Food Preference Shift in C57BL/6 Mice Following Exercise Endurance Protocol

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Abstract

Physical activity is pertinent in improving various metabolic functions and affects homeostatic centers of neural networks that impacts food preferences. The experiments in this study investigated how exercise affects food preference consisting of 4 multi-macronutrient diets consisting of high sucrose, high non-simple carbohydrates, high sucrose and high fat, and high fat diets. The experimental group was exercised on treadmills during weekdays for 3 weeks, and the sedentary group was the negative control. A body composition and the intraperitoneal glucose tolerance test (IPGTT) done on all mice group pre and post exercise protocol.

Our hypothesis was that mice will show a reduced preference for palatable food such as a high sucrose diet, an increase in lean muscle body content, and an increased ability to metabolize sucrose. Our results showed all groups of mice did not have a significant difference in preference between the two groups of mice initially. However, following the exercise protocol, the sedentary mice exhibited an increased preference to the sucrose diet, while the exercised mice consumed relatively the same amount. Additionally, the exercised mice groups showed a better glucose metabolization according to the IPGTT. Finally, post exercise, the exercise groups exhibited an increase in body fluid content compared to baseline.

In subsequent experiments, an endurance test can be conducted to determine the efficiency of the experimental protocol.

Keywords: food preference, multi-macronutrients, treadmills, glucose tolerance, body composition

Introduction

According to current world population health statistics, obesity is the leading cause of ill-health surpassing undernutrition and infectious disease (Kopelman, 2000). It leads to the proliferation of metabolic and coronary diseases such as cardiovascular diseases, type 2 diabetes, and high blood pressure (Wilfley, Hayes, Balantekin, Buren, and Epstein, 2019). In the United States, obesity has impacted one third of the U.S. adults and 17% of children, it is characterized as a body mass index of greater than 40 kg per square meters (Wilfley et al.).

Physical activity has the tendency to lower blood pressure, higher insulin sensitivity and a favorable plasma lipoprotein profile. Additionally animal models show a suppression of atherogenesis (fatty plaque) and increase in nitric oxide which are vasodilator mediators, and a lower resting heart rate cardiac due to cardiac hypertrophy (Nystoriak and Bhatnagar, 2018). Exercise has shown to have beneficial effects on both physical and mental health, as well as neural changes.

According to the Sprague-Dawley rat model exercised on wheel running, rats showed an avoidance in high fat, high sugar diets, acute decrease in food intake and body weight for a short period of time. With longer access to wheel running, food intake increased but weight remained relatively lower compared to the sedentary group (Moody, Lianf, Choi, Moran, and Liang, 2015).

Our preliminary studies in Sprague Dawley Rats (both males and females) showed that animals decreased preference for high sugar food after long-term training. The aim of this study is to assess whether also mice display the same behavioral phenotype after exercise. This application will allow us to study the mechanisms that regulate this shift in food preference, using neuronal manipulation technique in transgenic mice, easily to perform in comparison to rats (Ellenbrock and Youn, 2016).

Methods

Equivalent 12 male and 12 female C57BL/6 (B6) mice are separated into two groups:

- Exercised B6 Mice - experimental group
- Sedentary B6 Mice - negative control group

Important Notes:

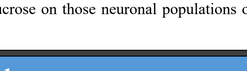
- Food preference diets: high sucrose diet (3.79 kcal/g), high fat diet (5.41 kcal/g), and high sucrose and fat diet (4.85 kcal/g), and high non-simple carbohydrate diet (3.79 kcal/g)
- Exercise only occurred on weeks days

Exercise group

Food preference diets and no exercise	Chow diet and Progressive exercise training from week 1 to week 3 respectively • Range of speeds: 5 meters per minute to 15 meters per minute • Range of exercise session: 20 minutes to 60 minutes	Food preference diet and exercise based on week 3 progressive training protocol
8 days	3 weeks	8 days

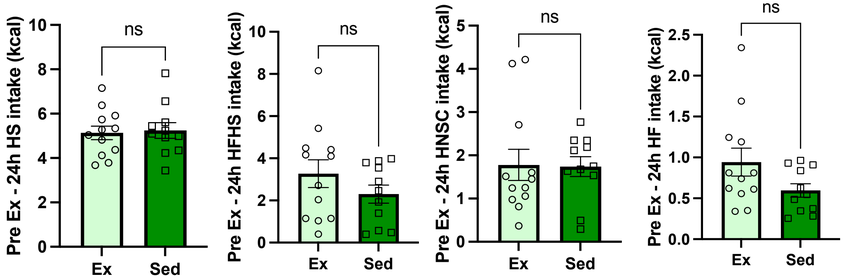
Sedentary group

Food preference diets and no exercise	Chow diet and sedentary session in the treadmills equivalent to exercise time in the experimental group in corresponding weeks	Food preference diet and equivalent sedentary session time

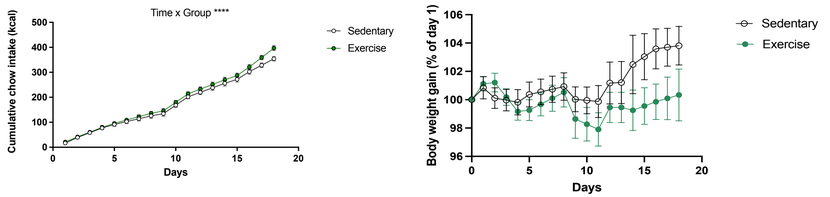


Results

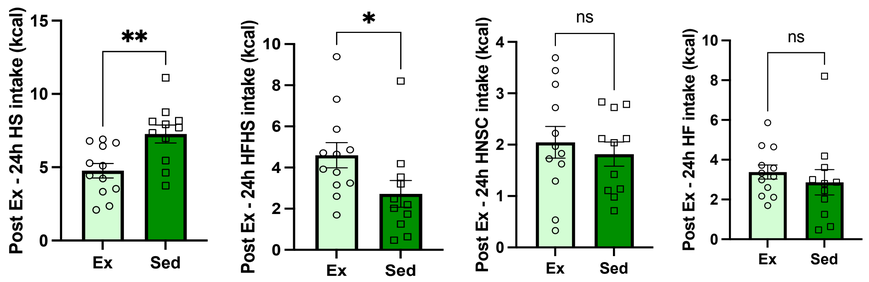
8 days – Baseline food preference of all mice groups (no exercise)



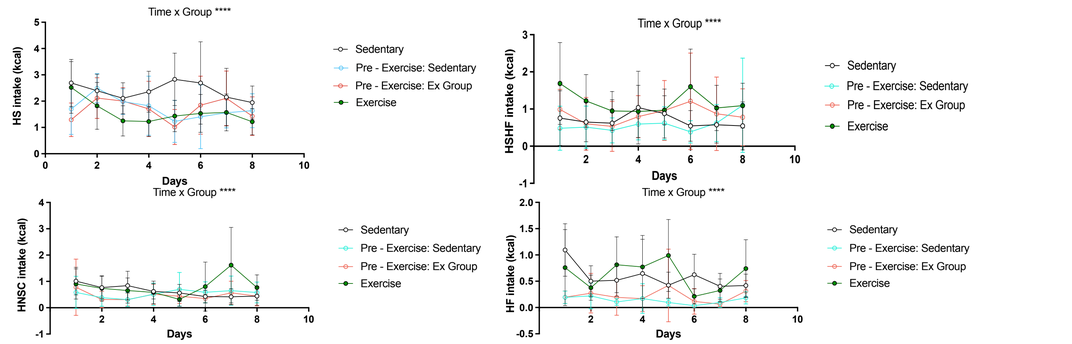
3 weeks of chow diet intake of sedentary and exercised mice groups, along with body weight gain



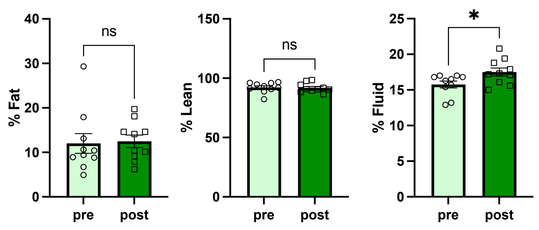
8 days –Post exercise food preference baseline of all mice groups (exercise)



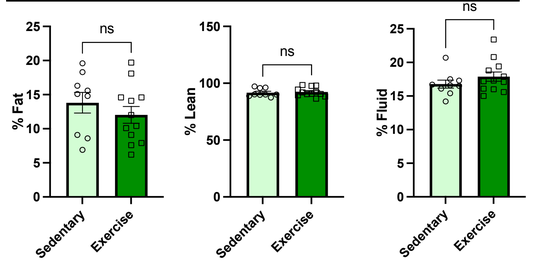
8 days – Food preference trend of all mice groups (Pre & Post Exercise Protocol)



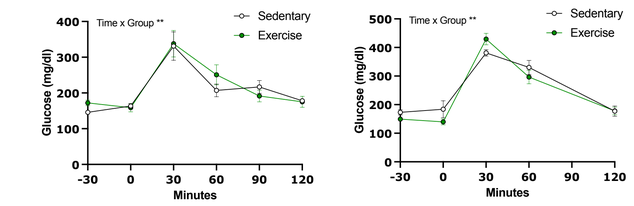
Body composition of only experimental (exercise) group pre/post exercise



Body composition of all mice groups post exercise



Baseline V.S. Post Exercise IPGT Test



Conclusion

Initial preference (8 days / food preference diet / no exercise)

- The food preference between the both exercise and sedentary groups in both male and female B6 mice show no significant preference in diet
- The mice seem to consume the high sucrose diet the most, consuming an average of 5 kilocalories per day

During the 3-week exercise protocol (18 days / chow diet / exercise)

- The exercise group had a greater chow intake during the 18 days exercise protocol
- However, while the sedentary group continued to gain weight, the exercise group maintained a relatively a stable weight, showing resistance to weight gain

Post 3 weeks exercise protocol (8 days / food preference diet / exercise)

- Following exercise, there was a significant difference in food preference in two diets which are the high sucrose and high fat and sucrose diet
- The combined sedentary mice group significant ate a greater amount of high sucrose diet and smaller amount of the high fat and sucrose diet compared to the exercise group
- The other two diet did not show any significant change between the two diet

8 day food preference trends for baseline and post exercise

- The sedentary mice group seems to increase high sucrose diet intake compared to baseline, while exercise mice decreased their intake
- Additionally, the exercised mice group consumed a greater amount of high sucrose and high fat diet following exercise, while the sedentary group remained the same

Body Composition

- The percent fat, lean, and fluid did not show a significant difference in the sedentary and exercise mice, however, the exercised mice showed an increase percent fluid content post exercise

IPGT test

- Post exercise, the exercise group showed showed a better glucose metabolization, as it took a shorter period for the blood glucose level to return to normal in exercised mice

Future Direction and Challenges

In the future we hope to perform this experiment in TRPM5 knockout mice to observe whether this preference shift is exhibited in mice that do not have the ability to taste. If the results are replicated, this could indicate a potential gut/brain pathway that dictates the preference towards palatable foods.

Additionally, another route that can be taken is to identify the neurons activated by exercise and the effects of sucrose on those neuronal populations or pathways.

Acknowledgements

- I would like to extend my deepest gratitude to Dr. Nicholas J. Betley for allowing to be part of his lab.
- I would like to thank Lavinia Boccia Ph.D. Postdoctoral Fellow for her valuable guidance during my training in experimental procedure and understanding experimental methodology.
- Lastly, I would like to thank the University of Pennsylvania, along with Ruth Marcus Kanter (College Alumni Society Undergraduate Research Grant) for their funding, supporting, and extending this incredible opportunity to participate in research.

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