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# Long, Hot Summer: A Preliminary Investigation of Seasonal Variations in the Physical Fitness Performance Of Law Enforcement Recruits in Southern California

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## ABSTRACT

Law enforcement agencies (LEA) conduct physical testing to assess readiness of recruits prior to academy training. The LEA in this study uses a test battery called the Validated Physical Ability Test+ (VPAT+) on set dates during the year, typically performed outdoors. Warmer ambient temperatures can negatively affect physical performance via increased heat stress and decreased time to muscular fatigue. Differences in performance on these tests due to warmer temperatures could have implications for recruit performance. The purpose of this study was to determine whether seasonal differences in temperature impacted LEA recruit performance in their VPAT+ performance. Retrospective analysis was conducted on data from four classes, which encompassed 375 recruits from one LEA. The classes completed the VPAT+ during four different seasons (Fall (FALL): ♂ = 71, ♀ = 18, temp = 22-28°C, humidity = 20-32%; Winter (WIN): ♂ = 73, ♀ = 11, temp = 18-26°C, humidity = 8-11%; Spring (SPR): ♂ = 75, ♀ = 27, temp = 22-29°C, humidity = 23-50%; Summer (SUM): ♂ = 83, ♀ = 17, temp = 21-25°C, humidity = 39-71%). The VPAT+ occurred in the week prior to the start of academy and included: push-ups and sit-ups completed in 60 s; arm ergometer revolutions in 60 s; 75-yard pursuit run (75PR); seated medicine ball throw with an x kg ball (MBT); vertical jump (VJ); and multistage fitness test (MSFT). To compare groups, a one-way ANOVA was used with a Bonferroni post hoc ( $p < 0.05$ ). There were significant differences between the seasons in certain VPAT+ tests. For push-ups, WIN and SUM performed 16% and 19% better than SPR, respectively. For the MBT, SUM performed 18% better than FALL. For the arm ergometer, SPR and SUM performed 8-9% better than WINTER, and SUMMER performed 11% better than FALL. WIN performed significantly better than SUM, SPR, and FALL in the MSFT, completing 18%, 27%, and 16% more shuttles. No significant differences were found in sit-ups and VJ. Variability in VPAT+ performance across the seasons could be due to class-to-class fitness variations in recruits. However, WIN was significantly better in the MSFT, which is a maximal running test. Warmer temperatures can increase cardiovascular strain, while humidity can decrease sweat evaporation rates. Both factors can result in an increased rate to fatigue and poorer performance on the MSFT. LEA staff may need to consider ambient temperatures and humidity during tests such as the VPAT+ due to potential negative effects on recruit performance, and this is particularly true for maximal running tests.

## INTRODUCTION

- Law enforcement agencies (LEA) conduct physical testing to assess readiness of recruits prior to the start of academy training (1). The LEA in this study uses a test battery called the Validated Physical Ability Test+ (VPAT+) on set dates during the year. The VPAT+ consists of recruits performing tests such as: push-ups, sit-ups, medicine ball throw, vertical jump (VJ), arm ergometer, 75-yard pursuit run (75PR), and the multi-stage fitness test (MSFT). These tests are typically performed outdoors.
- Warmer ambient temperatures can negatively affect physical performance via increased heat stress and decreased time to muscular fatigue (2, 4). The combination of both of these factors could result in the reduction of oxygen being readily supplied to the muscle tissue to sustain adequate energy expenditure demands (2).
- Humidity prevents the evaporation of sweat from the skin to occur, creating a reduced rate of heat loss at higher humidity which increases skin temperature. Skin temperature is a key factor in the fatigue process in the muscles (4).
- Differences in performance on these tests due to warmer temperatures could have implications for recruit performance not only during pre-academy, but during academy training as well. Fitness assessments performed in extreme conditions during the hiring process could have an influence on recruit employment.
- The purpose of this study was to determine whether seasonal differences in temperature and relative humidity impacted LEA recruit performance during their VPAT+ fitness assessment.

## METHODS

- Retrospective analysis was conducted on data from four classes during different environmental seasons. The environmental conditions for each season are displayed in Table 1. Ambient temperatures and humidity percentages were obtained via meteorological records (4).
- The sample included 375 recruits from one LEA.:
  - Fall (FALL): males = 71, females = 18; Age = 28.3 ± 6.9 years; Height = 175.6 ± 8.5 cm; Body Mass = 79.7 ± 14.8 kg
  - Winter (WIN): males = 73, females = 11; Age = 27.8 ± 7.7 years; Height = 172.9 ± 8.4 cm; Body Mass = 81.7 ± 13.9 kg
  - Spring (SPR): males = 75, females = 27; Age = 26.8 ± 6.4 years; Height = 170.5 ± 10.1 cm; Body Mass = 78.5 ± 14.4 kg
  - Summer (SUM): males = 83, females = 17; Age = 26.5 ± 4.9 years; Height = 171.0 ± 9.6 cm; Body Mass = 80.8 ± 14.8 kg
- The VPAT+ occurred in the week prior to the start of academy and consisted of: push-ups and sit-ups completed in 60 s; seated medicine ball throw with a 2 kg ball (MBT); VJ; arm ergometer revolutions in 60 s; 75PR; and MSFT.
- To compare the groups, a one-way ANOVA was used with a Bonferroni post hoc for multiple comparisons ( $p < 0.05$ ) was utilized.

**Table 1.** Ambient Temperatures and Humidity Percentages across the four seasons.

	Fall	WIN	SPR	SUM
Ambient Temp.	22-28°C	18-26°C	22-29°C	21-25°C
% Humidity	20-30%	8-11%	23-50%	39-71%

## RESULTS

- Significant differences were found between the seasons in specific VPAT+ tests, and the descriptive data is displayed in Table 2.
- For the push-ups, WIN and SUM performed 16% and 19% significantly better than SPR.
- In the MBT, SUM performed 18% significantly better than FALL.
- Regarding the arm ergometer, SPR and SUM performed 8-9% better than WINTER, while SUMMER performed 11% better than FALL.
- WIN performed significantly better than SUM, SPR, and FALL in the MSFT, completing 18%, 27%, and 16% more shuttles.
- No significant differences were found in sit-ups, VJ, and the 75PR.

**Table 2.** Descriptive data (mean ± SD) between seasons and VPAT+.

	FALL	WIN	SPR	SUM
Push-Ups	41.21 ± 16.02	45.16 ± 13.41*	38.54 ± 15.38	44.99 ± 17.78*
Sit-Ups	35.06 ± 8.62	35.79 ± 10.17	36.66 ± 12.94	37.71 ± 9.77
MBT (cm)	5.71 ± 1.34	6.16 ± 1.11	6.15 ± 1.46	6.27 ± 1.28 <sup>§</sup>
VJ (cm)	51.49 ± 12.89	54.20 ± 12.30	53.33 ± 14.75	55.58 ± 12.64
Arm Erg. (revs)	123.11 ± 21.33	115.17 ± 24.84	130.13 ± 20.61 <sup>†</sup>	131.68 ± 19.28 <sup>†§</sup>
75 PR (sec)	17.32 ± 1.74	16.97 ± .95	17.01 ± 1.15	17.42 ± 1.40
MSFT (shuttles)	17.32 ± 1.74	16.97 ± .95 <sup>‡</sup>	17.01 ± 1.15	17.42 ± 1.40

\*Significantly ( $p < 0.05$ ) different than SPR.

<sup>§</sup>Significantly ( $p < 0.05$ ) different than FALL

<sup>†</sup>Significantly ( $p < 0.05$ ) different than WIN.

<sup>‡</sup>Significantly ( $p < 0.05$ ) different than FALL.

<sup>‡</sup>Significantly ( $p < 0.05$ ) different than FALL, WIN, and SPR.

## CONCLUSIONS

- Warmer ambient temperatures, coupled with high relative humidity, could have negatively affected recruit performance. This was indicated by Maughan et al. (4), who found that a reduced rate of heat loss at higher levels of humidity, coupled with warmer temperatures, progressively impaired exercise capacity.
- It should be noted that variability in VPAT+ performance across the seasons could be due to class-to-class fitness variations in recruits (3). However, WIN was still significantly better in the MSFT, which is a maximal running test. Aerobic activities have been shown to be greatly influenced by hot environments as a result of increased skin temperature, which decreases cardiac output (4).
- Warmer temperatures can increase cardiovascular strain, while humidity can decrease sweat evaporation rates. Both factors can result in an increased rate to fatigue and poorer performance on the MSFT (3). A decrease in cardiac output due to warmer environmental conditions can prevent adequate blood flow to the skeletal muscle and has been shown also decrease  $VO_{2max}$  (2,4).
- A recruit's performance in fitness assessments could impact possible employment. Ambient weather conditions could have a significant influence on how a recruit performs during fitness assessments, thus potentially playing a role in the hiring process.
- LEA staff may need to consider ambient temperatures and humidity during tests such as the VPAT+ due to possible adverse effects on recruit performance, and this is particularly true for maximal running tests.

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