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Changes in food intake during the COVID-19 pandemic in New York City

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ABSTRACT

The COVID-19 pandemic and stay-at-home orders across the nation have had substantial consequences on access to food and dietary behaviors. We investigated the dietary intake of adults in NYC, before and during the COVID-19 period. A subset of participants ($n = 31$) from an NIH-funded multi-level discount supermarket study were assessed. In this study, the experimental groups received a 0% (control), 15%, or 30% discount on fruits, vegetables, and noncaloric beverages for 8 months. The discount level for the participants who were selected for this study did not change from the pre-COVID to during COVID periods. Dietary intake data was collected using three unannounced 24-h dietary recalls (2 weekdays, 1 weekend) during each period. Changes in total daily kcal of food and beverages, total g of solid food, energy density of solid food (kcal/g), and g of fruit and vegetables, soda, non-caloric beverages, and snack foods were analyzed using multivariate linear regression. Energy density (ED) increased during COVID ($+0.02 \pm 0.5$ [SD], $F[4,26] = 3.0$, $p = 0.038$). There was an interaction by gender ($t = -3.2$, $p = 0.0035$) such that ED increased for females ($+0.27 \pm 0.46$, $p = 0.037$) and decreased for males (-0.22 ± 0.32, $p = 0.012$). The change in ED is likely due to the circumstances surrounding COVID-19, e.g. being at home, stress, and food shortages.

1. Introduction

The COVID-19 pandemic and lockdown orders across the U.S. have had unintended consequences on access to food and lifestyle behaviors. Lifestyle behaviors such as dietary intake may be influenced during anxiety-inducing times (McEwen & Stellar, 1993; Torres & Nowson, 2007). We investigated dietary intake of adults in New York City (NYC) who were shopping at a Foodtown supermarket before and during the COVID-19 period. This appears to be the first study to collect detailed dietary intake data following COVID-19 onset. The New York State PAUSE program was an executive order issued by Governor Andrew Cuomo in response to the COVID-19 pandemic. This mandate included orders to close nonessential businesses, to stay indoors with exceptions to go outdoors for essential duties, to socially distance when outdoors, to avoid gatherings, and to wear masks when outdoors and indoors when around other people, except for household members (Health NYSDo, 2020). The COVID-19 pandemic may increase stress levels, and stress can increase or decrease food intake (Anton & Miller, 2005; Wallis & Hetherington, 2009). Quarantine may lead individuals to turn to highly processed and energy-dense foods and foods with lengthy shelf lives (Mattioli et al., 2020). As people were losing jobs and filing for unemployment (Kochhar, 2020), access to food, especially foods that are relatively expensive and short-lived, such as fruits and vegetables, may be negatively impacted.

Dietary intake data was collected as part of an NIH-funded supermarket study. The supermarket study began in September of 2018 and is an ongoing randomized, controlled trial (RCT) with two intervention groups (15% and 30% discounts on fruits, vegetables, and non-caloric beverages) and a control group (0% discount) during an 8-month period. A 2-month baseline period with no discount, preceded the 8-month intervention, and was followed by a 4-month period, during which there is no discount. Participants included in the COVID study were drawn from all of the supermarket study periods. Food intake was obtained by three unannounced 24-h dietary recalls, including two weekdays and one weekend day, during each period.

We hypothesized that fruit, vegetable, and non-caloric beverage intake would decrease, and snack food and soda intake would increase during the COVID-19 period relative to pre-COVID-19. The increase in snack food and decrease in fruit and vegetable intake should lead to an increase in energy density (kcal/g) of solid food intake, the primary outcome variable.

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Table 1
Baseline characteristics.

Characteristics		All Groups	Control Group (n = 22)	15% Discount Group (n = 3)	30% Discount Group (n = 6)
Age		39.4 ± 12.6	39.0 ± 13.2	34.7 ± 2.1	43.3 ± 13.8
[a]**Body Weight (kg)**		81.1 ± 17.8	83.0 ± 19.8	70.3 ± 9.9	81.6 ± 12.3
[a]**BMI (kg/m^2)**		28.2 ± 5.8	28.7 ± 6.3	24.3 ± 0.7	28.5 ± 5.0
Annual Household Income		$68,786 ± 48,182	$64,974 ± 46,930	$61,700 ± 46,500	$84,417 ± 58,009
Gender	**Male**	16	10	2	4
	Female	15	12	1	2
Ethnicity	**Hispanic**	3	2	0	1
	Non-Hispanic	25	17	3	5
	N/A	3	3	0	0
Race	**Caucasian**	15	8	3	4
	African American	5	5	0	0
	Asian	4	3	0	1
	Pacific Islander	1	1	0	0
	Mixed	1	1	0	0
	Other	2	1	0	1
	N/A	3	3	0	0

Means ± SD for age, body weight, BMI, annual household income.
[a] Body Weight and BMI were obtained during the pre-COVID period at visits to the hospital in between the two sets of dietary recalls.

2. Materials and methods

2.1. Study design

We used February 20th, 2020 as the date of COVID-19 onset, which was about one week before the following events: the first COVID19-related death in the U.S., the first reported case in NYC, and initial reports of the stockpiling of foods (Goldstein & McKinley, 2020; Schmidt; Taylor). Dietary recalls collected before February 20th are referred to as "pre-COVID", and those collected on or after February 20th are referred to as "during COVID". The ongoing supermarket study provided a context for this natural experiment.

2.2. Participants

The study included those participants (n = 31) for whom dietary intake data was collected pre-COVID and during COVID. The convenience sample was from the control group (n = 22) and from both discount groups (30% discount group: n = 6; 15% discount group: n = 3), for whom the discount level did not change between the dietary recalls pre- and during COVID. Data for participants in the control group were collected from all three study periods (baseline, intervention, follow up), as their discount level (0%) did not change, whereas data for participants in the discount groups (15%, 30%) were collected from the intervention period alone, resulting in a larger number of participants from the control group. The average number of days between dietary recall records was 147 ± 53 (SD) with a range of [67–274]. The 24-hr food intake records were conducted in the middle of the baseline and follow-up periods, and two were in the middle of the first half and the second half of the intervention period. There was a relatively shorter interval of about 90 days between the baseline (0–2 mo) and first intervention period (2–6 mo) dietary records. Participant demographics are shown in Table 1.

2.3. Protocol

Dietary intake data were collected from previously scheduled 24-h recall dates from the supermarket study. 24-hour dietary recall data were collected by phone by trained research assistants using the USDA Five-Step Multiple-Pass Method. Two unannounced weekday dietary recalls and one unannounced weekend dietary recall were collected during each time period (pre COVID and during COVID) and averaged for analysis, as this is the standard method used in studies assessing dietary intake (Appelhans et al., 2017; Barnes et al., 2015; French et al., 2014; Grandy et al., 2018; Raatz et al., 2015). For the relatively few (8%) missing dietary recalls, the first set (pre-COVID) and second set (during COVID) of recalls were matched by weekday-weekend ratio, e.g. if a participant was missing a weekend recall in the pre-COVID period, only the weekday recalls from the COVID-19 period were included in the analysis. Changes in total daily kcal of food and beverages, total grams (g) of solid food, energy density of solid food (kcal/g), and g of fruit and vegetables (together and separate), soda, non-caloric beverages (bottled water, carbonated water, diet soda, together and separate), and snack foods (salty and sweet, together and separate) were calculated. Intake data from 24-h dietary recalls were analyzed using FoodWorks 18 (The Nutrition Company, Long Valley, NJ).

2.4. Data analysis

Multivariate linear regression was performed to assess the changes in the variables of interest while controlling for covariates. The covariates included age, gender, and discount level, as these had a significant impact on the dependent variables assessed regardless of period. Days between the two sets of dietary recalls, income, and last measured body weight during the pre-COVID period were covariates that did not show a significant impact, and thus were not included in our selected model. The selected model used the three covariates together: gender*-age*discount level. An outline of the models and interactions assessed prior to selecting the main model can be seen in Supplementary Table 1. Cohen's d effect sizes were calculated, where d = 0.2 is considered small, d = 0.5 medium, and d = 0.8 large. We conducted post-hoc t tests when the regression analysis was significant, based on two-tailed α = 0.05. Data were analyzed using RStudio (Version February 1, 5019).

2.5. Power analysis

Sample sizes were based on the 2011 Spill et al. study (Spill et al., 2011), which had a similar design to the current supermarket study. Spill et al. assessed vegetable consumption, total energy intake, and energy density of food consumed by children in three different treatment groups, containing different proportions of vegetables in the meal provided to obtain 100% (control), 85%, or 75% ED (energy density). Group means and standard deviations for daily energy density of foods (kcal/g) and total daily energy intake of foods (kcal) for the 100% ED and 75% ED groups in the Spill et al. study were used. Power was set at 0.80 and α at two-tailed 0.05. Sample size calculations employed a power analysis calculator at www.biomath.net/power. The sample size needed to show an effect in the change in energy density was n = 18, and for total daily energy intake of foods was n = 12. With 31 participants in our study, we appeared to have adequate power. However, the sample size is still relatively small, and therefore these findings, particularly for the interaction between gender, should be interpreted with caution.

3. Results

This study assessed changes in dietary intake in a sample of adults in NYC before and during the COVID period, using 3 unannounced 24-h dietary recalls during each period on two weekdays and one weekend day. The outcomes of interest included total kcal, total kcal of solid food alone, total g of solid food alone and energy density (kcal/g) of solid

Table 2
Changes in outcome measures.

	Mean (COVID - preCOVID) ± SD	F-statistic (4,26)	P-value
Total Calories	−108 ± 553	0.2	0.95
Total Calories (Solid food only)	−47.6 ± 576	0.9	0.48
Total Grams (Solid food only)	−11.7 ± 274	2.0	0.12
Energy Density	+0.02 ± 0.5	3.0	0.038[a]
Fruit & Veg (g)	+18.9 ± 214	0.3	0.85
Fruit (g)	+20 ± 113	0.8	0.53
Vegetables (g)	−1.04 ± 206	0.4	0.84
Soda (g)	−1.8 ± 60.5	2.1	0.11
Total Noncaloric Beverage (g)	+89.7 ± 276	1.0	0.45
Bottled Water (g)	−15.4 ± 115	1.3	0.29
Carbonated Water (g)	+89.5 ± 245	0.5	0.71
Diet Soda (g)	+15.6 ± 74.8	0.1	0.97
Total Snacks (g)	−20.1 ± 78.5	0.5	0.72
Salty Snacks (g)	−14.4 ± 47.8	1.9	0.14
Sweet Snacks (g)	−5.49 ± 69.5	0.3	0.88

F-statistic and p-values from multivariate linear regression.
[a] $p<0.05$, significant.

food alone, fruit and vegetables (together and separate), soda, noncaloric beverages (bottled water, carbonated water, diet soda, together and separate), and total snacks (salty and sweet, together and separate). Findings from the multivariate linear regression are shown in Table 2.

There was a significant overall increase (+0.02 ± 0.5 [SD]) in energy density (kcal/g) ($F[4,26] = 3.0$, $p = 0.038$). Additionally, there was a significant gender interaction ($t = -3.2$, $p = 0.0035$) as energy density increased for females (+0.27 ± 0.46, $d = 0.59$, $p = 0.037$) and decreased for males (−0.22 ± 0.32, $d = -0.71$, $p = 0.012$). Changes for the other outcome measures were not significant.

4. Discussion

Based on 24-h dietary recalls, there was a significant overall increase in the energy density of solid food intake from pre-COVID to during COVID. There was also a difference between genders, with energy density of solid foods consumed by females increasing, while decreasing for males. We had hypothesized that fruit, vegetable, and non-caloric beverage intake would decrease, and snack food and soda intake would increase, such that energy density would increase, during the COVID-19 period. Our findings support our hypothesis for an increase in energy density of solid foods during the COVID-19 period. This effect, however, was only seen in females, as males showed a decrease in energy density of solid foods. Women are more likely to have intakes exceeding recommendations for total sugar, saturated fat, and total fat than men (Bennett et al., 2018) and more likely to eat such foods in response to stress (Barrington et al., 2014). The significant increase in the average energy density of solid foods consumed by participants was not reflected in changes in fruit and vegetable intake, expected to decrease, or snack food intake, expected to increase. However, intakes from other food categories that we did not analyze might have changed, including breads, pasta, meats, and prepared salads. Thus, it is likely that a combination of changes in the amounts of various high and low energy-dense foods contributed to the observed change in energy density.

A recent related population-based study using an online questionnaire investigated changes to eating habits and lifestyle in Italy during COVID-19 and found that participants ages 18–30 reported greater adherence to the Mediterranean diet (Di Renzo et al., 2020), and that 17.8% of all responders reported reduced appetite, while 34.4% reported increased appetite. A limitation of that study is that an online questionnaire was sent only once during the COVID period to collect qualitative dietary information, rather than detailed dietary intake data.

The strengths of our study include the use of 24-h dietary recalls following the USDA Five-Step Multiple-Pass Method and comparisons of intake within the same participants. Limitations include the lack of post-COVID data, as we are still in the COVID period and the lack of body weight comparisons between pre- and during COVID periods. Another limitation is the unequal numbers in participants drawn from the three intervention groups (0%, 15%, 30% discount) of the supermarket study. Lastly, a limitation is the relatively small sample size of the study, and more so when assessing by each gender.

In summary, our findings show a significant increase in the energy density of solid foods intake overall during the COVID period. However, the increase in energy density was seen in the females only and a decrease was seen for the males. These changes are likely due to the circumstances surrounding COVID-19, including stay-at-home orders, decreased job security, anxiety about exposure to the virus, and food shortages. These stress-inducing conditions may have induced females to consume more energy-dense foods but apparently did not influence the males in the same way. Future directions include gathering post-COVID data.

Declaration of competing interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2021.105191.

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Clinical trial registration

Multi-level Supermarket Discount Study, NCT04178824.

Data sharing

Individual de-identified participant summary dietary intake data, study protocol, and statistical analysis plan will be shared per request from other investigators.

References

Anton, S. D., & Miller, P. M. (2005). Do negative emotions predict alcohol consumption, saturated fat intake, and physical activity in older adults? *Behavior Modification, 29*(4), 677–688. https://doi.org/10.1177/0145445503261164

Appelhans, B. M., French, S. A., Tangney, C. C., Powell, L. M., & Wang, Y. (2017). To what extent do food purchases reflect shoppers' diet quality and nutrient intake? *International Journal of Behavioral Nutrition and Physical Activity, 14*(1), 46. https://doi.org/10.1186/s12966-017-0502-2

Barnes, T. L., French, S. A., Harnack, L. J., Mitchell, N. R., & Wolfson, J. (2015). Snacking behaviors, diet quality, and body mass index in a community sample of working adults. *Journal of the Academy of Nutrition and Dietetics, 115*(7), 1117–1123. https://doi.org/10.1016/j.jand.2015.01.009

Barrington, W. E., Beresford, S. A., McGregor, B. A., & White, E. (2014). Perceived stress and eating behaviors by sex, obesity status, and stress vulnerability: Findings from the vitamins and lifestyle (VITAL) study. *Journal of the Academy of Nutrition and Dietetics, 114*(11), 1791–1799. https://doi.org/10.1016/j.jand.2014.03.015

Bennett, E., Peters, S. A. E., & Woodward, M. (2018). Sex differences in macronutrient intake and adherence to dietary recommendations: Findings from the UK biobank. *BMJ Open, 8*(4), Article e020017. https://doi.org/10.1136/bmjopen-2017-020017

Di Renzo, L., Gualtieri, P., Pivari, F., Soldati, L., Attinà, A., Cinelli, G., Leggeri, C., Caparello, G., Barrea, L., Scerbo, F., et al. (2020). Eating habits and lifestyle changes during COVID-19 lockdown: An Italian survey. *Journal of Translational Medicine, 18*(1), 229. https://doi.org/10.1186/s12967-020-02399-5

French, S. A., Mitchell, N. R., Wolfson, J., Harnack, L. J., Jeffery, R. W., Gerlach, A. F., Blundell, J. E., & Pentel, P. R. (2014). Portion size effects on weight gain in a free living setting. *Obesity, 22*(6), 1400–1405. https://doi.org/10.1002/oby.20720

Goldstein, J., & McKinley, J.. Internet https://www.nytimes.com/2020/03/01/nyregion/new-york-coronvirus-confirmed.html.

Grandy, M., Snowden, J. M., Boone-Heinonen, J., Purnell, J. Q., Thornburg, K. L., & Marshall, N. E. (2018). Poorer maternal diet quality and increased birth weight. *Journal of Maternal-Fetal and Neonatal Medicine, 31*(12), 1613–1619. https://doi.org/10.1080/14767058.2017.1322949

Health NYSDo. Internet https://coronavirus.health.ny.gov/new-york-state-pause (accessed June 10 2020).

Kochhar, R. (2020). Unemployment rose higher in three months of COVID-19 than it did in two years of the Great Recession. Internet https://www.pewresearch.org/fact-tank/2020/06/11/unemployment-rose-higher-in-three-months-of-covid-19-than-it-did-in-two-years-of-the-great-recession/ accessed Date Accessed.

Mattioli, A. V., Sciomer, S., Cocchi, C., Maffei, S., & Gallina, S. (2020). "Quarantine during COVID-19 outbreak: Changes in diet and physical activity increase the risk of cardiovascular disease". *Nutrition, Metabolism, and Cardiovascular Diseases*. https://doi.org/10.1016/j.numecd.2020.05.020

McEwen, B. S., & Stellar, E. (1993). Stress and the individual: Mechanisms leading to disease. *Archives of Internal Medicine, 153*(18), 2093–2101. https://doi.org/10.1001/archinte.1993.00410180039004

Raatz, S. K., Jahns, L., Johnson, L. K., Crosby, R., Mitchell, J. E., Crow, S., Peterson, C., Le Grange, D., & Wonderlich, S. A. (2015). Nutritional adequacy of dietary intake in women with anorexia nervosa. *Nutrients, 7*(5), 3652–3665. https://doi.org/10.3390/nu7053652

Schmidt, A.. Internet https://www.foxbusiness.com/lifestyle/coronavirus-fears-americans-stockpile-groceries-medication.

Spill, M. K., Birch, L. L., Roe, L. S., & Rolls, B. J. (2011). Hiding vegetables to reduce energy density: An effective strategy to increase children's vegetable intake and reduce energy intake. *American Journal of Clinical Nutrition, 94*(3), 735–741. https://doi.org/10.3945/ajcn.111.015206

Taylor, D. B.. Internet https://www.nytimes.com/article/coronavirus-timeline.html.

Torres, S. J., & Nowson, C. A. (2007). Relationship between stress, eating behavior, and obesity. *Nutrition, 23*(11), 887–894. https://doi.org/10.1016/j.nut.2007.08.008

Wallis, D. J., & Hetherington, M. M. (2009). Emotions and eating. Self-reported and experimentally induced changes in food intake under stress. *Appetite, 52*(2), 355–362. https://doi.org/10.1016/j.appet.2008.11.007