonstrate whether the 300-m run could serve as a viable alternative fitness assessment to the 20m-MSFT, even though it has a shorter duration and does not have the direction changes inherent to the 20m-MSFT. It was hypothesized that there would be a strong negative correlation between the number of shuttles completed in the MSFT and the 300-m run time. It was further hypothesized that the results from the MSFT and 300-m run would be predictive of each other.

METHODS

Participants

Retrospective data for a convenience sample of 15 incumbents (age = 32.00 ± 7.72 years; body mass = 84.37 kg ± 11.15 kg; height = 1.83 ± 0.08 m: body mass index [BMI] = 25.04 ± 2.01 kg·m^{-2}) were used in this investigation for descriptive and comparative purposes. Based on the archival nature of these data, this investigation qualified for exempt review through an Institutional Review Board for human subjects.

Table 1. Correlations between the incumbent (n = 15) ages, body mass, height, body mass index (BMI), shuttle score in the 20-meter (m) multistage fitness test (20m-MSFT), and time in the 300-m run.

		Age	Body Mass	Height	BMI	20m-MSFT
Body Mass	r	-0.12				
	p	0.68				
Height	r	-0.22	0.82			
	p	0.44	<0.01*			
BMI	r	0.07	0.78	0.30		
	p	0.80	<0.01*	0.29		
20mMSFT	r	-0.11	-0.17	0.00	-0.25	
	p	0.70	0.55	1.00	0.38	
300-m Sprint	r	-0.13	-0.06	-0.22	0.12	-0.61
	p	0.65	0.83	0.43	0.68	0.02*

* Significant (p≤0.05) relationship between the two variables.

Protocol

provided to the primary investigator via the representatives of the law enforcement agency being studied. As these data collected were retrospective, the primary investigator obtained detailed testing descriptions from the participating agency's training staff who were experienced and qualified Tactical Strength and Conditioning Facilitators (TSAC-F), similar to the procedures of Lockie et al. (22). The 20m-MSFT was performed on the first testing session and the 300-m test was performed exactly seven days later at the 2nd testing session. Testing occurred in the early morning in temperate conditions typical of central Colorado.

20-m Multi-Stage Fitness Test (20m-MSFT): After performing a brief 5-minute warm-up lead by an academy training instructor qualified as a TSAC-F, incumbents began the test. Procedures for this test have been described by Léger and Lambert (21). Incumbents were required to run back and forth between two lines marked on the ground spaced exactly 20-m apart. The speed of running for this test is standardized by pre-recorded auditory cues (beeps). The initial speed for the test is set at 8.5 kilometers per hour ($km \cdot hr^{-1}$) and increased by 0.5 $km \cdot hr^{-1}$ with each additional stage. This test is scored according to the final stage and shuttle (e.g. Stage 5.5) the participant is able to achieve before being unable to run at the speed required. The test was terminated when the participant was unable to reach the next line twice in a row in accordance with the auditory cues. Final scores by stage and shuttle were converted to total number of shuttles completed.

300-m Run: Procedures for this test have previously been described by Cocke et al. (9) . Prior to performing the 300-m run, incumbents performed a brief 5-minute warm-up lead by a training instructor qualified as a TSAC-F. Once the warm-up was completed, the incumbents were instructed to run at maximal speed for 300-m on a predetermined course around an outdoor, concrete, running track. This course was selected based on its proximity to the training academy, distance, and minimal changes in terrain and grade. Incumbents performed this test one at a time, and once the 300-m distance was covered times for each participant were recorded to the nearest 0.10-second on a handheld stopwatch. Timing via stopwatches is standard practice in LEA testing (3, 9, 12, 22, 32). Furthermore, testers trained in the use of stopwatch timing procedures for running tests, which they were in this study, can record reliable and consistent data (15). Each incumbent performed two test trials with approximately 5 minutes rest between trials. The best time for each incumbent was utilized for the final statistical analysis.

Statistical Analysis
The collected data for each incumbent were entered into Microsoft Excel and then exported into Statistical Package for Social Sciences (SPSS) 24.0 for further analysis. Descriptive data (mean±standard deviation [SD]) were produced for each variable. Trial-to-trial reliability of 300-m times measured in this study was assessed by intra-class correlation coefficients (ICC) calculated from a 2-way mixed method consistency model for single measures. An ICC equal to or above 0.70 was considered acceptable (2). Pearson's correlations were performed to investigate relationships between the descriptive data for the incumbents, 20m-MSFT shuttle score, and 300-m run time. The alpha level for this analysis was set at $p \leq 0.05$. The correlation strength was designated as: an r between 0 to 0.3, or 0 to -0.3, was considered small; 0.31 to 0.49, or -0.31 to -0.49, moderate; 0.5 to 0.69, or -0.5 to -0.69, large; 0.7 to 0.89, or -0.7 to -0.89, very large; and 0.9 to 1, or -0.9 to -1, near perfect for relationship prediction (16). A linear regression scatter plot for the 20m-MSFT and 300-m sprint was also constructed to assess whether there was a predictive relationship between these tests.

RESULTS

The mean number of shuttles completed in the 20m-MSFT was 78.20±17.82. This was equivalent to a level 9, shuttle 6 for the 20m-MSFT. The mean 300-m run time for the incumbents was 46.40±4.14 s. The ICC for the 300-m run was 0.94, indicating high inter-trial reliability. The correlations between the descriptive data for the incumbents, and the 20m-MSFT shuttle score and 300-m run time, is shown in Table 1. Body mass had very large, positive correlations with both height and BMI. Nonetheless, there were no significant correlations between the incumbent ages, body mass, height, or BMI with the 20m-MSFT or 300-m run. There was a large, negative relationship between the 20m-MSFT shuttle score and 300-m run time. However, there was a low R^2 value in the regression equation (Figure 1).

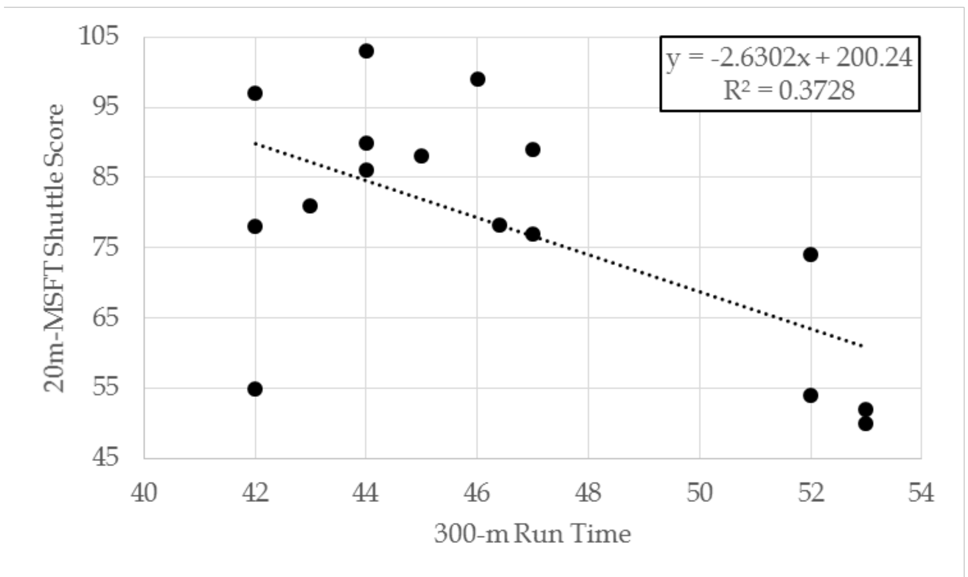

Figure 1. Regression analysis of the number of shuttles completed in the 20m-MSFT and 300-m run time for each incumbent (n=15).

DISCUSSION

This study investigated the 300-m run as a potential substitute for the 20m-MSFT. Due to the need for LEOs to have an appropriate aerobic capacity and the need for a time-efficient and accurate way to measure aerobic fitness, this study investigated the relationships between the 300-m run and the 20m-MSFT. Although historically used as an assessment of anaerobic capacity, if the 300-m run demonstrated a strong relationship with the 20m-MSFT, it could provide some indication of aerobic capacity. This would be especially applicable for those LEOs where the 20m-MSFT may not be appropriate. The results from this study firstly demonstrated that the 300-m run timed via stopwatches, which is standard practice in law enforcement populations(3, 9, 12, 22, 32), provided an ICC of 0.94. This was well in excess of 0.70 (2), and indicated high trial-to-trial reliability. Secondly, the results showed that there was a large negative correlation (*r*=-0.61) between performance on the 300-m run and number of shuttles completed on the 20m-MSFT. Despite this large correlation, the predictive relationship between these two tests were low. This may indicate that while the 300-m run does relate to the 20m-MSFT, it may miss assessing other qualities specific to the 20m-MSFT. Nevertheless, these results are important for trainers and those involved in the assessment of potential recruits and incumbent LEOs. This is especially true given the time constraints associated with physical assessments in these populations (28).

The large relationship between the 300-m run time and the number of shuttles completed on the 20m-MSFT suggests that both the 300-m run and the 20m-MSFT measure some similar qualities, such as the ability to complete high-intensity running. This can be explained physiologically through anaerobic adaptations that contribute to improved aerobic performance on longer duration runs (34, 35), such as that completed in the 20m-MSFT. Improved running economy is one such adaptation, whereby the energy required to complete a longer duration run is reduced due to adaptations to the muscle that allow improved tolerance to forces generated during take-off and landing during a run (33). The ability to generate and absorb force are essential for maximal sprint performances (23), such as that required in a 300-m run. These same qualities are also important for an assessment such as the 20m-MSFT, which requires the ability to tolerate forces over a longer period of time. It should also be noted that LEOs generally need a range of physical capabilities to be proficient in their job (12) , so a contributing factor to this relationship could also be that fitter officers could perform better in different assessments such as the 20m-MSFT and 300-m run. Nonetheless, taken together with the knowledge that many essential job functions, such as short-distance pursuits and sprinting, occur over relatively short distances, the 300-m run could be a useful tool for assessing high-intensity running capabilities for LEOs, while also providing some indication of aerobic capacity.

Further to the relationships between the 300-m run and 20m-MSFT, the results also showed two very large correlations between body mass and height (r=0.82) and body mass and BMI (r=0.72). These results are to be expected given the relationships shown between height and body mass in the general population (4). These findings are notable as people with a higher body mass can generate greater ground reaction force during a run (19). For LEOs, this means a longer assessment such as the 20m-MSFT could expose officers to repetitive impacts and physiological and biomechanical stress, whereas a shorter test such as the 300-m run may limit these impacts and stress. This is very important for older officers due to the potential for age-related joint degeneration (8, 17, 24), and officers with a history of lower-limb impairments. Limiting risk exposure during testing is an important consideration for law enforcement agencies when assessing incumbent officers.

Despite the significant relationships between the 300-m run and 20m-MSFT, the regression equation showed a low predictive relationship between the 300-m run and 20m-MSFT. In the context of this study and as previously stated, these results suggest that while the 300-m run does relate to the 20m-MSFT, it may miss assessing other qualities specific to the 20m-MSFT. It is likely that anaerobic power is primarily measured by the 300-m run (34), and while this contributes to aerobic fitness, other contributing factors important to the 20m-MSFT performance may not be measured by this assessment. Although there are challenges in attempting to predict aspects of physical performance (26), there is still practical application of this result specific to law enforcement populations. It may not be appropriate for training instructors and TSAC-F to use an assessment such as the 20-m-MSFT in certain officers, such as those who are older or have difficulty making sharp changes of direction due to the 'wear and tear' associated with the profession. Although the results from this study show low predictive qualities between the 20m-MSFT and 300-m run, the 300-m run could still be a useful performance assessment for older officers, or those that may not change direction as effectively due to physical impairments. The 300-m run does relate to aspects of aerobic fitness, and features a shorter duration with no stressful changes of direction.

There are several limitations for this study that should be noted. The sample size for this study was relatively small (n=15). The assessment of LEOs can be time consuming, and law enforcement agencies are often time-poor with regards to being able to assess their incumbents, which restricted the availability of data for LEOs who completed both the 20m-MSFT and 300-m run. Another limitation was that only one such alternate running test to the 20m-MSFT was investigated in this study. Other maximal running tests, such as the 500-m or 2.4 km (1.5 mile) run could be compared to the 20m-MSFT to elucidate other relationships. Only one LEA participated in the study as well. The physical qualities of LEOs may vary across different agencies, so a variety of agencies should be investigated in future research. Nonetheless, within the context of these limitations, these data did suggest a relationship between the 300-m run and the 20m-MSFT, which demonstrated some potential for the 300-m run as an alternative fitness assessment for LEOs for which the 20m-MSFT may not be appropriate.

In conclusion, the results from this study showed that there was large negative relationship between 300-m run time and number of shuttles completed on the 20m-MSFT. However, the results also showed that there was only a limited predictive relationship between the two tests. It could be surmised that although both assessments may provide a measure of high-intensity running, there could be certain aspects of aerobic or general fitness that are not captured in the 300-m run assessment. Nonetheless, the 300-m run may still be useful as an assessment for those LEOs, including older officers or officers with physical impairments who may not be able to tolerate a longer running assessment.

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