Chronobiology of Glucose's Effect on Anaerobic Exercise

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Abstract:

Chronobiology is the study of the underlying time-based mechanisms found in organisms. It has been well documented that the human body's ability to process glucose is better in the morning compared to the evening (4,6). This could potentially impact one's high intensity, short duration exercise performance that relies primarily on carbohydrate metabolism depending on what time of day carbohydrates were consumed. Therefore, the purpose of this study is to determine if the chronobiology of glucose affects anaerobic power. Twelve subjects were recruited to consume 75 grams of glucose at 6 am and 4 pm on two separate occasions. Blood glucose was measured throughout 90 minutes post ingestion. Subjects then performed 2 30-second lower body power (Wingate) tests separated by 7 minutes. The results didn't find statistically significant data when comparing morning and evening blood glucose consumption. No statistical significance was found in peak power or mean power produce from the Wingate tests.

Introduction:

Chronobiology studies the natural physiological rhythms of organisms by looking at the biology of time and internal clocks. It has been well documented that the human body's ability to process glucose is better in the morning compared to the evening (1,4,6).The increased sensitivity is due to more efficient secretion of insulin in the morning through beta cells resulting in increased regulation of beta cells through Clock BMAL1. The central brain clock in the hypothalamic suprachiasmatic nucleus (SCN) is responsible for the sleep-wake cycle and synchronizes other rhythms throughout the body by utilizing various pathways (3,5). Cortisol is one hormone that is released via connections to the SCN. Cortisol secretion peaks before the onset of an active period. Both insulin signaling and secretion are affected as a result of cortisol secretion. Insulin secretion rate will decrease as a result of cortisol secretion because pancreatic beta cells will have a higher workload and thus less secretion is necessary (2,7). This could potentially impact one's high intensity, short duration exercise performance that relies primarily on carbohydrate metabolism.

Hypothesis:

Since it is known that the body will be better process glucose in the morning the expectation is that the body will better utilize the increase in glucose during anaerobic exercise and return to fasting blood glucose.

Methods:

Participants

Nine (n=6 female, n= 3 male) physically active college students (20.11 yrs ±1.17; 65.5 in ± 3.82; and lbs ±25.87) participated in the study. Each of the 9 participants self-identified as being without any preexisting metabolic conditions. All participants reported that they were considered physically active by participating in physical activity for at 30 minutes a day for the past 3 months. Participants were recruited from the campus by word of mouth and advertising flyers. This study was approved through the Institutional Review Board at the University of Mount Union, and all participants signed informed consent documents prior to any experimental testing.

Experimental Design

The participants met a total of two times throughout this study. The first meeting consisted of the participants reporting to the lab at 6:00 am on the first day of testing following a 6 hour fast. Fasting blood glucose was measured followed by consumption of 10z of a 75g Azer Scientific Glucose Tolerance Test Beverages in 10 minutes. Fifteen minutes post consumption t the first blood glucose measurement was taken followed by every 15 minutes for 90 minutes. Subjects remained seated throughout the duration of the trial. Following the 90 participants completed 2 30-second Wingate trials on a Veletron Cycle Ergometer (Racer Mate, Version 1.0.2) with 7 minutes between each test. Blood glucose was measured between each test and 10 minutes after the final test. For the second day of testing, participants began testing at 4:00 pm. Participants arrived fasted for 6 hours and the same procedure from the morning trial was followed.

Figure 1. Oral Glucose Tolerance Test comparing morning vs evening (p= .538).

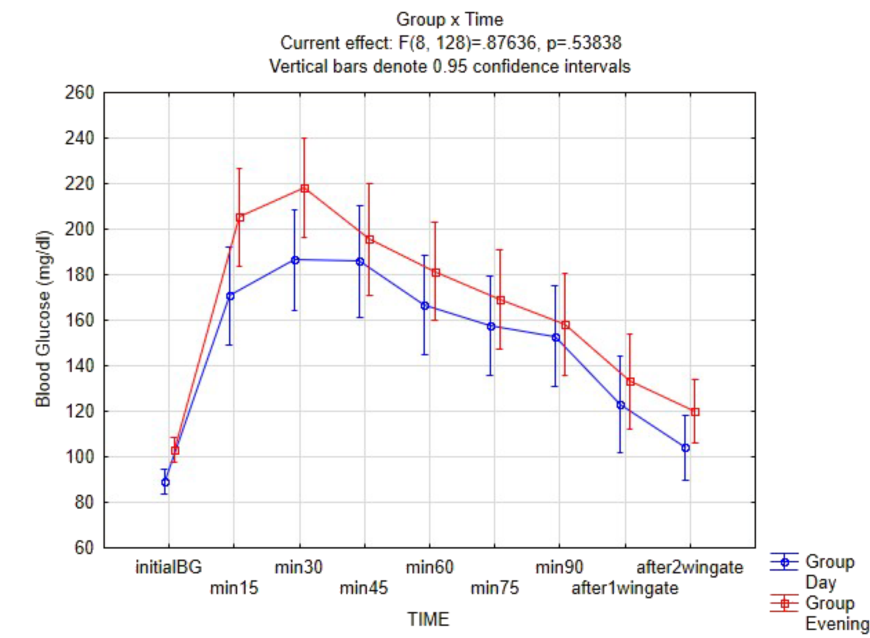


Figure 2. Oral Glucose Tolerance Test time effect (p=0.00).

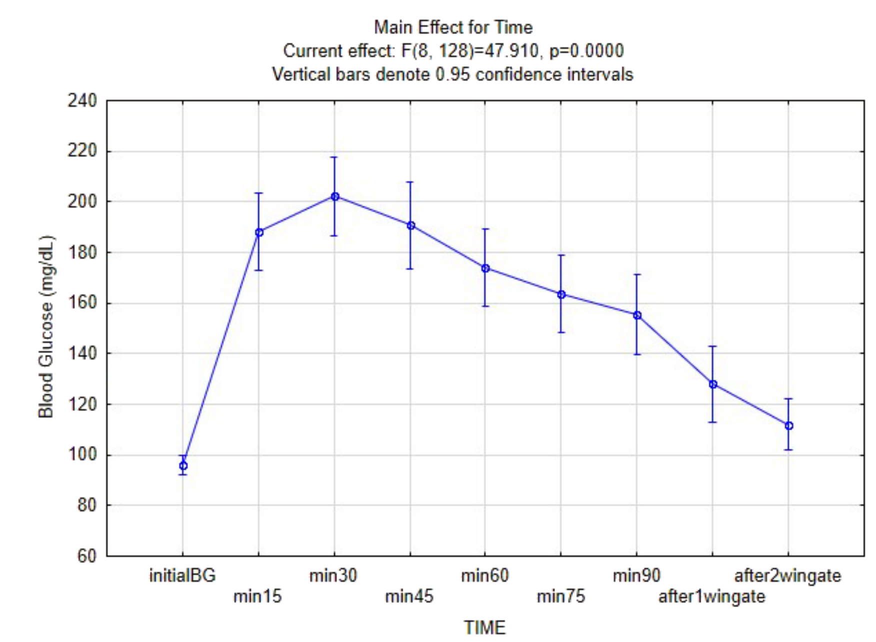


Figure 3. Oral Glucose Tolerance Test group effect (p=.081).

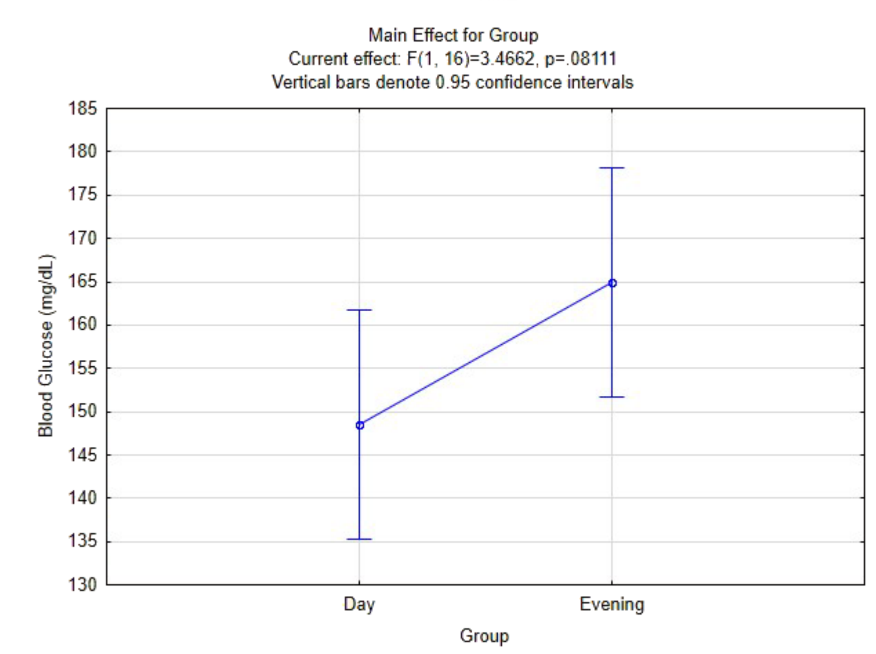


Figure 4. Peak Power (p= .388).

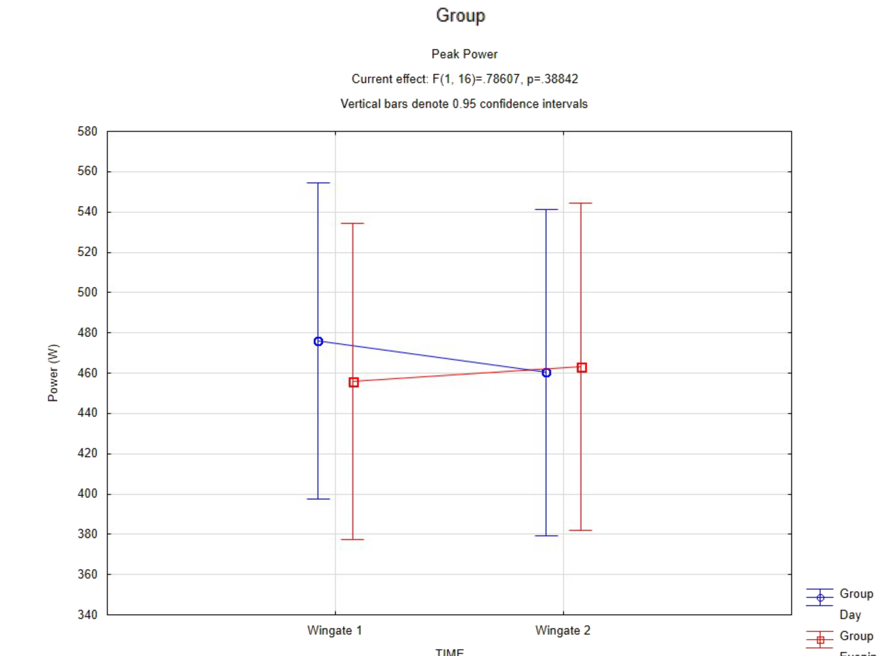
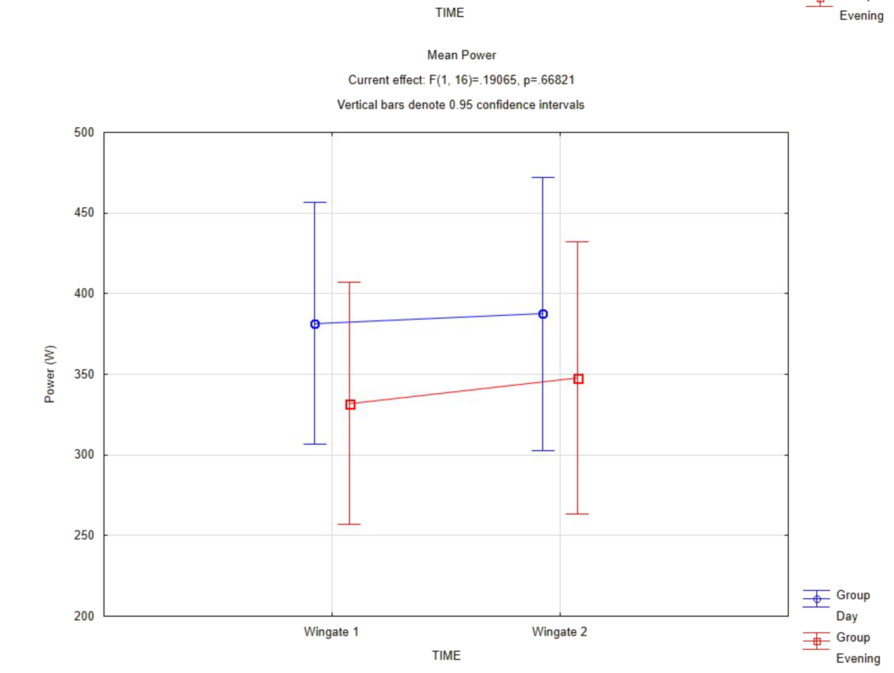


Figure 5. Mean Power (p= .668).



Results:

Table 1. Descriptive data

					Morning				Evening			
	Age	Gender	Height (inches)	Weight (pounds)	peak power (W) during 1st wingate	Mean power (W) during 1st wingate	peak power (W) during 2nd wingate	Mean power (W) during 2nd wingate	peak power (W) during 1st wingate	Mean power (W) during 1st wingate	peak power (W) during 2nd wingate	Mean power (W) during 2nd wingate
Subject 1	18	F	70.5	146	423	272	455	322	414	300	393	300
Subject 2	21	M	68	175	588	547	670	620	593	413	608	482
Subject 3	19	F	61	106	253	178	236	177	326	197	355	218
Subject 4	22	F	62	142	429	392	461	412	407	260	451	273
Subject 5	20	F	64	170	576	457	551	460	483	405	484	399
Subject 6	20	F	62	130	584	464	404	321	369	289	390	294
Subject 7	21	M	70	185	635	512	597	554	598	444	628	503
Subject 8	20	M	69	130	428	355	413	341	477	374	445	358
Subject 9	20	F	63	129	367	257	356	280	437	306	415	304

Discussion:

Although no interaction was found in the OGTT between morning and evening consumption of carbohydrates, there was a trend (p=0.08) in the group main effect over the course of 90 minutes (Fig 3). This finding aligns with previous research on the dawn phenomenon (4). A relationship between the timing of glucose consumption and blood sugar has previously been established (1,4,6). Thus, blood glucose appears to be better processed in the morning. The synchronization pathways of peripheral clocks by the SCN describes a close relationship between Clock BMAL1 and daily rhythms of the body (3). This study showed the successful restoration of circadian rhythm by the release of cortisol (5). It has also been shown that insulin secretion (decrease) is affected by the release of cortisol (2,7). This can impact the amount of glucose utilized in anaerobic exercise as seen in the data collected.

Conclusions:

These data suggest that regardless of time of consumption of carbohydrates there is no statistical difference on blood glucose levels over a period of 90 minutes. The data also suggests that there is no statistical difference in the power output post glucose consumption Due to limited sample size, future research is warranted to further investigate the chronobiology of carbohydrate consumption and its potential impact on anaerobic power.

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