The Effect of the Temperature of Plain or Sweetened Water on Body Composition in Rats

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Keywords

Water · Temperature · Sweeteners · Weight · Body composition

Abstract

Introduction: Humans are known to adapt to external temperature variations by altering energy intake, expenditure, and body fat storage for insulation [1, 2]. However, it is not clear whether the temperature of ingested water would induce such effects. Similarly, the involvement of the temperature of the ingested beverage has not been addressed in terms of body weight changes [3]. **Objectives:** This study was to investigate the effect of the ingestion of plain or sweetened water with varied temperatures on growth measures of rats. **Methods:** Approval was obtained from the Institutional Animal Care and Use Committee of the American University of Beirut. After a 1-week adaptation period, 5- to 6-week-old male Sprague-Dawley rats were randomly divided into their respective experimental groups, housed individually ($22 \pm 1^\circ\text{C}$, reverse light cycle 12:12 h dark/light, light off at 10:00 a.m.) with free access to food and beverage for 8 weeks. **Experiment 1 (Plain Water):** Two groups of rats ($n = 9$) consumed room-temperature [$\sim 22^\circ\text{C}$] (NW) or cold [$\sim 5^\circ\text{C}$] (CW) water. **Experiment 2 (Sweetened Water):** Four groups of rats were offered sweetened water for 12 h, followed by

plain water; (1) 10% sucrose + cold temperature (CS, $n = 7$), (2) 10% sucrose + room temperature (NS, $n = 8$), (3) 0.05% acesulfame K + cold temperature (CA, $n = 7$), and 4) 0.05% acesulfame K + room temperature (NA, $n = 8$). Food and beverage intake, body weight, and body composition were monitored using NMR minispec (LF110 Body Composition Analyzer, Bruker, USA) and energy expenditure was calculated based on the equation developed by Ravussin et al. [4]. Significance was set at a p value < 0.05 . **Results:** Experiment 1: Body weight changes were similar between groups (Fig. 1-Exp 1a). In the CW group, lean body mass (%) was significantly higher, while body fat (%) was lower than the NW (Fig. 1-Exp 1b, c). These changes may relate to the calculated total energy expenditure [NW: 66.73 ± 4.49 kcal/day and CW: 73.75 ± 3.92 kcal/day] (p value = 0.003) since energy intake (NW: 89.97 ± 7.63 kcal/day vs. CW: 93.29 ± 6.26 kcal/day, p value = 0.329) was similar between groups. Experiment 2: Body weight of the CA group was higher than that of the other groups (Fig. 1-Exp 2a). Lean body mass (%) of the sucrose-sweetened water groups (Fig. 1-Exp 2b, c) was significantly higher, while body fat (%) was lower than that of the non-caloric sweetened water groups; these were not affected by the temperature of the beverage. Those variations are mostly explained by the differences in energy expenditure (p value temperature $\times$ sweetener = 0.015), as energy intake was not significantly different between groups. **Conclusion:**

Experiment 1: Plain water

Experiment 2: Sweetened water

Fig. 1. Body weight (g), lean body mass (%), and body fat (%) of the rats over 8 weeks. Experiment 1 – weekly body weight (a), lean body mass (b) and body fat (c) gain of group CW: cold water (about 4°C); group NW: room-temperature water (about 22°C). Blue lines refer to CW; red lines refer to NW. A two-way ANOVA was performed with time and temperature of the water as factors, and time set as random. Experiment 2 – weekly body weight (a), lean body mass (b) and body fat (c) gain from baseline in grams of group CS: cold water (about 4°C) sweetened with 10% sucrose;

group NS: room-temperature water (about 22°C) sweetened with 10% sucrose; group CA: cold water (about 4°C) sweetened with 0.05% acesulfame K; group NA: room-temperature water (about 22°C) sweetened with 0.05% acesulfame K. A multiple-way ANOVA was performed with time set as random, temperature of beverages and type of sweeteners as factors. All data are expressed as mean values and standard deviations of all values. Significance was set at $p < 0.05$. CW, cold water; NW, normal temperature water.

Cold plain water decreased body fat and increased lean body mass with no effect on total body weight. Sucrose-sweetened water had a better impact on body composition irrespective of the temperature of the beverage. The beneficial effects are mainly due to increased energy expenditure rather than variations in energy intake. Thus, the energy cost of warming the water seems to have been derived from an increase in fat oxidation.

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Statement of Ethics

The Institutional Animal Care and Use Committee (IACUC) of the American University of Beirut (AUB), Lebanon, approved the experimental protocol (No.18-02-453). The study was performed in accordance with the criteria outlined in the Guide for the Care and Use of Laboratory Animals.

Conflict of Interest Statement

C.E.M. received travel expenses and registration fees from Danone Research to attend the 2019 Hydration for Health Scientific Conference. The other authors declare no conflict of interest.

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Author Contributions

O.O. conceived and designed the experiment; C.E.M., M.E.R., and N.E.H. carried out the experiments and conducted the laboratory analysis. All authors analyzed the data and were involved in the write up of the paper and had final approval of the submission.

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