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ARTICLE

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Household food waste trending upwards in the United States: Insights from a National Tracking Survey

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Abstract

Three successive administrations have supported the United States' 2015 goal to reduce food waste. Households waste more food than other supply chain segments, however, few data sources are available to track US households' progress toward this goal. We provide insights from the first four waves of a novel national survey designed to track such waste. We find a 280% year-over-year increase in self-reported waste between early 2021 and early 2022, which militates against national goal achievement. We find households wasted more food during weeks they dined out and that sample households dined out significantly more in 2022 than in 2021.

KEYWORDS

COVID-19, food waste, household, survey

JEL CLASSIFICATION

D12, Q19, Q53

1 | INTRODUCTION

After food leaves the farm in the United States, approximately 30% (66.5 million tons) is wasted (Buzby et al., 2014). Once loss and waste at the primary production level is included, this translates to ~78 million tons of food that will be wasted along the food value chain each year (ReFED, 2022). Producing this lost and wasted food requires about 30 million acres of cropland, 4.2 trillion gallons of irrigation water, 780 million pounds of pesticides, and 1.8 billion pounds of nitrogen fertilizer, with the uneaten food representing greater than 1250 calories and about one pound of food per capita per day (Conrad et al., 2018). Further, most wasted food and accompanying inedible food

scraps are landfilled in the United States, which leads to additional climate impacts associated with the release of carbon dioxide and methane (Bernstad & la Cour Jansen, 2012).

These impacts have resulted in the establishment of a food waste reduction goal as part of the United Nations Sustainable Development Goals (United Nations, 2023, goal 12.3) as well as federal government initiatives in the United States. In 2015 the Obama administration committed to halving food loss and waste by 2030 (a goal mirrored in the U.N. Sustainable Development Goals) with the two subsequent administrations continuing support for food waste reduction initiatives (USDA, 2015, 2018, White House, 2021). Furthermore, several food waste provisions were included in the bipartisan 2018 Farm Bill (Berkenkamp, 2018; Sandson, 2018) and are being featured in legislative talking points for the 2023 Farm Bill (American Farm Bureau Federation, 2023).

Despite bipartisan support for food waste reduction (Pingree, 2018), the US lacks federally implemented, regularly occurring quantitative measurements of food wasted at the household level, which is the single largest source of wasted food (37% of food wasted across the US food supply chain, ReFED, 2022) and is estimated to account for about 32%–43% of household food (Smith & Landry, 2021; Yu & Jaenicke, 2020). While analyses of particular cross-sectional data sets have provided some key insights into US household food waste (Landry & Smith, 2019; Smith & Landry, 2021; Yu & Jaenicke, 2020), a lack of data collected regularly over time inhibits assessment of progress toward national goals, further articulation of the magnitude and patterns of wasted food, and identification of drivers of unwarranted waste. Given the ongoing discussion of how food waste might be addressed via the 2023 Farm Bill (American Farm Bureau Federation, 2023), the lack of such data hampers informed policy discussion on a topic that has become an element of one of the most influential policy vehicles affecting the US food system. Furthermore, there are calls to implement a national consumer food waste reduction campaign (NASEM, 2020), and the lack of tracking data inhibits formation and evaluation of any future efforts.

With this in mind, we commenced collection of household food waste data via self-administered surveys in early 2021 from samples of consumers drawn from throughout the United States. The survey builds upon a validated online survey (van Herpen, van Geffen, et al., 2019) as adapted and validated for US audiences (Shu et al., 2021) in which respondents are first directed to monitor discarded food over the next 7 days and then administered a survey a week later where respondents report waste from the previous week in 24 distinct categories. While self-reports of food waste yield estimated levels that are substantially (~40%) less than direct physical measurement of household food waste streams (Hoover & Moreno, 2017; van Herpen, van der Lans, et al., 2019; WRAP, 2020), this approach is effective at tracking changes in waste and identifying differences between subgroups of households with well-known variations in food waste levels (van Herpen, van der Lans, et al., 2019; Shu et al., 2023, 2021; WRAP 2020).

Four survey waves were administered with data collections launched in February, July, and December of 2021 and in February of 2022. We find a 280% year-over-year increase in self-reported household food waste between early 2021 and early 2022. We note data collection commenced during the early rollout of COVID vaccines in the United States and spans the peak in Omicron-variant cases. Therefore, it lacks coverage before the onset of the COVID-19 pandemic. Without data including the 2015 baseline period for establishing the national goal, we cannot be certain if this large year-over-year increase jeopardizes achievement of the 2030 US food waste reduction goal. However, all else equal, a large year-over-year increase in waste from the household sector militates against national goal achievement. Furthermore, the data reported here can serve as a baseline for informing the creation and evaluating the progress of any future consumer food waste reduction campaigns.

We also note that our data collection period is inextricably linked with post-COVID household trends in the United States, which may undermine the data's ability to inform us about 'normal' waste levels among US households. However, modeling suggests that the probability of a pandemic with similar health impacts as COVID-19 is about 2% in any year and growing over time (Marani et al., 2021). While the disruption to household food routines due to a future pandemic is difficult to

predict, it is likely that household responses over the course of the COVID-19 pandemic will inform public and private strategy and decision-making if/when such circumstances occur again.

In addition to the 280% year-over-year increase, we confirm several patterns of behavior identified in previous work and identify novel insights that improve our understanding of consumer food waste patterns as household behaviors evolved with COVID-19 pandemic and response. Importantly, we find that households that eat all meals at home waste significantly less than households that eat out, and, as households returned to more frequently eating meals away from home in February of 2022, households with atypical levels of waste cite this as the most common reason for their profligate behavior. While previous work has documented eating out as a factor in household food waste creation in other countries (WRAP, 2022), our repeated cross-sectional data provides insights into the US context and permits us to track the prevalence of meals away from home as conditions changed as well as the accompanying amounts and reasons for higher levels of waste. We also find that higher levels of waste due to the discard of expired items purchased in bulk or on sale peaked during February of 2022. We confirm several key patterns observed elsewhere (greater waste per person among younger respondents and in smaller households), find no evidence of other waste drivers identified in some previous work (income, region of residence, education, ethnicity), and find some results contrary to previous results (more waste among the most frequent grocery shoppers).

2 | METHODS

2.1 | Participants

US residents who participate in consumer panels managed by a commercial vendor were invited by email or text message to participate in a two-part online survey during four waves of data collection: February and March of 2021 (Feb 21 wave, 425 initiated, 361 completed), July and August of 2021 (Jul 21 wave, 606 initiated, 419 completed), December of 2021 and January of 2022 (Dec 21 wave, 760 initiated, 610 completed), and February, March, and April of 2022 (Feb 22 wave, 607 initiated, 587 completed). We are not able to determine if any respondents participated in multiple waves, i.e., if any of the observations are repeat participants.[1]

All participants provided informed consent and received compensation. Inclusion criteria included age 18 years or older and performance of at least half of the household food preparation. No data was collected during major holidays, that is, the weeks of the Fourth of July (Independence Day), Thanksgiving, Christmas or New Years. Recruitment quotas were implemented to ensure sufficient representation by geographical region, race, and age group. Post hoc sample weights were constructed to reflect population characteristics on age, income, and household size. The protocol was approved by the local Internal Review Board.

2.2 | Materials

Before the February 2021 wave 1 data collection, a pilot study was launched in Fall 2020 to validate the approach and assess its precision (Shu et al., 2021). The approach begins with participants completing an initial survey that ends with an announcement that a follow-up survey will arrive in about 1 week, and that for the next 7 days, participants should pay close attention to the amounts of different foods their household throws away, feeds to animals or composts because the food is past

[1]However, during a replication of this survey in November and December of 2022 featuring 1086 respondents, we asked "Have you ever participated in a survey asking you to record your food waste?"; only 6% said yes.

date, spoiled or no longer wanted for other reasons. They are told to exclude items they would normally not eat, such as bones, pits, and shells. Approximately 7 days later they received the follow-up survey, which elicited the amount of waste in up to 24 categories of food and included other questions (see supplemental materials for core survey questions).

Waste amounts in each category are reported by selecting from one of several ranges of possible amounts. The gram weight for categories with volumetric ranges (e.g., listed in cups) were derived by assigning an appropriate mass to the midpoint of the selected range consistent with the food category. For the categories with highly variable weight per volume (e.g., a cup of raw asparagus weighs about seven times more than a cup of raw chopped arugula), we use the profile of items most consumed in the United States to determine the appropriate gram weight (USDA, 2021). For display purposes, the 24 categories are consolidated into eight more general categories. Total weekly household food waste is calculated by summing up reported gram amounts across all categories. We divide this total by the number of household members to generate the per person weekly food waste amount.

2.3 | Data analysis

Wave-by-wave means were calculated using post hoc weights with confidence intervals constructed using robust standard errors. A randomly assigned subgroup of participants in waves 2–4 received versions of the survey with formatting and wording that varied from the wave 1 version, while the remainder received the exact same formatting and wording as wave 1. The means and confidence intervals for waves 2–4 were adjusted via ordinary least squares regression to ensure the means from all waves reflect identical survey wording and formatting. To associate per person household waste with household and respondent characteristics, we use censored regression analysis to account for the occurrence of multiple participants reporting zero waste during their reporting week. All analyses are completed in Stata (Version 14.2) with statistical significance set at the 5% level.

3 | RESULTS

Household food waste generation increased between each of the four waves of data collection and resulted in a 280% year-over-year increase (between the first and fourth waves) with 363.47 g/person more in February 2022 versus February 2021 wave (two-sided $t = 4.32$, $p < 0.001$, $df = 1970$, 95% confidence interval: [198.63, 528.31], see Figure 1). Fresh produce was the largest fraction of waste in each wave (Figure 1) with each of the eight categories of waste detailed in Figure 1 increasing significantly between the first and fourth waves.

The 280% year-over-year increase is large in magnitude and warrants further investigation to ensure that it may not be the outcome of unchecked data errors or driven by outliers. In terms of unchecked data errors, we note that respondents did not report open-ended values for the waste quantities, which would be the most obvious concern under this umbrella.[2] To address the issue of outliers, we focus on effects near the median of the distribution by estimating a quantile regression. Instead of a 280% year-over-year increase identified at the mean, we find a 492% increase at the median, suggesting a focus on the mean presents a smaller magnitude increase than a focus on the middle of the distribution.

Key aspects of household time use, food preparation patterns, and economic status changed over the course of the four waves of data collection as the country adjusted to the evolving rates and

[2]Respondents had to select from five quantitative bins for each food and drink category, and very few selected the largest bin for any given category. Specifically, of all 24 food categories, fresh fruit had the highest incidence of choosing the largest category of waste (more than four pieces of fruit), and only 4.4% chose this category. All other categories featured less than 2% selecting the largest category.

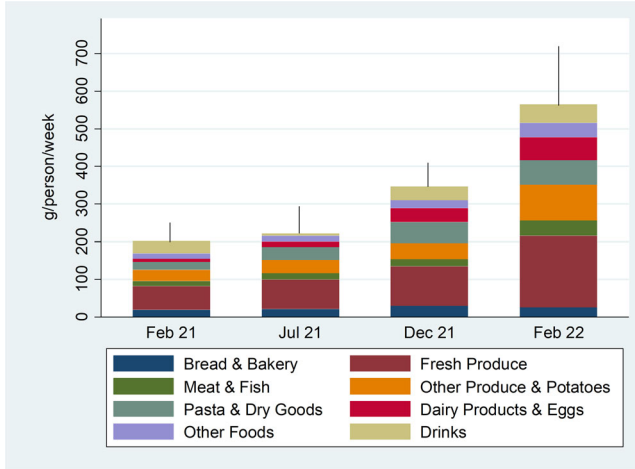

FIGURE 1 Mean weekly waste (g/person) by food category and data collection wave. Whiskers represent 95% confidence intervals. Respondents by wave: Feb 21 = 361, Jul 21 = 419, Dec 21 = 610, Feb 22 = 587. Amounts reflect food once deemed edible by the respondent, that is, exclude items such as bones and pits

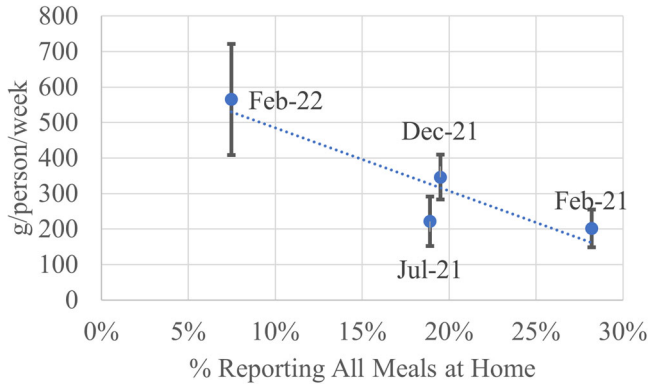

FIGURE 2 Scatterplot of mean food waste per person per week (g) and the % reporting no dine-out meals by survey wave. Vertical error bars are 95% confidence intervals. Dotted line is the best-fit regression line. *N* by wave: Feb 21 = 361, Jul 21 = 419, Dec 21 = 610, Feb 22 = 587.

variants of COVID. The collapse of restaurant dining after the initial onset of COVID is well documented (Chetty et al., 2020). This pressed many people to prepare a larger portion of their meals at home (Bender et al., 2022; Ellison et al., 2021; IFIC 2020a; Roe et al., 2021). By plotting the percent of households in the sample who report preparing all their meals at home during their reporting week against weekly per person waste in Figure 2, we reveal a strong association between the two behaviors with about an 18 g increase in waste/person/week for every additional percent of the sample that reports some dining out behavior. In February 2021 more than one-quarter of sample households reported that all meals were prepared at home, which dropped to 19% in both July 2021 and December 2021. By the February 2022 wave, only about 7% of households were in this group. While the percent of meals prepared at home was itself strongly correlated with the percent of nonsleeping time respondents reported being at home (Supporting Information: Figure SA1), we did not find any significant relationship between the total amount of time respondents spent in the home and waste once the percent of meals prepared at home was controlled (Table 1).

TABLE 1 Censored regression coefficients, weekly all category food waste/person (g).

Variables	Sample mean	Coef.	Robust Std. Err.	*p* value
Female (yes = 1)	0.59	−21.986	45.165	0.626
Age (base: 18–44)	0.38			
45–64	0.35	−127.952	49.456	0.010
65 and older	0.27	−187.922	70.509	0.008
Race (base: White)	0.77			
Black	0.08	185.209	70.677	0.009
Asian	0.09	−8.258	76.399	0.914
Other identities	0.06	3.264	67.975	0.962
Hispanic or Latino (Yes = 1)	0.09	125.431	104.299	0.229
Highest education (base: <Bachelor)	0.47			
Bachelor's degree	0.34	−92.679	50.407	0.066
>Bachelor	0.19	−39.990	62.785	0.524
Employment status (base: full-time)	0.47			
Part-time	0.09	48.960	73.819	0.507
Others	0.44	−13.146	50.689	0.795
Household income (base: ≤$50k)	0.38			
50–99k	0.29	38.464	58.160	0.508
≥100k	0.33	21.737	59.896	0.717
Household size (base: =1)	0.27			
=2	0.36	−389.214	68.918	<0.001
≥3	0.37	−514.777	82.778	<0.001
% of HH members that are adult males	39.0	−51.239	101.670	0.614
% of HH members that are adult females	48.4	46.955	105.675	0.657
% HH members are that are children <5 years	4.3	438.498	370.866	0.237
Region (base: Northeast)	0.20			
South	0.29	−68.975	59.737	0.248
Midwest	0.22	−90.693	55.564	0.103
West	0.29	−81.411	60.390	0.178
Grocery shopping frequency (base: ≥2/week)	0.27			
Weekly	0.52	−91.579	50.102	0.068
2–3/month	0.17	−50.827	74.537	0.495
Monthly	0.04	−393.764	103.647	<0.001
% of nonsleeping time spent at home	64.2	.502	.874	0.566
All meals prepared at home (yes = 1)	0.18	−134.016	64.531	0.038

(Continues)

TABLE 1 (Continued)

Variables	Sample mean	Coef.	Robust Std. Err.	*p* value
Any issues that led to unusual waste (yes = 1)	0.66	623.287	57.714	<0.001
Wave by version (base: Feb 21)	0.18			
Jul 21—standard version	0.08	12.526	81.110	0.877
Jul 21—variation	0.13	99.231	75.725	0.190
Dec 21—standard version	0.16	88.761	61.722	0.151
Dec 21—variation	0.16	319.656	79.302	<0.001
Feb 22—standard version	0.13	312.927	86.472	<0.001
Feb 22—variation	0.16	175.441	73.304	0.017
Observations		1977		
Left-censored observations		422		
Uncensored observations		1535		
$F(33, 1944)$[a]		7.90		<0.001

[a]Two-sided test statistic for null hypothesis that all independent variables are jointly equal to zero. The *p*-values reported are from a two-sided *t*-test of the null hypothesis that the individual censored regression coefficient equals zero ($df = 1950$).

The positive correlation between consumers eating meals away from home and the amount of food waste created in home has been previously noted in the gray literature for the United Kingdom (WRAP, 2022). However, establishing this correlation in the United States is important as food procurement patterns differ substantially between the two countries. For example, the United Kingdom's prevalence of eating meals prepared outside the home at least once a week was 48% (Adams et al., 2015, covering 2008-12) and 84% in the United States (Kant et al., 2015, covering 2007-10) while during the first year of COVID 51% of U.K. households shopped weekly or more frequently while only 41% did so in the United States (YouGov, 2021).

The association between consuming all meals at home and waste is strongest for the drinks category and also statistically significant for fresh produce (Figure 3a). Several other household characteristics that were prone to change over the course of households' response to COVID also reveal significant association with total waste and key waste subcategories. For example, respondents were asked to report if they faced any issues during their reporting week that caused them to create atypical waste levels (e.g., unexpectedly dining out, the procurement of perishables that decayed faster than expected, etc.). About half of respondents reported such issues in the February 2021 wave, and this grew steadily to 79% in the February 2022 wave. Not surprisingly, there was a significant positive association between reporting such events and total waste (as well as each category of waste), with the largest effects holding for waste in the drinks category (which included milk) and the dairy/eggs category (Figure 3b).

The issues most frequently reported were waste due to dining out unexpectedly, which increased significantly from about 12% in February 2021 to 32% a year later (20.3 pp increase, two-sided $t = 4.10$, $p < 0.001$, $df = 1976$, 95% confidence interval: [10.6%, 30.1%]) and expiration of food due to bulk purchases, which increased significantly from 12% to 24% during the same period (12.2 pp increase, two-sided $t = 2.62$, $p = 0.009$, $df = 1976$, 95% confidence interval: [3.1%, 21.4%]). Respondents were also significantly more likely to report that eating fewer meals at home contributed to unexpected food waste issues, which complements the "unexpectedly eating out" result and points to shifts in meal provisioning as a potential explanatory figure for the large year-over-year increase in waste. Supporting Information: Figure SA2 presents the February 2021 and

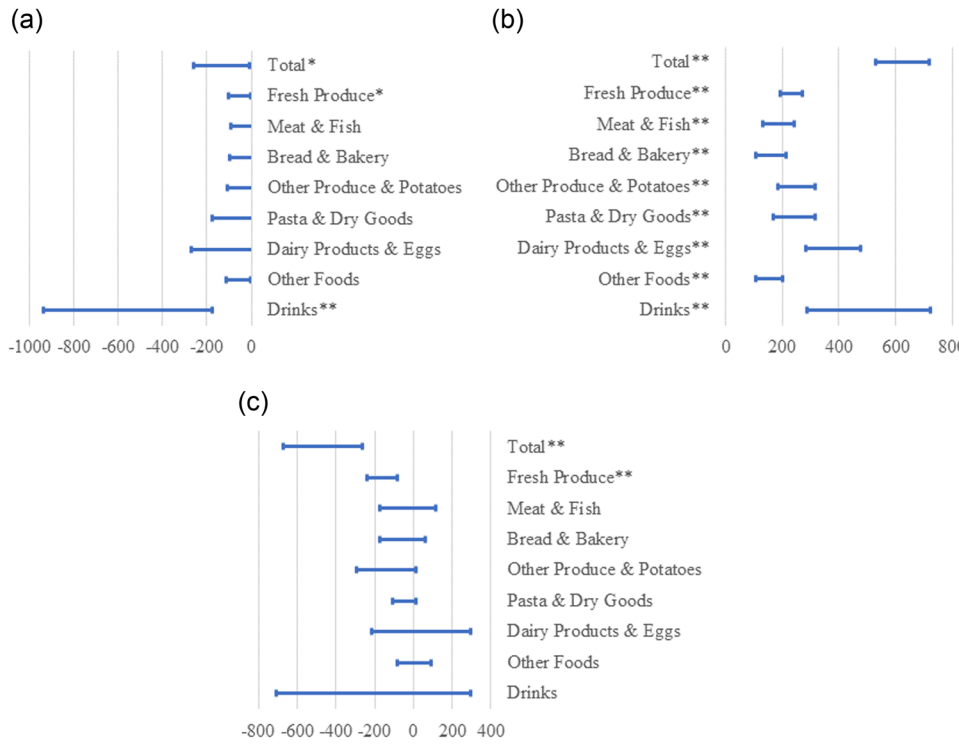

FIGURE 3 Censored regression coefficients and 95% confidence intervals for (a) all meals consumed at home, (b) if self-reported issues during reporting week, and (c) shops for food once a month (vs. multiple times/week) by waste category. Categories with *, ** have effects that are significantly different from zero at the 5% and 1% levels, respectively, for a two-sided *t*-test assessed using robust standard errors and $df = 1946$. $N = 1977$ for each regression.

February 2022 values for each category of reported reasons for unexpected food waste during respondents' reporting weeks.

Employment opportunities reported by survey respondents fluctuated throughout this period with those being unemployed, unable to work, a student, or retired declining from 53.2% of the sample in February 2021 to 42% in February 2022, while those reporting full-time work grew from 36% to 51% during this same period. We find no significant association between employment status and total waste per person and few instances of statistically significant relationships within particular categories of waste.

COVID also shaped the food shopping habits of many households (Ellison et al., 2021; IFIC 2020b). In our sample, those shopping infrequently (less than once a week) declined from 23% in February of 2021 to 18% a year later, though this change was not statistically significant (−5.5 pp, two-sided $t = 1.28$, $p = 0.20$, $df = 1976$, 95% confidence interval: [−14.0%, 2.9%]). While shopping frequency did not change significantly across waves, waste patterns differed by shopping frequency, with respondents who shop once a month or less frequently wasting significantly less food overall and significantly less fresh produce in particular (Figure 3c) than those who shop more frequently. We note this pattern contrasts with the results of Smith and Landry (2021), who found the greatest waste among households shopping only once per month or less frequently, though their data are from the 1970s and may represent a different era of food acquisition, storage conditions, and production patterns.

The results also confirm a number of previously identified regularities between respondent characteristics and waste levels, including that per person waste decreases with the number of people in a household (Smith & Landry, 2021; Yu & Jaenicke, 2020) and the age of respondent

(NASEM, 2020; Schanes et al., 2018). The literature is mixed in terms of whether there is a relationship between waste and characteristics such as household income, respondent race, ethnicity, education, or region of residence (NASEM, 2020; Schanes et al., 2018; Smith & Landry, 2021; Yu & Jaenicke, 2020). We find no evidence of a relationship between waste per person and household income, region of residence, education, or ethnicity. We do find that respondents who identified as Black reported significantly more waste than those who identified as White.

4 | DISCUSSION

Because our data only begins in 2021, we are unable to provide a full assessment of progress at the household level toward the 50% reduction goal set by the United States in 2015. Even if there was significant progress towards the goal between 2015 and the time of our first measurement, the 280% year-over-year increase bodes poorly for goal attainment. We note that this increase in waste occurred in the face of higher food prices, with the February 2022 Consumer Price Index for Food being 7.9% higher than the previous February (Federal Reserve Bank St. Louis, 2022). Given that others have found food waste production to be highly negatively responsive to food prices (Landry & Smith, 2019), the documented trend operates against predictions of reduced household food waste in the face of these higher food prices.

While these initial increases in food prices have not appeared to temper increases in household food waste, additional price increases experienced during 2022 and forecasted for the following year could lead to threshold effects that motivate changes in household behaviors and lead to less waste. However, if consumers turn to bulk purchasing as a means to reduce the per unit cost of food acquisition, it may not necessarily lead to less waste, as our data reveal respondents increasingly implicating bulk-purchased items as a reason for unusual levels of waste during their reporting week. Previous literature points to post-COVID increases in consumer cold storage capacity (e.g., adding an extra refrigerator or freezer, see Bender et al., 2022), which may mean that bulk purchased items may also include refrigerated and frozen foods items in addition to shelf-stable items.

Increases in household food waste during the post-COVID period have also been observed in the United Kingdom, where national tracking studies commenced before the onset of COVID. Self-reported household food waste for core food items in the UK declined by more than 30% after the onset of COVID before nearly returning to pre-COVID levels by the Autumn of 2021 (WRAP, 2020, 2023). The early post-COVID reduction in household waste in the United KIngdom was accompanied by self-reports of more fastidious household food management practices (e.g., creation of shopping lists, checking of food in storage) that were driven by consumer desires to reduce the number of shopping trips and facilitated by additional time available due to the lockdown. However, most consumers also predicted that such conditions would not persist when living conditions returned to pre-COVID routines (WRAP, 2020). Follow-up work in 2021 and 2022 confirmed UK consumers' own predictions: return to pre-COVID busy schedules undermined adherence to early-lockdown household food management improvements that supported lower waste amounts (WRAP, 2022, 2023).

While trends in the United Kingdom also reveal increases in waste between early 2021 and 2022, they are not as extreme as the increase observed in the United States data (Supporting Information: Figure SA3). In the United Kingdom the increase between January 2021 and September 2022 is 26% (22.6%/17.9%) while the increase in the United States is 280% (564.9/201.5). Part of this difference may be driven by differences in reporting approach. The figures from the United Kingdom are based on four categories (bread, potatoes, milk, and chicken), which omits the produce category that is often the food product with the greatest quantity of waste. Further, the waste reporting is in terms of the percent of food wasted from the most recent purchase occasion, which will miss discard of shelf-stable and frozen items with longer shelf-lives that were not part of the most recent purchase occasion. This may be important as we find that in February 2022, 24.4% of the US respondents

noted the cause of unusual waste levels during their reporting week was "Expired/excessive items from bulk or batch shopping in warehouse clubs…" This is more than double the percent reported during any previous wave and, if a similar increase in waste had occurred in the United Kingdom, it would likely not be identified by their question format.

While the trend measured in the United States is more extreme than that in the United Kingdom similar themes concerning changes in household routines emerge. In our United States data the fraction of nonsleeping time spent away from home increased and the fraction of meals prepared at home declined year over year while increased reports of issues causing atypical waste levels (e.g., unexpectedly eating out, more meals away from home) comport with busier schedules than those observed in the first year after the onset of COVID. This may align with Smith and Landry's (2021) observation that higher levels of food waste are attributable to characteristics such as the ability and desire to organize household food production between shopping trips. This points to the need for tools that help consumers reduce food waste in the face of the return of a more hectic pace of daily life. Given the natural motivation provided by recent increases in food prices, messaging that poses food waste reduction as a means to ease the economic pressures of tighter food budgets and take fewer trips to the store that require expensive fuel may provide a motivational lever upon which to launch such campaigns.

We note several limitations of the study. These include the previously noted caution that self-reported waste levels tend to be substantially less than waste levels measured via direct measurement, such as via curbside audits of household waste (van Herpen, van der Lans, et al., 2019). Further, recruitment occurred via established online consumer panels. While results were weighted post hoc on several demographic variables critical to household food waste generation (age, household size, income), we recognize that those affiliated with online consumer panels may hold distinct household food patterns that could influence waste behaviors.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the Environmental Data Initiative at https://doi.org/10.6073/pasta/33762da1c9eb20ba3e12d23fe73e67f7 [data set] Roe, B.; 2023; U.S. household food waste tracking data in support of Li et al. 2023; ver 1; Environmental Data Initiative https://doi.org/10.6073/pasta/33762da1c9eb20ba3e12d23fe73e67f7 (Accessed 2023-04-05). The data will be made publicly available at https://www.american.edu/library/collections/digital_repository.cfm upon the acceptance of the manuscript for publication.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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