

Effect of Post-Prandial Exercise Duration on Glucose and Insulin Responses to Feeding

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PURPOSE

Obesity is reaching an alarming incidence. In the United States alone 55% women and 63% of men over the age of 25 are either over weight or obese (Must et al. , 1999). Due to the rising incidence of obesity in developed countries there has been an increase in interest in the health effects of obesity. Sedentary living and high carbohydrate intake have been found to lead to insulin resistance and compensatory hyperinsulinemia, even when blood glucose concentrations remain normal (Foster-Powel and Miller, 1995). Sedentary living, high carbohydrate intake and the resulting hyperinsulinemia may be the common link between sedentary living and obesity on the one hand and the rising incidence of “diseases of civilization” including: hypertension, obesity, coronary disease, and type 2 diabetes on the other hand (Chakravarthy and Booth 2004, Reaven, 1988; DeFronzo and Ferrannini, 1991; Reaven, 1994). Hyperinsulinemia has also been suggested as a causative link to a variety of conditions or diseases such as acne, early menarche, increased stature, myopia, skin tags, polycystic ovary syndrome, male vertex balding and epithelial cell (breast, prostate, etc.) carcinomas (Cordain, 2003).

Chronic exercise has been shown to increase insulin sensitivity and decrease hyperinsulemia. Increased muscle stimulation leads to an increase of glucose absorption due to increased membrane permeability (Ivy, 1987). It has been suggested that exercise increases the amount of insulin-responsive glucose transporters and other enzymes that control transport, storage, and oxidation of glucose (Ivy, 1987). Increases of glucose uptake lowers blood glucose, resulting in a decrease in insulin release. In sedentary individuals the reduced number of insulin sensitive glucose transporters leads to a larger insulin concentration necessary to maintain normal blood glucose concentrations (e.g. hyperinsulinemia)

Glucose concentration tends to spike after eating a meal. However it has been found that exercise can also act acutely to regulate glucose and reduce the amount of insulin necessary to manage the glucose load from a meal. A recent study from our laboratory demonstrated the effects of moderate intensity post-prandial exercise on glucose and insulin responses (Foster, 2002). That study demonstrated that exercise moderates glucose and insulin responses to a meal, but that the effects of exercise are short lived and the levels of glucose and insulin increased following exercise.

In view of the simplicity of recommending post prandial exercise as a strategy for controlling hyperglycemia and hyperinsulinemia, the purpose of the present study was to determine if the magnitude of glycemic and insulinemic control was responsive to the duration of post-prandial exercise.

METHODS

The subjects were 9 males and 2 females that were apparently healthy and moderately active. All subjects provided informed consent before participation, and the protocol had been approved by the UWL Institutional Review Board for the Protection of Human Subjects. Following a maximal incremental treadmill test, performed to determine exercise capacity; the subjects were tested four additional times. The maximal treadmill test included four minutes at 3.5 mph and a 0 degree grade with a 2% increase in grade every two minutes until the subject was fatigued. While the subject was exercising on the treadmill respiratory metabolism was measured using open circuit spirometry. The v-slope method was be used to determine ventilatory threshold.

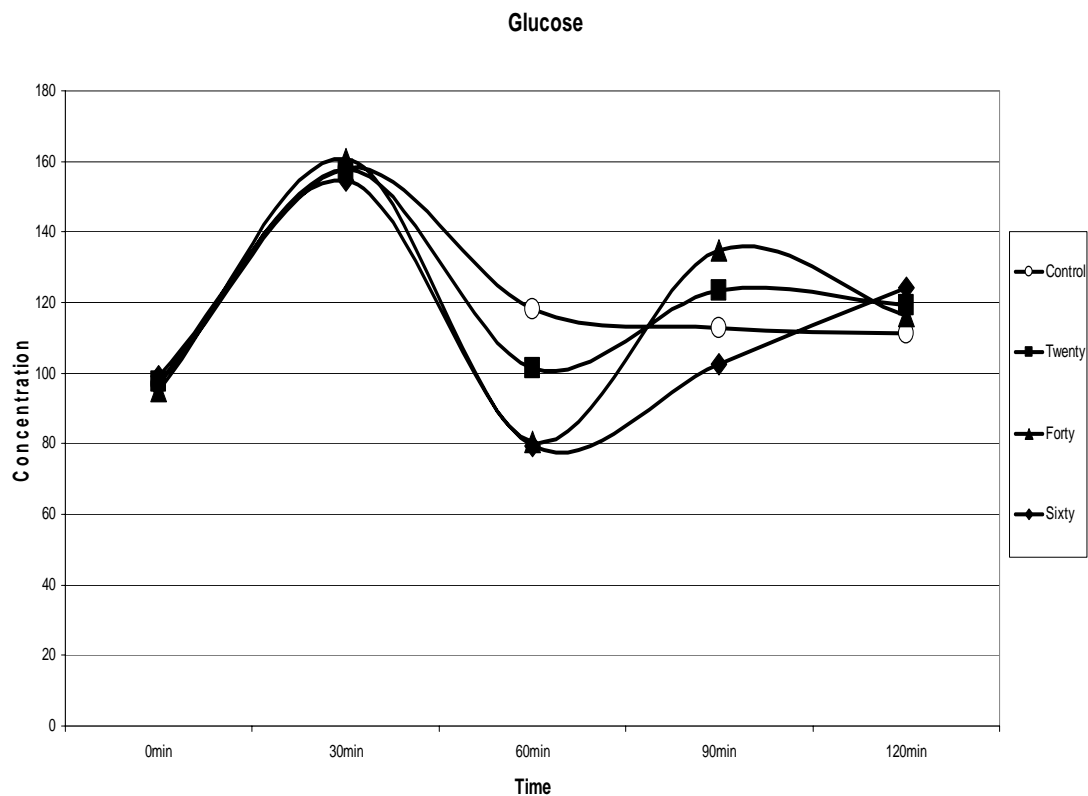
The four experimental exercise sessions were performed in random order and consisted of a standard meal followed by exercise bouts of 20, 40 & 60 minutes at moderate intensity or by rest. All subjects were asked to fast for at least six hours prior to testing. As soon as the subjects reported to the lab fasting glucose and insulin concentrations were measured using capillary blood obtained from a fingertip. This sample begins the time sequence for the rest of the study. Additional blood samples were acquired at 30 minute intervals. The subject then consumed a meal of approximately 900 kcal, consisting of a Turkey Sandwich on White Bread, Macaroni and

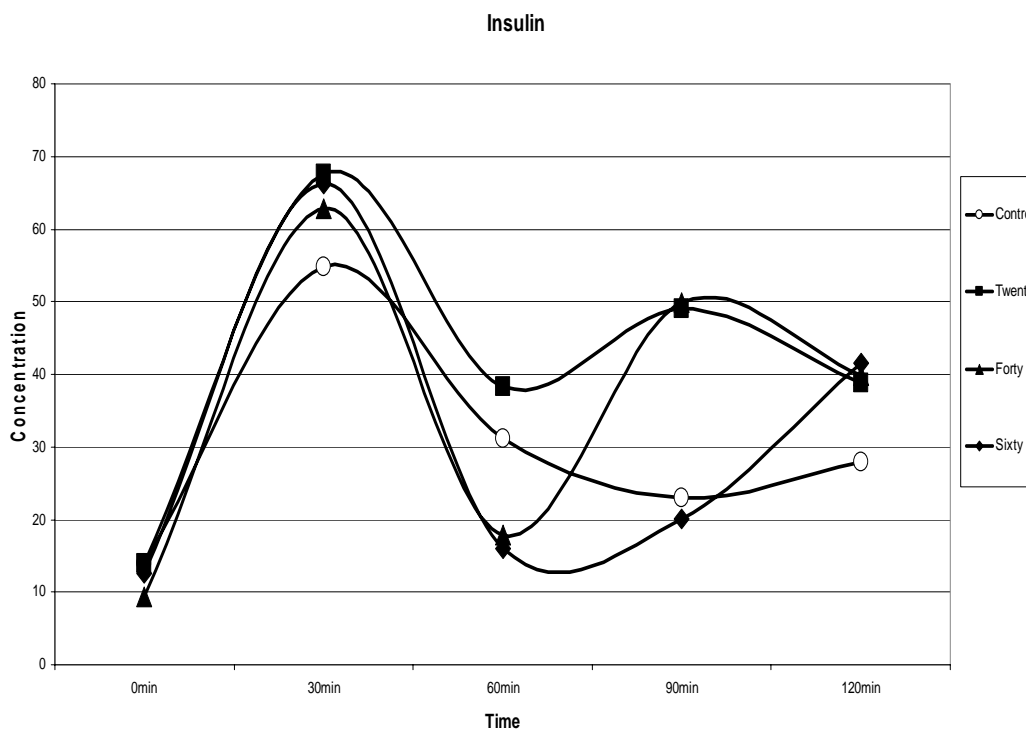
Cheese, and 12 ounces of Cranberry Juice. The ingestion of the meal took approximately 20 minutes. The exercise sessions required the subject to walk on a treadmill beginning at 30 minutes (e.g. 10 minutes after the meal) for 20,40, or 60 minutes at a pace determined from the treadmill test at the first session. A speed and grade combination that evoked an intensity of 70% of the oxygen consumption (VO_2) at the ventilatory threshold was used. Perceived exertion was recorded using the Category Ratio version of the Rating of Perceived Exertion scale. Blood samples were analyzed for glucose using dry chemistry, and for insulin using ELISA assay kits.

RESULTS

The mean HR during the exercise bouts was 66 % of HRmax and the mean RPE was 3, both of which are consistent with easy –moderate exercise.

The longer bouts of exercise produced a greater decrease in glucose and insulin. This can be seen in Figures 1 & 2. The first point on the graph is the fasting concentration followed by a increase in glucose and insulin concentrations after the meal. After this point the concentrations began to decrease, with all of the exercise groups showing a larger decrease than the resting state (open circle). Glucose and insulin concentrations then rebounded to normal values after exercise was stopped. Of the four protocols, the sixty minutes of exercise showed the largest decrease over time, and also demonstrated a smaller rebound after exercise stopped.





DISCUSSION

The results showed a decrease in insulin and glucose concentrations with longer exercise duration that was more pronounced than our earlier study using only 20 minutes of exercise. This is because exercise facilitates glucose transport without the presence of insulin, and more exercise contributes proportionately to a larger decrease. The rebound after the exercise is over may have occurred because exercise delayed gastric emptying and food was still emptying from the stomach after the exercise bout. Although exercise is not thought to influence gastric emptying until the intensity passes the ventilatory threshold, this is the simplest explanation for the present findings. A reasonable continuation of this study would be to see what the response would be with the same exercise protocol but with a low glycemic index meal.

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