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Effects of Sugar-Sweetened Beverages on Glycemic and Insulinemic Outcomes: A Randomized Control Trial

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ABSTRACT

Reducing sugar-sweetened beverage (SSB) consumption is associated with improved metabolic health in adults, but there is limited experimental research examining the consequences of adding SSBs to the diet, particularly in healthy individuals. The aim of the current study was to determine whether there were differences in glycemic and insulinemic outcomes following three weeks of added caffeine-free soda, 100% fruit juice, or water in healthy young adults. College-aged participants (21.2±2.8yrs; n=36) were randomized to one of three beverage conditions: water (W), caffeine-free soda (S), or 100% fruit juice (FJ). Participants completed baseline anthropometric measurements, and fasting and SSB-tolerance glycemic and insulinemic assessments (via fingerstick and venous blood samples). Participants consumed two servings/day (~710 mL) of their assigned beverage for three weeks. Baseline assessments were repeated following the 3-week intervention. There were no significant effects of time or beverage condition for glucose (incremental area-under-the-curve) ($M\pm SD$; Baseline: W:1367±1022, S:1804±1192, FJ:1588±1144 mg/dL x 2hr; 3-weeks: W:1166±1128, S:1800±1256, FJ:1151±795 mg/dL x 2hr; $ps>0.05$) and insulin (incremental area-under-the-curve) ($M\pm SD$; Baseline: W:1602±910, S:2022±1065, FJ:1863±993 mg/dL x 2hr; 3-weeks: W:1369±655, S:1658±1036, FJ:1875±691 mg/dL x 2hr; $ps>0.05$). Following the 3-week intervention, changes in fasting glucose ($p=0.88$), fasting insulin ($p=0.97$), and Homeostatic Model Assessment for Insulin Resistance ($p=0.96$) were not significantly different between beverage conditions. These results suggest that in healthy young adults, under free-living conditions, the addition of SSBs to the diet for three weeks does not modify glycemic or insulinemic outcomes. Longer-term trials and studies that include participants with increased metabolic risk are needed to further elucidate glycemic and insulinemic responses following the addition of SSBs to the diet.

BACKGROUND

- Sugar-sweetened beverages (SSBs) are major sources of added sugars in the U.S.
- SSBs account for one third of added sugar consumption in U.S. children and adults¹.
- The increasing rates of SSB consumption runs parallel with the rising rates of diabetes and obesity².
- Previous research studies have shown a link between the consumption of SSBs and an increased risk of metabolic syndrome and insulin resistance³⁻⁵.

PARTICIPANTS

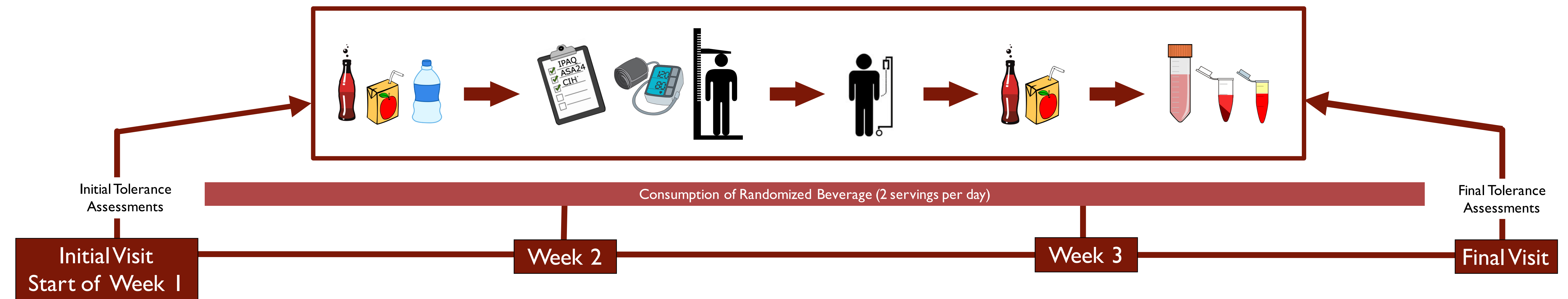
- 36 participants (male and female) between ages 18-30
- Participants were free of diabetes and glucose or lipid lowering medication.
- Participants had 2 or fewer risk factors for cardiovascular disease according to current American College of Sports Medicine Guidelines.

Table 1: Baseline Participant Characteristics

	All (n=34)	Soda (n=10)	Fruit Juice (n=12)	Water (n=12)
Gender (Male:Female)	18M:18F	7M:5F	3M:9F	8M:4F
	Mean ± SD			
Age (yr)	21.3 ± 2.7	21.1 ± 2.6	21.9 ± 2.2	20.8 ± 3.4
Height (cm)	174.7 ± 7.5	173.7 ± 7.9	170.9 ± 7.5	179.4 ± 7.1
Weight (kg)	74.9 ± 13.8	72.9 ± 15.6	75.7 ± 13.2	76.2 ± 12.5
Waist Circumference (cm)	88.6 ± 10.8	88.3 ± 13.9	90.0 ± 9.6	87.4 ± 8.9
Body Fat (%)	27.0 ± 11.0	25.8 ± 12.4	32.5 ± 11.3	22.8 ± 9.4
Systolic Blood Pressure (mmHg)	116.7 ± 11.6	119.2 ± 12.5	111.7 ± 9.0	119.2 ± 13.2
Dystolic Blood Pressure (mmHg)	67.5 ± 10.1	71.9 ± 11.8	65.1 ± 7.5	65.4 ± 11.1

METHODS

- Participants were randomized to a beverage category (caffeine-free soda, 100% fruit juice, and water).
- Baseline assessments of height, weight, waist circumference, blood pressure, body fat percentage were performed.
- Participants underwent a glucose tolerance test where they consumed 50 grams of carbohydrate as either caffeine-free soda or 100% fruit juice.
- Repeated blood samples were collected via a catheter inserted in the participant's forearm to assess glucose over a 2-hour period after consumption.
- After collecting measurements, participants were given a 3-week supply of their beverage condition and were expected to drink 2 servings/day for 3 weeks.
- Following the 3 weeks, participants visited the laboratory to repeat all assessments measured during the first visit.



RESULTS

Figure 1: Insulin Levels Pre- and Post-Intervention

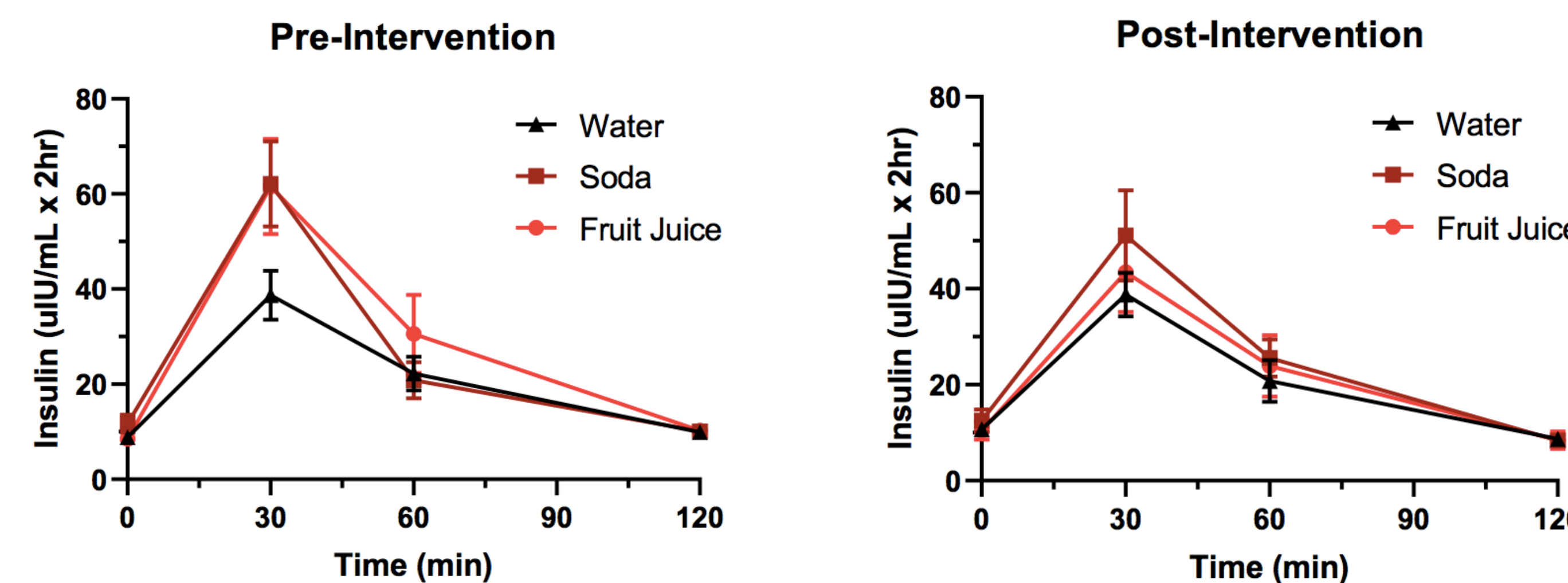


Figure 3: Insulin Incremental Area Under the Curve (iAUC)

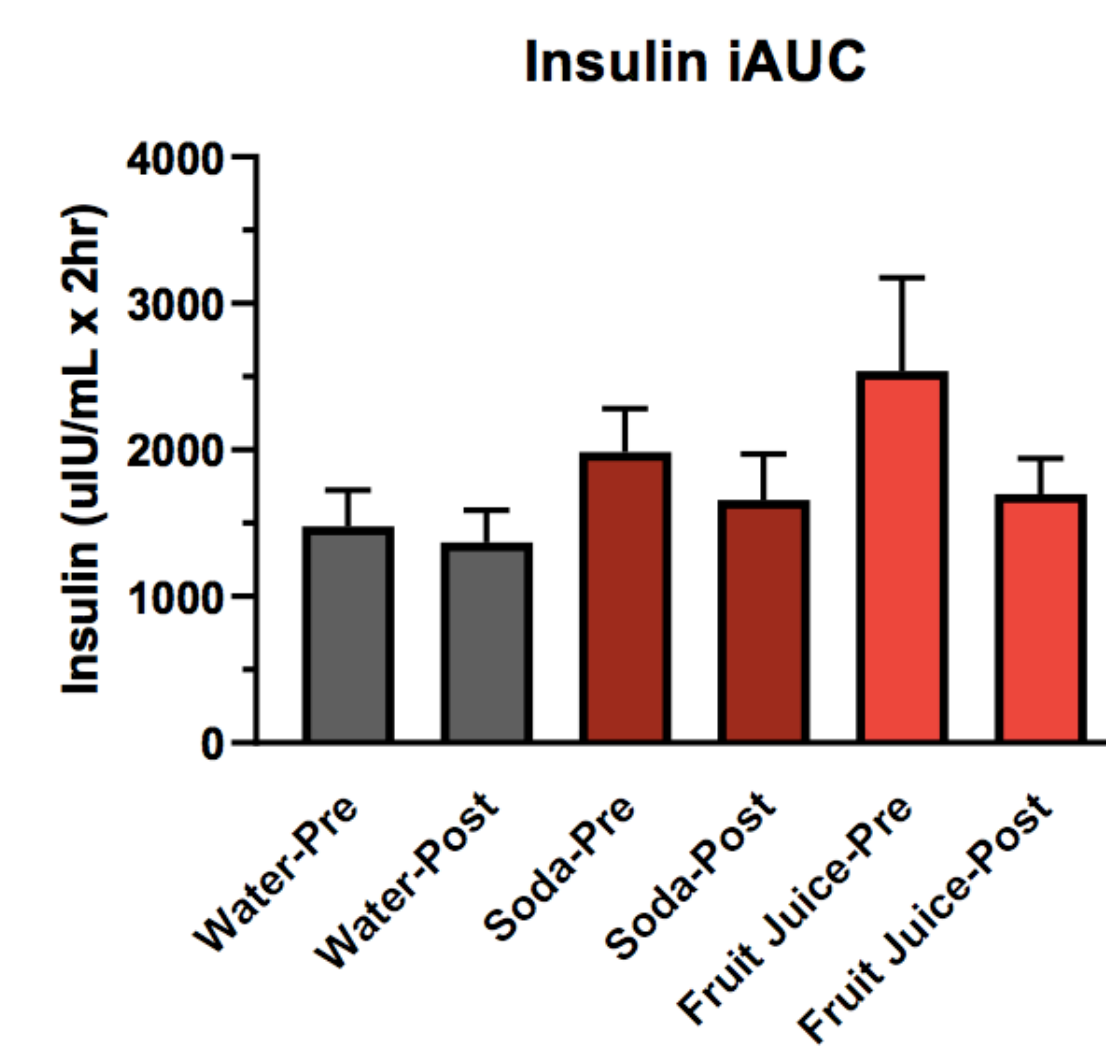


Figure 2: Glucose Levels Pre- and Post-Intervention

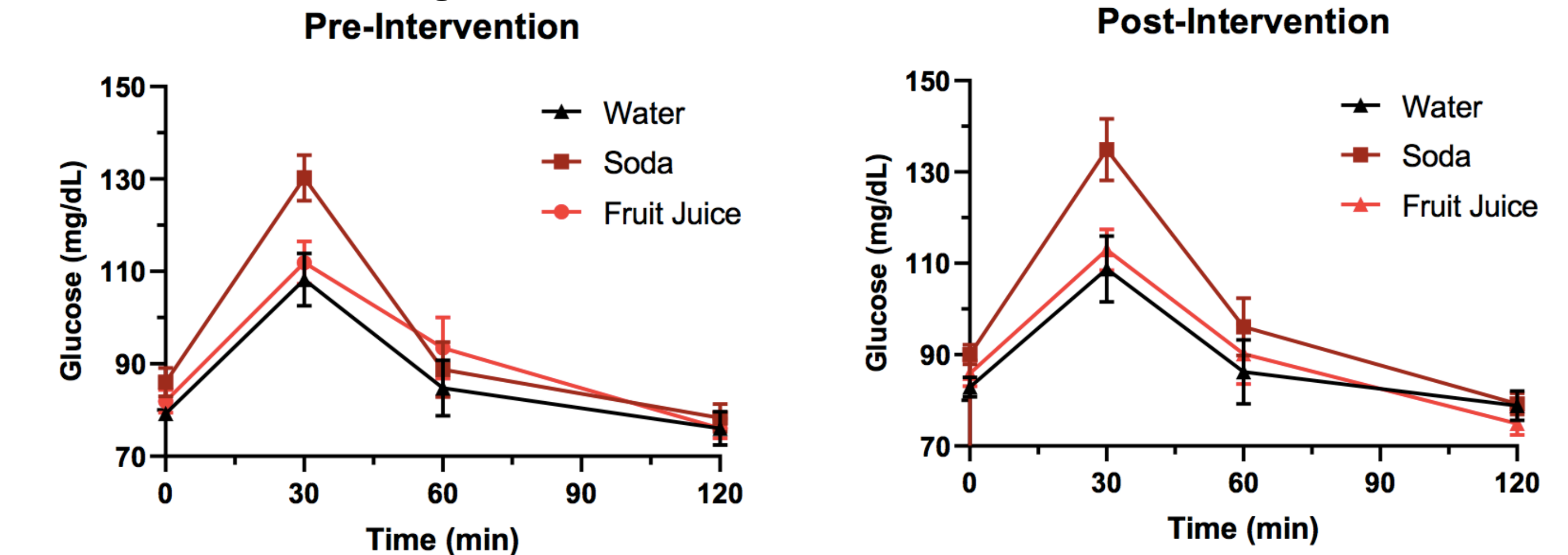


Figure 4: Glucose Incremental Area Under the Curve (iAUC)

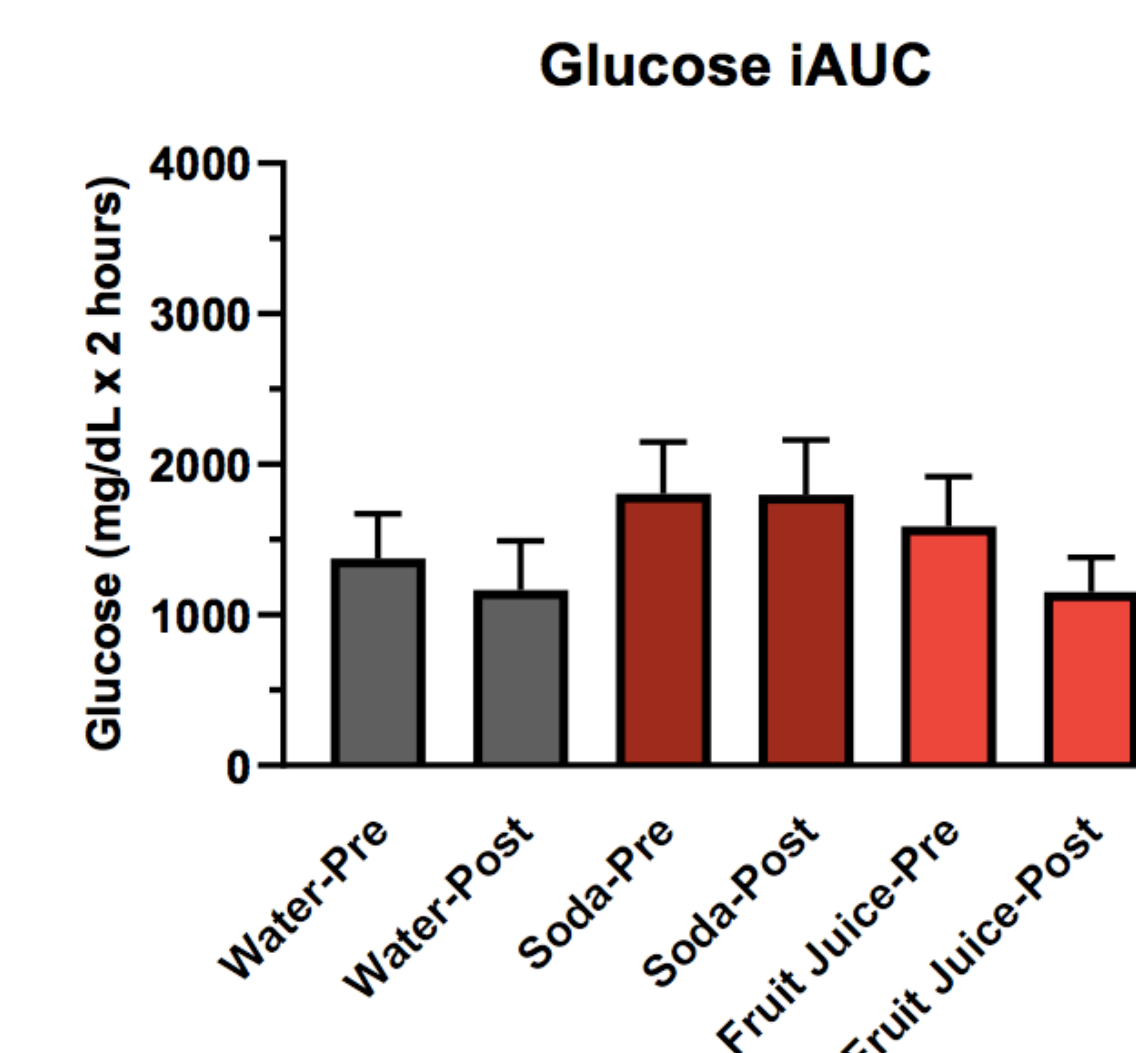


Fig. 1 & 2: There were no significant differences between the soda and fruit juice conditions in glucose and insulin responses following SSB consumption for pre- and post-intervention. Error bars indicate standard deviation.

•For the entire cohort, there were no significant changes in in fasting glucose ($p=0.88$), fasting insulin ($p=0.97$), and Homeostatic Model Assessment for Insulin Resistance ($p=0.96$).

Fig. 3: There were no significant effects of time or beverage condition for insulin (incremental area-under-the-curve) ($M\pm SD$; Baseline: W:1602±910, S:2022±1065, FJ:1863±993 mg/dL x 2hr; 3-weeks: W:1369±655, S:1658±1036, FJ:1875±691 mg/dL x 2hr; $ps>0.05$). Error bars indicate standard deviation.

Fig. 4: Similarly, there were no significant effects of time or beverage condition for glucose (incremental area-under-the-curve) ($M\pm SD$; Baseline: W:1367±1022, S:1804±1192, FJ:1588±1144 mg/dL x 2hr; 3-weeks: W:1166±1128, S:1800±1256, FJ:1151±795 mg/dL x 2hr; $ps>0.05$).

CONCLUSIONS

- Results show no differences in glucose and insulin responses between the caffeine-free soda and 100% fruit juice conditions.
- In healthy and young adults, under free-living conditions, the addition of SSBs to the diet for 3 weeks does not significantly modify insulinemic and glycemic outcomes.
- Longer-term trials are needed to elucidate the potential differential glycemic control responses to SSBs versus 100% fruit juice.

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