TOPICS IN EXERCISE SCIENCE AND KINESIOLOGY

Early-Morning and Late-Night Maximal Runs: Metabolic and Perceived Exertion Outcomes

Process of Science

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Abstract

- People may exercise at the ends of their day to fit activity into their schedule; the purpose of this investigation was to determine if metabolic or perceived exertion outcomes differed between maximal runs early in the morning and late at night.
- After consuming a standardized, glucose drink, thirteen recreationally active individuals completed an early-morning and a late-night run on the treadmill while researchers measured metabolic (aerobic capacity and substrate usage) and perceived exertion outcomes.
- **Point of application #1**: Aerobic capacity (maximal consumption of oxygen) and the usage of fat as a fuel to support energy production during exercise were similar between runs.
- **Point of application #2:** Maximal perceived exertion (Borg's 6-20) was similar during early-morning and late-night runs.
- **Point of application #3:** While research indicates that people may prefer activity in the morning or evening, and this might impact metabolic responses to the exercise bout, most of our participants (n=8) identified with no preference for exercising in the early-morning or late-night.
- Key Words: glucose; CHO shake; VO_2max; fat oxidation; effort

Introduction

There is evidence to suggest that the physiological outcomes of an exercise bout may be impacted by whether the session occurs in the early-morning or late-night (4; 8). It is of interest to understand if metabolic outcomes (aerobic capacity and fuel substrate usage) differ during maximal runs early in the morning (6:00-9:00) and late at night (21:00-24:00; see Point of Application #1). Exercise professionals may also be concerned with how a variable such as perceived exertion may change based on the time of day that exercise occurs (see Point of Application #2). The chronotype of an individual (meaning the preference for morning, evening, or neither) may be an overlooked independent variable that could affect responses during exercise at ends of the day (2; 9; see Point of Application #3). Finally, it is known that outcomes of an exercise bout can be influenced by pre-exercise nutritional choices (7). The purpose of this research was to compare metabolic and perceived exertion outcomes during maximal runs in the early-morning and late-night after providing a standardized, glucose drink.

Methods and Results

Thirteen participants (females=8, males=5) were enrolled. Participants completed a familiarization trial prior to their early-morning and late-night maximal runs. During familiarization, each participant jogged on the treadmill at a "slow but comfortable jogging speed." The speed was then increased until each participant perceived the exercise intensity as a 12-13 on Borg's 6-20 RPE scale (1). This speed was recorded and utilized during the early-morning and late-night trials. Each maximal test was intended to elicit a VO_{2max} response around the 10-minute mark by maintaining treadmill speed and increasing grade 2% every 2 minutes. Heart rate, aerobic capacity (maximal oxygen consumption), respiratory exchange ratio (relative use of fat as a metabolic fuel), and perceived exertion (Borg's 6-20) were recorded during each stage and at test termination. To standardize nutrition, each participant consumed a glucose-rich drink two hours prior to each test (80% carbohydrate, 3% fat, and 17% protein). The drinks were prepared based on body weight to represent approximately one-quarter of the day's estimated energy requirements. After both runs were complete, each participant completed the online Morningness-Eveningness Questionnaire (MEQ, http://www.cet-surveys.com/index.php?sid=61524) to determine chronotype (adapted from 3). Aerobic capacity, the usage as fat as a fuel to support exercise energy production, and maximal perceived exertion were similar during runs ($p > .05$). Because most participants ($n=8$) identified with neither a preference for morning nor night, there was not enough evidence to determine if chronotype could influence the outcomes investigated.

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1. Aerobic capacity and the usage of fat as a fuel were similar between runs.

The early-morning and late-evening runs lasted a mean of 10.2 (±2.3) minutes and 9.9 (±2.6) minutes, respectively. Aerobic capacity, measured as maximal consumption of oxygen, was not different (p=.68) between testing in the early morning (47.5 mL/kg/min) or evening (47.8 mL/kg/min), as displayed in Figure 1a. Maximal oxygen consumption was measured using a 15-breath moving average sampling frequency (6). Oxygen consumption and respiratory exchange ratio were used together to assess total fat oxidation. Usage of fat as a fuel did not differ (p=.64) between early-morning (24.8 kcal) and late-night (27.2 kcal) tests, as shown in Figure 1b. While some individuals believe exercise at a certain time of day may increase fat burning during exercise, our data does not support the notion. Fat oxidation may have been suppressed by the high level of glucose provided prior to each run.

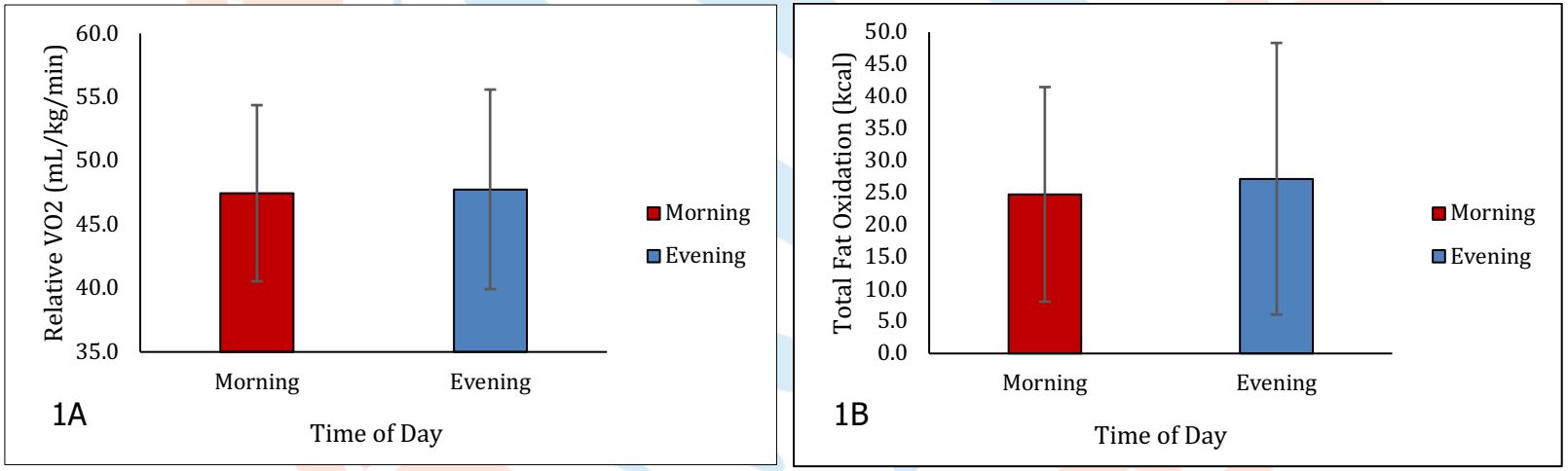

Figure 1. Maximal oxygen consumption (1a, left) and total fat oxidation (1b, right) were not different between the 13 participants performing the early-morning and late-night runs (p>.05). Values are provided as means ± standard deviations.

2. Maximal perceived exertion was similar between runs.

Rated on Borg's 6-20 scale, participants perceived their maximal exertion to be similar during early-morning (18.7) and late-night (18.6) maximal running (p=.61; displayed in Figure 2a). Some individuals may plan exercise at a certain time of day because they perceive it to be easier, but our data do not offer evidence of this phenomenon. Heart rate response, a physiological indicator of exercise intensity, was visually and statistically similar at all stages and at test termination (p>.05; displayed in Figure 2b).

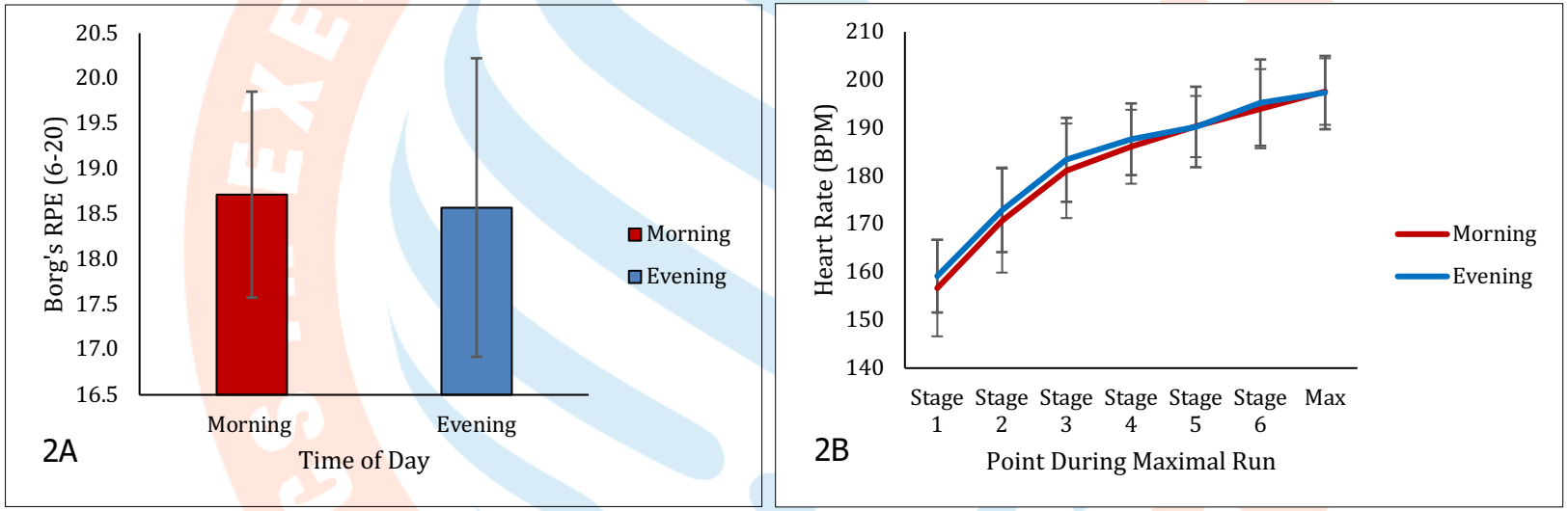

Figure 2. Maximal RPE (2a, left) of the 13 participants was similar between early-morning and late-night runs (p>.05), and heart rate response (2b, right) was visually and statistically similar during all stages (p>.05). Values are provided as means ± standard deviations.

3. Most of our participants did not identify with a preference for morning or night.

After completing both the morning and evening runs, all 13 participants completed the online MEQ to determine if they were a morning-type, neither-type, or evening-type (MEQ score range in Table 1). Participants' respective chronotypes are of interest; the present study evaluated whether aerobic capacity, total fat oxidation, or perceived exertion differed when participants exercised near their preferred time of the day. As noted above, no differences were found in metabolic or perceived exertion outcomes between the early-morning and late-night runs. Interestingly, this may be partially explained by the fact that most of our participants (*n*=8) identified as neither-types. Research is sparse, but there is evidence of chronotype affinities reported from a previous observation (https://sleephabits.net/morningness-eveningness-questionnaire). In this previous observation, morning-types are referred to as "larks" and evening-types are labeled "owls."

Table 1. The number of morning-types, neither-types, and evening-types, ranges of MEQ scores associated with those designations, and reported chronotype affinities from previous observation are displayed.

	Morning-types ("Larks")	Neither-types (N/A)	Evening-types ("Owls")
MEQ Score Range	59-86	42-58	16-41
Our Sample, n and %	*n*=5 38.5%	*n*=8 61.5%	*n*=0 0%
Previous Observation	10%	70%	20%

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Equipment and Resources Utilized

- ParvoMedics metabolic cart, TrueOne 2400, ParvoMedics, Sandy, UT
- Morningness-Eveningness Questionnaire (http://www.cet-surveys.com/index.php?sid=61524). The survey was adapted from original research by Horne and Östberg (Horne, J.A.; Östberg, O. (1976).
- Borg's scale of Rating of Perceived Exertion (6-20)
- Polar heart rate monitor, Kempele, Finland
- A 15-breath moving average sampling frequency was used, Scheadler, C. M., Garver, M. J., & Hanson, N. J. (2017). The Gas Sampling Interval Effect on VO2peak Is Independent of Exercise Protocol. *Medicine & Science in Sports & Exercise*, *49*(9), 1911–1916. doi:10.1249/mss.0000000000001301
- The high-glucose drink (80% carbohydrate, 3% fat, and 17% protein) consisted of a yogurt base with strawberries, blueberries, table sugar, and protein powder blended together.