Short Communication

Anaerobic and aerobic contributions to 800 m and 8 km season bests

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Objective: Both anaerobic and aerobic factors contribute to distance running performance. How these factors relate to middle and long distance running performance in National Association of Intercollegiate Athletics (NAIA) runners has not been previously determined. The purpose of this study was to examine relationships between anaerobic and aerobic assessments and two season best race times (800 m and 8 km) in NAIA runners participating in track and cross-country at a small Midwestern American college.

Design: This study employed a cross-sectional design. Data was collected from a lab visit as well as from season best running times.

Methods: 11 subjects (f = 4) completed a graded exercise test for VO_2max and ventilatory threshold assessment, a 40 m sprint, a standing long jump, and a vertical jump. Correlations were performed between 800 m and 8 km season bests and the aforementioned tests.

Results: 800 m run time correlated only with VO_2max ($r = -.600$; $p = .044$). 8 km run time correlated most strongly with vertical jump height ($r = -.823$; $p = .011$) but also with 40 m sprint ($r = .704$; $p = .039$) and VO_2max ($r = -.670$; $p = .047$).

Conclusions: Anaerobic and aerobic contributions to season best race times in NAIA runners were slightly different than expected based on previous work in different populations. This information may be useful for NAIA track and cross-country coaches interested in determining tests that best relate to running performance in their athletes.

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Key words: NAIA ■ collegiate ■ runners ■ VO_2max

INTRODUCTION

Both anaerobic and aerobic factors contribute to distance running performance.[1-3] Many collegiate runners must compete in multiple events ranging from middle distance (800 m) to long distance (8 km and 10 km). While long distance running is largely aerobic, middle distance running requires significant contributions from both the anaerobic and aerobic energy systems for adenosine triphosphate generation.[4]

Previously, the relationships between anaerobic and aerobic predictors of running performance have been measured in various groups such as male National Collegiate Athletic Association (NCAA) Division I cross-country runners[2], female NCAA Division I cross-country runners[5], male distance runners[4,6], and recreational male and female distance runners[1]. National Association of Intercollegiate Athletics (NAIA) runners have not been well-studied as a unique group. The NAIA governs small university athletic programs; it includes approximately 65,000 student athletes and over 250 colleges and universities.[7] Although previous studies of competitive runners may possibly have included NAIA athletes, it is thought that a sample of specifically NAIA runners will be more homogenous and provide useful information. The purpose of this study was to examine relationships between anaerobic and aerobic assessments and two season best race times (800 m and 8 km) in NAIA runners participating in track and cross-country at a small Midwestern American university. This information may be useful for NAIA track and cross-country coaches interested in determining tests that best relate to running performance in their athletes. It was hypothesized that 800 m season best performance would correlate well with both anaerobic tests (standing long jump, vertical jump, 40 m sprint) and a single aerobic test (VO_2max) while 8 km season best performance would correlate best with the aerobic test.

METHODS

Subjects

Seven men and four women, aged 18-22 years, volunteered for this study. All subjects participated in cross country and indoor and outdoor track and field during the 2015-16 National Association of Intercollegiate Athletics season at Lindenwood University Belleville. No subject sustained any significant injuries during the course of the study. The study was approved by the Institutional Review Board of Lindenwood University Belleville, Belleville, Illinois, USA (Institutional Review Board number 00005).

Study design

Subjects were tested with one aerobic assessment and several anaerobic assessments at the beginning of cross country season between August and September 2015. A 40 m sprint, standing long jump, and vertical jump were completed at one

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visit in an indoor turf room and assessment of height, body mass, and a maximal oxygen consumption (VO_2max) and ventilatory threshold test were completed at another visit in the exercise science laboratory. Both visits took place within the same week with approximately four days allotted between visits. The 40 m sprint, standing long jump, and vertical jump were considered anaerobic assessments while the VO_2max test was considered the aerobic assessment. As subjects were collegiate athletes familiar with treadmill running and exercise testing, no familiarization sessions were used. Race times were recorded from the beginning of September 2015 – May 2016 by Track & Field Results Reporting System (TFRRS). Season best performance is the best reported time obtained during NAIA competition.

Anthropometric measurements

Subjects' height and body mass was measured with minimal clothes and no shoes. Height was measured with a TANITA HR-200 stadiometer. Body mass was measured on a TANITA WB 100A Class 3 scale.

40 m sprint

Each subject had three attempts to sprint 40 m as fast as possible from their choice of a standing position or three point start. The best attempt was recorded. All times were measured with a stop watch.

Standing long jump

Subjects stood with toes behind the starting line and jumped forward as far as possible. Subjects had to land on both feet and distance jumped was measured from the rearmost heel to the starting line with a universal measuring tape. Each subject had three attempts and the furthest one was measured to the nearest cm.

Vertical jump

All subjects performed three attempts to jump as high as possible. Subjects jumped straight up on a wall and placed a piece of tape as high as possible. Distance jumped was then measured to the nearest cm with a universal measuring tape.

VO_2max test

All subjects completed a continuous graded exercise test on a treadmill (Woodway, Model 4Front, USA) to determine their maximal oxygen consumption (VO_2max) and ventilatory threshold (VT). The beginning speed was self-selected at 0% grade, every 2 minutes the grade was increased by 1.5%, and the system recorded all data every 30 seconds. A metabolic cart (True One 2400 metabolic measurement system, Parvo-Medics Inc, Sandy, UT) collected and analyzed the breath-by-breath expired gases. The test was terminated at volitional fatigue which was verified by observation of RER values (>1.1) and RPE values of approximately 20 (Borg's 6-20 point scale). VO_2max was defined as the maximum value reached during the test. VT was defined as the ventilatory break point and calculated automatically by the True One 2400 software.

Statistical analysis

Due to a small sample size, relationships between variables were assessed using Spearman's Rho. Although season bests were collected across a variety of races (Table 1A), correlations were only run on the two races (800 m and 8 km) with the largest sample size. Alpha was set at 0.05. SPSS (version 23) was used for all analyses.

Table 1A Season best race times across various events

Individual Subjects	Sex	Fall 2015 (outdoor)		Winter 2016 (indoor)				Spring 2016 (outdoor)			
		8 km min	5 km min	1 mile min	3 km min	5 km min	800 m min	Half-marathon min	5 km min	1500 m min	800 m min
01	M	31.18	---	5.19	---	---	2.13	---	---	4.31	2.09
02	M	28.48	---	4.50	9.47	17.04	---	78	17.23	4.17	2.11
03	M	28.29	---	5.10	---	---	2.07	---	---	---	2.04
04	M	27.08	---	4.53	9.40	16.30	---	74	16.28	4.28	2.18
05	M	26.08	---	---	---	16.34	---	---	15.46	4.21	2.07
06	M	26.59	---	4.37	9.22	15.57	---	73	16.00	4.07	2.02
07	M	26.04	---	4.40	9.45	16.23	---	74	15.56	4.22	2.10
08	F	---	25.35	---	---	---	2.48	---	---	---	2.47
09	F	---	21.11	---	---	---	---	---	---	---	---
10	F	---	21.20	---	---	---	---	---	---	---	---
11	F	---	---	8.09	---	---	3.38	---	---	---	3.17

Season best race times across the outdoor fall 2015, indoor winter 2016, and outdoor spring 2016 running seasons.

RESULTS

Subject Characteristics

Subjects (n = 11; female = 4) were all NAIA runners on the track and cross-country teams at Lindenwood University Belleville, a small Midwestern American college. Age was 19 ± 2 years, height was 167 ± 10 cm, weight was 59 and ± 10 kg, and VO_2max was 57 ± 11 ml/kg/min (mean ± standard deviation). Season best race times are presented in Table 1A.

Correlations

Positive correlations existed for VO_2max and standing long jump (r = 0.790; p = 0.002), for 40 m sprint and 8 km season best time (r = 0.704; p = 0.039), and for vertical jump and 8 km race time (r = 0.823; p = 0.011; Table 1B and Figure 1A-C). Negative correlations existed for VO_2max and 40 m sprint time (r = -0.927; p < 0.001), VO_2max and 8 km season best race rime (r = -0.679; p = 0.047), VO_2max and 800 m race time (r = -0.600; p = 0.044), and standing long jump and 40 m sprint (r = -0.854; p < 0.001; Table 1B and Figure 1D-G).

DISCUSSION

The main findings from this study were the following: 1) in NAIA collegiate runners, 8 km season best time correlated with an equal amount of strength with both 40 m sprint and VO_2max and 8 km season best time correlated positively with vertical jump height; 2) 800 m season best time correlated only with VO_2max. The finding that the longer distance 8 km season best time correlated well with 40 m sprint and vertical jump was in contrast to our hypothesis that it would best correlate with VO_2max. Also in contrast to our hypothesis was the finding that the middle distance 800 m season best time only correlated with VO_2max; it did not correlate significantly with any measures of anaerobic ability.

The finding that 8 km season best time correlated with an anaerobic measure (40 m sprint) was not surprising as even longer distance running includes an anaerobic component.[1] In male and female recreational distance runners, it was found that 10 km run time correlated with several measures of anaerobic ability including 50 m sprint similarly to the present study.[1] What was unexpected was the similarity of the

Table 1B Correlations between 8 km and 800 m season best race times and various tests

		VO_2max (ml/kg/min)	Vent Thres (% VO_2max)	Standing Long Jump (m)	Vertical Jump (m)	40 m sprint (s)	8 km SB (min)	800 m SB (min; outdoor)
VO_2max (ml/kg/min)	r	1.000	-.047	**.790** *	-.047	**-.927** *	**-.679** *	**-.600** *
	Sig. (1-tailed)	.	.446	.002	.446	<.000	.047	.044
	N	11	11	11	11	11	7	9
Vent Thres (% VO_2max)	r	-0.47	1.000	-.261	.495	.183	.360	-.271
	Sig. (1-tailed)	.446	.	.219	.061	.295	.214	.240
	N	11	11	11	11	11	7	9
Standing Long Jump (m)	r	**.790** *	-.261	1.000	.219	**-.854** *	-.118	-.566
	Sig. (1-tailed)	.002	.219	.	.259	<.000	.400	.056
	N	11	11	11	11	11	7	9
Vertical Jump (m)	r	-.047	.495	.219	1.000	.113	**.823** *	-.306
	Sig. (1-tailed)	.446	.061	.259	.	.370	.011	.211
	N	11	11	11	11	11	7	9
40 m sprint (s)	r	**-.927** *	.183	**-.854** *	.113	1.000	**.704** *	.576
	Sig. (1-tailed)	<.000	.295	<.000	.370	.	.039	.052
	N	11	11	11	11	11	7	9
8 km SB (min)	r	**-.679** *	.360	-.118	**.823** *	**.704** *	1.000	.143
	Sig. (1-tailed)	.047	.214	.400	.011	.039	.	.380
	N	7	7	7	7	7	7	7
800 m SB (min; outdoor)	r	**-.600** *	-.271	-.566	-.306	.576	.143	1.000
	Sig. (1-tailed)	.044	.240	.056	.211	.052	.380	.
	N	9	9	9	9	9	7	9

Correlations (Spearman's rho) between selected variables. *Outdoor* race time during the outdoor track season, *SB* Season Best, *Vent Thres* Ventilatory Threshold. *Significant correlation at P < 0.05 (bolded).

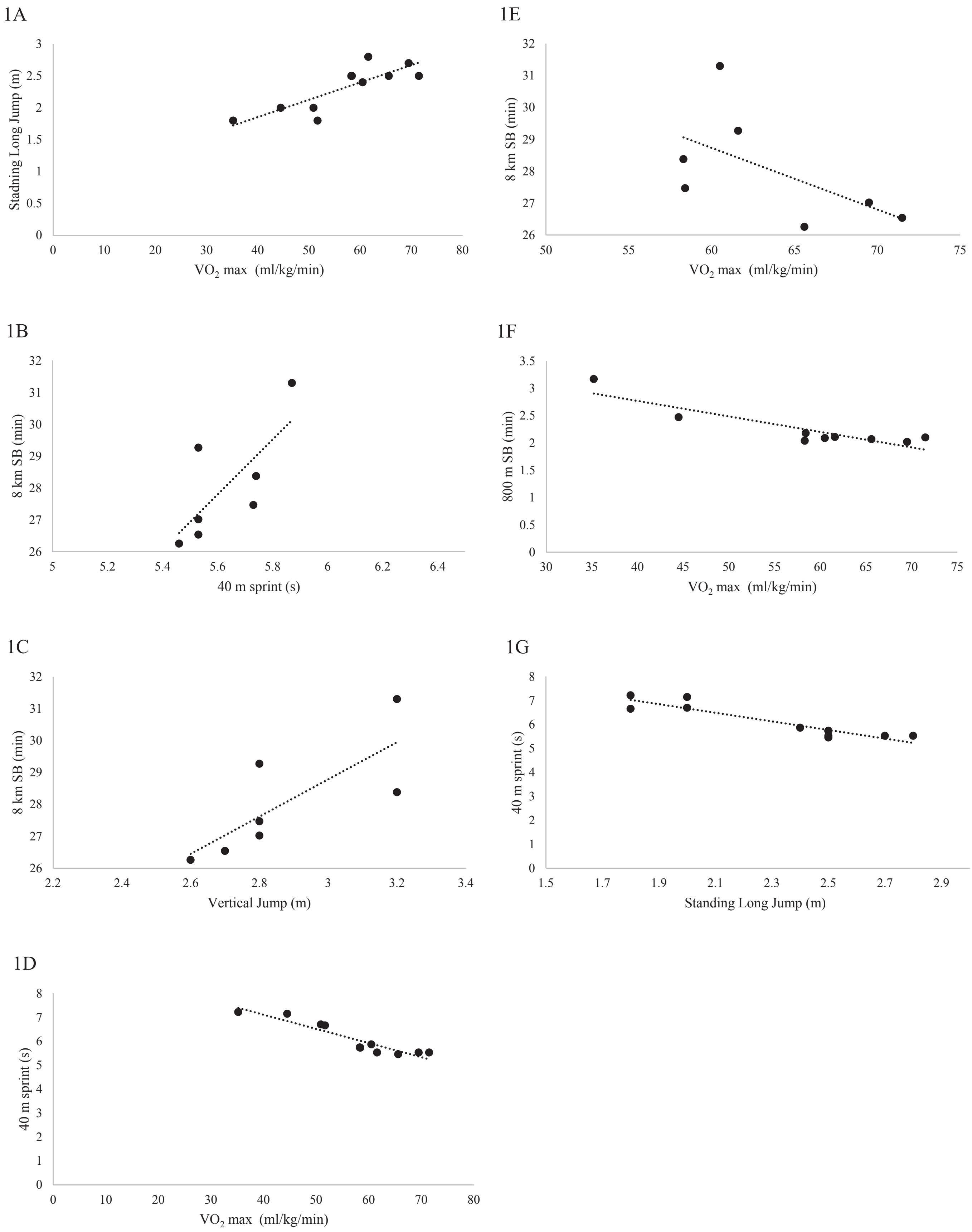

Figure 1 Graphical depiction of significant correlations. For r, p, and n, see Table 1B.

strength of this correlation compared to the VO_2max correlation as VO_2max is known to be related to endurance running performance.[8] VO_2max, running economy, and lactate threshold are thought to be the key influences of long distance running performance[9] so the strength of the 40 m sprint to 8 km run time was intriguing. The strong positive correlation found between vertical jump and 8 km season best time was unexpected and contrary to previous literature.[1] It is speculated that, while 40 m dash is a sport-specific test for runners, vertical jump is a non-habitual movement for runners and thus, this test may have not been ideal for assessment of anaerobic capabilities in this population. Finally, the lack of a correlation between ventilatory threshold and 8 km running time was not expected as ventilatory threshold is thought to be somewhat reflective of the lactate threshold and has previously been found to strongly correlate with 10 km running time in experienced male distance runners.[10]

The finding that 800 m run time only correlated with VO_2max was unexpected. Although both middle and longer distance running performance are influenced by aerobic and anaerobic contributions, it is thought that middle distance running particularly relies on a large anaerobic component.[3] Several studies have shown relationships between middle distance running performance and anaerobic measures. Deason et al. (1991) showed that in male distance runners a strong relationship existed between 800 m run time and the more purely anaerobic 300 m run time ($r = 0.826$) while the relationship between 800 m run time and VO_2max was non-significant ($r = -0.491$) with alpha set at 0.05. Houmard et al.[6] found in well-trained male distance runners that 5 km race time (another middle distance) was moderately correlated to both vertical jump height ($r = -0.73$) and VO_2max ($r = -0.60$). In a study of NCAA Division I female cross-country runners, it was found that anaerobic energy production contributed to 5 km velocity along with aerobic contributions.[5]

These discrepancies in the present findings from those of previous research could possibly be explained by the relative athletic abilities of the athletes as NAIA athletes are not at the competitive level of the NCAA Division I athletes examined in some other studies. In the present study, average VO_2max was 57 ml/kg/min while in both of the two aforementioned studies of male runners average VO_2max was approximately 62 ml/kg/min.[4,6] This is not a large difference, but could perhaps partially explain the discrepancies. In the aforementioned study of female cross-country runners[5], VO_2max was actually lower (54 ml/kg/min) than that of the present study which is perplexing unless we assume that they simply had better racing ability due to better running economy (a variable not assessed in the present study). These differences in athletic ability could possibly have contributed to some of the differences seen between the present study and previous work although this idea is speculative. More work with larger sample sizes in this population would provide better insight into these differences.

CONCLUSION

In conclusion, relationships between anaerobic and aerobic measurements and season best running time in NAIA college runners were slightly different than expected based on previous work in non-NAIA runners.[1,4-6] 8 km run time was related to vertical jump height, 40 m sprint time, and VO_2max. Unexpectedly, 800 m season best time was only related to VO_2max and not to any anaerobic measures. These findings suggest that runners at this level may exhibit somewhat unique characteristics not seen at other levels of competition. This information may be useful for NAIA track and cross-country coaches interested in determining tests that best relate to running performance in their athletes.

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