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# Food Restriction and the Experience of Social Isolation

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Across 7 studies, food restrictions increased loneliness by limiting the ability to bond with others through similar food consumption. We first found that food restrictions predict loneliness using observer- and self-reports among children and adults (Studies 1–3). Next, we found mediation by the experience of worry and moderation by eating similar food as others. When restricted individuals were unable to bond over a meal (i.e., they ate different vs. the same food as others), they worried. These “food worries” mediated the effect of restrictions on loneliness (Studies 4 and 5). Moving to controlled experiments, manipulating the presence of a food restriction for unrestricted individuals increased reported loneliness (Study 6). This effect replicated in an experiment that capitalized on a naturally occurring food restriction—the holiday of Passover—where Jewish observers were restricted from eating chametz (leavened food; Study 7). Overall, while both food restrictions and loneliness are on the rise; this research found they may be related epidemics.

*Keywords:* food consumption, social isolation, belonging

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Food restrictions are on the rise across the globe (Sicherer & Sampson, 2018; Tang & Mullins, 2017). Within the United States, there was a 377% increase in severe food allergic reactions between 2007 and 2016 (FAIR Health [White Paper], 2017). People often associate food allergies, a medical condition in which the immune system reacts to certain foods, with children, but adults are affected as well. Further, the rate of children outgrowing their allergies is slowing, meaning children are carrying these allergies into adulthood (Savage, Matsui, Skripak, & Wood, 2007). Beyond food allergies, people may have other dietary restrictions for a host of reasons, including other health conditions (e.g., diabetic, low-sodium), cultural/religious reasons (e.g., Kosher), and ideological reasons (e.g., veganism).

Existing research has focused on the clinical component of health-related food restrictions (i.e., food allergies), examining their prevalence, etiology, management, and treatment (for review, see Sicherer & Sampson, 2018). However, food consumption has important consequences for social connection and cooperation (Lieberman, Woodward, Sullivan, & Kinzler, 2016; Woolley & Fishbach, 2017, 2019). Given this, identifying the psychosocial impact of dietary restrictions on the formation of healthy social relationships is critical. The current research accordingly investigated the influence of food restrictions on experienced social isolation (loneliness) in children and adults.

Using a multimethod approach, including large-scale surveys and controlled experiments, we tested the novel prediction that by limiting the ability to eat similar food as others, food restrictions lead people to feel excluded from the meal and the social bond. In examining this question, we draw on research from multiple disciplines, including psychology (Rozin, 2005), anthropology (Fox, 1994), and sociology (Fischler, 1988; Germov & Williams, 2008), which have investigated the social and cultural nature of food consumption. If eating similar food brings people together and strengthens bonds (Kittler, Sucher, & Nelms, 2017; Sobal, Bove, & Rauschenbach, 2002), food restrictions could limit one’s ability to bond over a meal.

## The Social Nature of Food Consumption

Food consumption is an inherently social activity, as people often acquire, prepare, and eat food in social contexts (Fischler, 1988; Lieberman et al., 2016; Rozin & Rozin, 1981). Food provides an avenue for people to communicate and relate to others, and food practices, from daily eating to celebratory occasions, are an im-

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Data, materials, and syntax can be assessed online at OSF: <https://osf.io/mgpz3/>.

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portant part of social interaction (DeVault, 1994; Fischler, 2011). In particular, food and drink consumption are often ritualized behaviors, enhancing social bonding (Fischler, 1988; Kniazeva & Venkatesh, 2007; Ratcliffe, Baxter, & Martin, 2019; Vohs, Wang, Gino, & Norton, 2013). Anecdotally, food and the notion of friendship are linguistically associated: the French word *compagnon* (companion) is derived from the word *pan* (bread); and the Chinese word *huoban* (friend) is constructed by the character *huo* (cooking) and *ban* (companion).

Experimental evidence for the link between food consumption and social connection is abundant. Developmental research has found children use social information to guide their food choices. Children were more accepting of unfamiliar foods offered by their mothers than by strangers (Harper & Sanders, 1975), consumed more food when eating with siblings than with strangers (Salvy, Vartanian, Coelho, Jarrin, & Pliner, 2008), and came to prefer previously disliked vegetables that were liked by peers (Birch, 1980). Relatedly, adults' food selection and consumption is influenced by the social affiliation goals they hold. People adopt the food practices of another group as a means of establishing a connection with that group (Guendelman, Cheryan, & Monin, 2011), and buy food they dislike if they believe it could help the social bond when consumed with others (Mead, Baumeister, Stillman, Rawn, & Vohs, 2011).

Whereas social ties or motives influence food consumption, the opposite pathway also exists: food consumption influences social connection. For example, strangers who ate similar food felt closer and trusted each other more than those who ate different food (Woolley & Fishbach, 2017), and eating food from a shared plate fostered greater cooperation than eating the same food, but from individual plates (Woolley & Fishbach, 2019). Thus, when sharing a meal, similar food connects, and the method of eating, whether from shared or separate dishes, matters for cooperation. It is possible that food restrictions, by limiting the ability to bond over a meal, contribute to loneliness.

### Food Restrictions and Loneliness

Can food restrictions cause loneliness? Qualitative interviews and surveys of those living with a food restriction (mainly children) suggest it is possible (Fenton, Elliott, & Clarke, 2013; Nettleton, Woods, Burrows, & Kerr, 2010; Pitchforth et al., 2011). Between 24–32% of food-restricted children reported experiencing bullying because of their restriction (Lieberman, Weiss, Furlong, Sicherer, & Sicherer, 2010; Shemesh et al., 2013). Interviews of those suffering from celiac disease, for example, documented that maintaining the diet was associated with feelings of isolation and was termed “a lonely struggle” (Sverker, Hensing, & Hallert, 2005). Yet, this prior research did not compare those with restrictions to those without and, thus, could not determine whether dietary restrictions are associated with—let alone, cause—social isolation. In addition, this past research focused on the experience of children who are food-restricted, yet social consequences of living with a food restriction likely extend beyond childhood. Children can retain their food restrictions as they enter adulthood, and adults can develop new restrictions (Gupta et al., 2019), which may cause loneliness. For example, a recent study of undergraduate students found an association between vegetarianism and depressive symptoms (Forestell & Nezelek, 2018), which are cor-

related with loneliness (Russell, Peplau, & Cutrona, 1980). The current research is accordingly the first to examine the association between restrictions and social isolation among children and adults. It is also the first, to our knowledge, to experimentally test the causal pathway between food restrictions and loneliness, and to test the psychological process underlying this relationship.

Loneliness is experienced as a discrepancy between a desired and achieved level of social connectedness (Perlman & Peplau, 1981). As such, loneliness is driven by perceived, rather than objective, isolation. Often, it is the quality, rather than the quantity, of social interactions that matters (Hawkey et al., 2008). There are two types of loneliness: situational and chronic. Situational loneliness is a transient experience of lack of social connection, which motivates the maintenance and formation of social connections (Cacioppo & Hawkey, 2009; Cacioppo et al., 2006). Repeatedly experiencing situational loneliness can lead to chronic loneliness; a state that persists over several years (Heinrich & Gullone, 2006; Shiovitz-Ezra & Ayalon, 2010).

Those with food restrictions are constantly navigating situations in which they are unable to eat what others eat; for them, most group meals involve experiencing situational exclusion. Compounded over time, this could lead to a chronic experience of loneliness such that those with food restrictions are lonelier, on average, than unrestricted individuals. Indeed, longitudinal studies have found that effects of loneliness can accrue over time (Cacioppo, Chen, & Cacioppo, 2017; Hawkey & Cacioppo, 2007). Given that food restrictions are often acquired at an early age (during childhood), they might have a chronic long-term effect. Thus, people who are habitually excluded from bonding over a meal come to feel greater loneliness than those who are not faced with such a restriction.

Accordingly, our main prediction is that having a food restriction predicts loneliness. When examining loneliness in the general population, those with food restrictions will report feeling lonelier than those without food restrictions. We expect this relationship extends beyond self-reports, such that external observers will perceive those with food restrictions to be lonelier than those without.

Moving to the underlying process, we expect that food restrictions are associated with negative feelings that we refer to as “food worries.” Food worries are people’s concerns about how others perceive them based on what they eat. They include thoughts about having to tell others that they do not eat a certain food, that choosing food is complicated and time consuming for them, and fear that others will reject them because of what they eat. We predict that food worries mediate the restriction-loneliness relationship.

We also predict moderation by dining experience. Restricted individuals’ typical group-dining experience is one in which they eat different food than other diners. However, when their restriction does not limit their ability to bond over a meal, restricted individuals should experience fewer food worries, and feel less lonely. Under this condition, the difference between restricted and unrestricted individuals will attenuate.

Finally, we predict that food restrictions not only predict, but further *cause* people to feel lonelier. Therefore, imposing a food restriction on someone will cause that person to experience situational loneliness. For example, when an underaged person is with peers who consume alcohol, or when an observer of Passover is

eating with others who consume leavened foods and is unable to eat those foods, these situationally restricted individuals will experience heightened loneliness.

These predictions should hold for any food restriction, regardless of its origin, including those self-imposed because of cultural, religious or ethical reasons, medically imposed (e.g., because of food allergies), and legally imposed. We accordingly operationalized food restriction in our studies as food avoided for at least one of the following reasons: health (e.g., allergy), cultural (including religious restrictions), ethical (e.g., vegetarianism), and legal (e.g., minimum drinking age). We did not include distaste of certain foods (e.g., dislike of olives or cilantro), which is less likely to impede consumption.

### Research Overview

Seven studies examined the effect of food restrictions on loneliness. First, we tested whether restrictions predict loneliness across diverse samples, including adults' self-reports (Study 1) and observers' reports of children (Study 2). We also examined this relationship using nationally representative survey data collected by the Centers for Disease Control and Prevention (CDC;  $N = 35,093$ ), in which parents or guardians reported children's food restriction (i.e., food or digestive allergies) and a proxy measure of loneliness (Study 3). Together, these studies tested for the ecological validity of the food restriction-loneliness association.

We next tested whether food worries mediate this restriction-loneliness association (Study 4), and whether this association attenuates (i.e., is moderated) when recalling a time when one could eat what others ate and, thus, could share in bonding over a meal (Study 5). Finally, we report controlled experiments, which examined whether assigning a food restriction to unrestricted individuals increased reported loneliness (Study 6), and whether a naturally occurring manipulation of restrictions—the holiday of Passover, when observant Jewish people refrain from eating leavened foods—increased loneliness (Study 7). Table 1 summarizes results across these studies.

Table 1  
Summary of Studies

Studies	Independent variable	Measures	Main finding
Study 1	Food restriction (self-reported)	Chronic loneliness	Food restrictions predicted loneliness in adults.
Study 2	Food restriction (teachers' reports)	Chronic loneliness	Food restrictions predicted loneliness in children.
Study 3	Food/digestive allergy in past year	Loneliness proxy: Difficulties getting along with others; often depressed; unhappy or tearful	Food restrictions predicted proxies for loneliness in children in CDC data.
Study 4	Food restriction (self-reported)	Chronic loneliness; food worries (concerned about how others perceive them based on what they can or cannot eat)	Food worries mediated the effect of food restrictions on loneliness in adults.
Study 5	Food restriction (self-reported)	Situational loneliness; food worries	Food worries mediated the effect of food restrictions on loneliness in adults recalling a typical dining experience (vs. a time they could eat what others ate).
Study 6	Food restriction (manipulated)	Situational loneliness	Assigned food restrictions caused greater loneliness.
Study 7	Food restricted during (vs. after) Passover	Situational loneliness	Food restrictions during Passover increased loneliness compared to when not restricted (after Passover).

Note. CDC = Centers for Disease Control and Prevention.

We predetermined sample sizes for all studies. For online studies (Studies 1, 2, 4, and 5), we calculated sample size to have 80% power to detect a small-to-medium sized effect. Sample sizes for lab and field studies (Studies 6 and 7) had 80% power to detect a medium sized effect (because of challenges of recruiting lab and field participants). We posted all data, materials, and syntax on Open Science Framework (OSF): <https://osf.io/mgpz3/>, including data for six studies reported in online supplemental materials (the results of the supplemental studies further support our hypotheses). Between the studies listed here and in the online supplemental materials, we report all studies conducted for this project.

### Study 1: Food Restrictions Predict Loneliness in Adults

This first study examined the association between food restrictions and loneliness in adults. Participants indicated whether they had a food restriction and then completed a loneliness scale and several demographic variables. We predicted that those with food restrictions would feel lonelier than those without restrictions.

#### Method

**Participants.** We opened the study for 500 participants on Amazon's Mechanical Turk (MTurk) and 505 workers completed the survey for \$0.30 (we report participant attrition for Studies 1–7 in the online supplemental materials; Zhou & Fishbach, 2016). Ten participants did not complete all measures (income:  $n = 8$ , age:  $n = 1$ , education:  $n = 1$ ), leaving 495 participants in the analyses ( $M_{age} = 35.25, 11.10; 47.7\%$  female).

**Procedure.** Participants reported the presence of a food restriction by checking a box corresponding to their food restriction (e.g., peanuts, shellfish, soy, wheat allergy, celiac disease, gluten sensitivity, vegan, vegetarian, Kosher, diabetic, etc.; see the online supplemental materials for breakdown by food restriction). Those who did not have a food restriction selected "none." We included an open response item for participants to write in any restriction

they had that was not included in the restriction list. Overall, 28.5% of participants reported having a food restriction, consistent with data from the Pew Research Center (2016). We measured loneliness using the three-item short form of the Revised UCLA Loneliness Scale (Hughes, Waite, Hawkey, & Cacioppo, 2004). Participants indicated how often they felt: lack of companionship, left out, and isolated from others (1 = *hardly ever*, 2 = *some of the time*, 3 = *often*). Following Hughes et al. (2004), we created a loneliness composite by summing the three items, with higher values indicating greater loneliness ( $\alpha = .88$ ;  $M = 5.25$ ,  $SD = 1.99$ , range = 3–9).

After assessing loneliness, as covariates, we measured several demographic and relationship characteristics associated with loneliness (Cacioppo et al., 2006; Luo, Hawkey, Waite, & Cacioppo, 2012): Age, gender, race/ethnicity, education, household income, marital status (married/unmarried), presence of relatives living nearby (yes/no), and presence of friends living nearby (yes/no). Previous research found a negative association between loneliness and income (Pinquart & Sorensen, 2001), being married (Tornstam, 1992), and having friends living nearby (Hawkey et al., 2008).

## Results and Discussion

We regressed loneliness on food restriction (present vs. absent). As predicted, having a food restriction was associated with greater loneliness ( $M_{\text{restricted}} = 5.75$ , 95% confidence interval [CI: 5.43, 6.08];  $M_{\text{unrestricted}} = 5.05$ , 95% CI [4.84, 5.25]),  $\beta = .16$ ,  $t(493) = 3.62$ ,  $p < .001$ , 95% CI [.32, 1.09].<sup>1</sup> This effect persisted when including all covariates in the model ( $M_{\text{restricted}} = 5.50$ , 95% CI [5.14, 5.86];  $M_{\text{unrestricted}} = 4.81$ , 95% CI [4.55, 5.06]),  $\beta = .16$ ,  $t(485) = 3.73$ ,  $p < .001$ , 95% CI [.33, 1.05] (see Table 2).

To test the robustness of the association between loneliness and food restrictions, we preregistered a direct replication of this study ( $N = 500$ ; registration: <https://aspredicted.org/cv4gx.pdf>), which again found that food restrictions predicted loneliness (model without covariates:  $\beta = .11$ ,  $t(498) = 2.43$ ,  $p = .016$ , 95% CI [.08, .79]; model with covariates:  $\beta = .09$ ,  $t(490) = 2.08$ ,  $p = .038$ , 95% CI [.02, .70]; see Supplemental Study 1 in online supplemental materials).

Table 2  
Study 1: Descriptive Statistics and Results of Regression Analysis Predicting Loneliness Including Covariates

Variables	Descriptives		Model			
	Mean/%	SD	$\beta$	$t$ -value	$p$ -value	95% CI
Food restriction	28.5%		.16	3.73	<.001	[.33, 1.05]
Age	35.25	11.10	-.04	-.98	.329	[-.02, .01]
Female	47.7%		-.08	-1.84	.067	[-.65, .02]
White	81.8%		-.02	-.48	.630	[-.53, .32]
Education	3.17	1.35	.05	1.17	.244	[-.05, .20]
Income	6.76	2.67	-.17	-3.67	<.001	[-.19, -.06]
Married	36.8%		-.13	-2.72	.007	[-.90, -.15]
Relatives living nearby	22.6%		-.02	-.53	.594	[-.52, .30]
Friends living nearby	32.9%		-.23	-5.28	<.001	[-1.35, -.62]

Note. CI = confidence interval.

We found a significant negative association between loneliness and higher income, being married, and living near friends across Study 1 and the replication study (Supplemental Study 1), consistent with prior research (Hawkey et al., 2008; Pinquart & Sorensen, 2001; Tornstam, 1992). To give some context to the magnitude of the relationship between food restrictions and loneliness, we note that this relationship was of a similar magnitude as the relationship between low income and loneliness (food restriction:  $\beta = .16$ ; income:  $\beta = -.17$ ), as well as that between being unmarried and loneliness ( $\beta = -.13$ ).

Study 1 supported our prediction that food restrictions are associated with increased loneliness in adults. This effect held when controlling for other predictors of loneliness. Moreover, the effect of having a food restriction on the experience of loneliness in this study was comparable with that of having a lower income or being unmarried. In our next study, we extended these results to examine whether loneliness is associated with the presence of food restriction in children.

## Study 2: Food Restrictions Predict Loneliness in Children

This study tested whether food restrictions predict loneliness among young children. We collected data from elementary school teachers who reported whether their students had a food restriction, as well as demographic and social covariates known to predict loneliness. We predicted that the presence of a food restriction would predict loneliness in children as observed by teachers.

## Method

**Participants.** We recruited 36 teachers (Grades K–6) to participate in our survey for a \$20 Amazon gift card using a Qualtrics Panel ( $n = 26$ ) and school contacts ( $n = 10$ ), aiming for a minimum of 500 students. Teachers had class sizes ranging from 10–33 students ( $M_{\text{size}} = 20.52$ ) and received instructions to answer questions about each of the students in their class, for a total of 710 students (46.2% female; average grade = 2.45, corresponding to average age of 7–9).

**Procedure.** Teachers were invited to complete a survey on student outcomes. First, they provided general information about their class (i.e., grade level and class size). They then answered the following questions for each student, using students' initials or ID number for anonymity: 1. Presence of food restriction (14.9%)<sup>2</sup>: "Please list any food restrictions that you know the student has. What is the exact food restriction? Please include health related, cultural, and religious food restrictions. If the student does not have a food restriction, write N/A," 2. Five filler questions about students' personalities (taken from the Big Five personality measures; Gosling, Rentfrow, & Swann, 2003), for example, "I see this

<sup>1</sup> We found a 14% increase in loneliness. This effect is similar in size to previous research conducted on MTurk. For example, Waytz, Chou, Magee, and Galinsky, 2015 (Study 2b) found that a high (vs. low) power manipulation decreased loneliness by 15%. We report standardized coefficients for regression analyses.

<sup>2</sup> Although children have a greater rate of food allergies than adults, they have a lower rate of other food restrictions (i.e., vegetarianism). Overall, we found lower rates of food restriction in children (Study 2) than adults (Study 1).

student as open to new experiences" (1 = *disagree strongly*, 5 = *agree strongly*), and 3. Main measure of perceived social isolation averaged across five items (Asher, Hymel, & Renshaw, 1984;  $\alpha = .89$ ;  $M = 2.20$ ,  $SD = .89$ ; range = 1–5): "Peers include the child," (reverse-coded), "The child is well-liked by the other children in the class," (reverse-coded), "The child has a lot of friends," (reverse-coded), "The child feels left out of things," "The child feels lonely" (1 = *not true at all*, 5 = *true all of the time*). We included five items from the Big Five personality measure because we did not want teachers to guess the hypothesis.

Next, we measured the following items as covariates: 4. Whether the student was new to the class. 5. Whether the student was a nonnative English speaker. 6. Whether the student had a learning disability or learning difficulty (yes/no). 7. Student gender. Upon completing these measures for the first student in class, teachers moved to the second student in class and so on, until they completed these items for all of their students.

## Results and Discussion

We analyzed the student data using a hierarchical linear model to account for the nesting of students (Level 1) within teachers (Level 2; Judd, Westfall, & Kenny, 2012). As predicted, having a food restriction was associated with significantly greater levels of loneliness ( $M_{\text{restricted}} = 2.41$ , 95% CI [2.20, 2.62];  $M_{\text{unrestricted}} = 2.17$ , 95% CI [2.02, 2.33]),  $\beta = .10$ ,  $t(702) = 2.69$ ,  $p = .007$ , 95% CI [.06, .41]. This pattern held when including all covariates ( $M_{\text{restricted}} = 2.78$ , 95% CI [2.54, 3.02];  $M_{\text{unrestricted}} = 2.58$ , 95% CI [2.38, 2.78]),  $\beta = .08$ ,  $t(689) = 2.34$ ,  $p = .020$ , 95% CI [.03, .37] (see Table 3).

This study found that students with food restrictions appear lonelier. To give some context to this finding, we compared the magnitude of the effect of restrictions to other predictors of loneliness. For example, the effect of restriction was larger than that of being a nonnative English speaker (food restriction:  $\beta = .08$ ; nonnative English speaker:  $\beta = .05$ ), and smaller than that of being a new student ( $\beta = .13$ ), and having a learning difficulty ( $\beta = .20$ ).

Recall that we measured Big Five personality items as a filler to prevent respondents from guessing the hypothesis. However, given that prior research found responses to two of these items—neuroticism (i.e., calm) and extraversion—correlate with loneliness (Abdellaoui et al., 2019; Cacioppo et al., 2006), we conducted explor-

atory analyses controlling for these items. We found that these items were correlated with loneliness in our study,  $r_{\text{calm}} = -.19$ ;  $r_{\text{extraverted}} = -.30$ , yet the relationship between food restrictions and loneliness remained unchanged when including these items as covariates (effect of food restriction when controlling for both calmness and extraversion:  $\beta = .08$ ,  $t(696) = 2.56$ ,  $p = .011$ , 95% CI [.05, .36]; effect of food restriction when controlling for calmness, extraversion, and all covariates:  $\beta = .07$ ,  $t(684) = 2.21$ ,  $p = .028$ , 95% CI [.02, .33]; see online supplemental materials).

Overall, food restrictions predicted loneliness, using data from observers (i.e., teachers) who provided external reports of children's loneliness. Teachers in this study were unaware of the hypothesis when providing social exclusion ratings, which suggest that, to the extent people hold lay beliefs that those with food restrictions are lonelier, we were not capturing those beliefs. This occurred even when controlling for personality measures associated with loneliness in children. We next tested this hypothesis using data collected by the CDC.

### Study 3: Food Restrictions Predict Loneliness in a Large-Scale, Nationally Representative Sample

To further test the effect of restrictions, we analyzed secondary data from the National Health Interview Survey (NHIS), a nationally representative sample of U.S. households conducted by the CDC. We examined the Sample Child component of the NHIS for 4 years from 2014 to 2017, which assessed whether a randomly selected child, in households with at least one child, had a food/digestive allergy. Although this survey did not measure loneliness outright, it measured three items that are a reasonable proxy of loneliness: (a) the child has difficulties getting along with other people, (b) is often depressed, and (c) is unhappy or tearful. Loneliness is strongly associated with depressive symptoms such as these in adults and children (Heinrich & Gullone, 2006).

## Method

Using the Sample Child component of the NHIS data collected by the CDC, we conducted retrospective analyses on the 2014, 2015, 2016, and 2017 deidentified data (for further information about NHIS and the questionnaire see [cdc.gov/nchs/nhis.htm](http://cdc.gov/nchs/nhis.htm)). Combined, this provided a total sample of 35,093 children ( $M_{\text{age}} = 10.80$ ,  $SD = 4.10$ , 48.4% female). This survey was completed by a parent or guardian for a child in the household and included a binary food allergy variable: "During the past 12 months, has {child} had any of the following conditions . . . Any kind of food/digestive allergy?" There were 6.1% who had a food/digestive allergy, which is similar to rates found in previous research on children's food allergies (Sicherer, Noone, & Muñoz-Furlong, 2001).<sup>3</sup>

We examined the following three measures as a proxy for loneliness: 1. "Overall, do you think that {child} has difficulties in any of the following areas: emotions, concentration, behavior, or being able to get along with other people?" (0 = *no*, 1 = *yes, minor difficulties*, 2 = *yes, definite difficulties*, 3 = *yes, severe*

<sup>3</sup> Study 2 assessed food restrictions more broadly, which likely explains the differences in food restrictions between these samples (Study 2: 15% had restrictions, Study 3: 6% had a food or digestive allergy in the past 12 months).

Table 3  
Study 2: Descriptive Statistics and Results of Regression Analysis Predicting Loneliness Including Covariates

Variables	Descriptives		Model			
	Mean/%	SD	$\beta$	<i>t</i> -value	<i>p</i> -value	95% CI
Food restriction	14.9%		.08	2.34	.020	[.03, .37]
Female	46.2%		-.03	-.87	.386	[-.16, .06]
Grade	2.45	1.61	.00	.02	.983	[-.09, .09]
Class size	20.52	5.73	.04	.43	.669	[-.02, .03]
New student	8.3%		.13	3.77	<.001	[.20, .63]
Nonnative English speaker	12.7%		.05	1.27	.205	[-.07, .33]
Learning difficulty	15.1%		.20	5.85	<.001	[.34, .68]

Note. CI = confidence interval.

difficulties), 2. “During the past 6 months, {he/she} has many worries, or often seems worried?” (0 = *not true*, 1 = *somewhat true*, 2 = *certainly true*) and 3. “During the past 6 months, {he/she} is often unhappy, depressed, or tearful?” (0 = *not true*, 1 = *somewhat true*, 2 = *certainly true*). We standardized and averaged responses ( $\alpha = .68$ ), with higher scores representing greater loneliness.<sup>4</sup>

In our analysis, we included the following demographic variables that typically covary with loneliness (Cacioppo et al., 2006; Luo et al., 2012): race (1 = White, 0 = not), age (in years; range = 4–17), gender, total combined family income (1 = \$0–\$49,999; 2 = \$50,000–\$99,999; 3 = \$100,000 and over), and learning disability (1 = yes, 0 = no). We also included the survey year as a covariate (1 = 2014; 2 = 2015; 3 = 2016; 4 = 2017).

## Results and Discussion

We regressed our proxy for loneliness on food/digestive allergy (present vs. absent). As we predicted, having a food/digestive allergy was associated with greater reported loneliness ( $M_{\text{restricted}} = .21$ , 95% CI [.18, .24];  $M_{\text{unrestricted}} = -.01$ , 95% CI [–.02, .01]),  $\beta = .07$ ,  $t(35,091) = 12.88$ ,  $p < .001$ , 95% CI [.19, .26]. These results replicated when including all covariates in the analysis (see Table 4). We provide a more in-depth analysis with more variables reported in this dataset, including other allergies, developmental delays, persistent health concerns, and more recent health concerns, in the online supplemental materials. Including these additional measures in our analysis, in addition to our covariates, resulted in a similar food/digestive allergy-loneliness association (Table S4 in online supplemental materials).

To give some context to the magnitude of this effect, having a food restriction on the loneliness proxy variable was comparable to low income (food restriction:  $\beta = .06$ ; income:  $\beta = -.07$ ), similar to Study 1, which also measured income.

In addition, we found evidence that food/digestive allergies are on the rise. A logistic regression of food restriction on survey year resulted in a statistically significant increase in reported food allergies in children across the four survey years (2014 = 5.6%, 2015 = 6.0%, 2016 = 6.2%, 2017 = 6.8%),  $b = .07$ ,  $SE = .02$ , Wald = 10.92,  $p < .001$ , odds ratio,  $OR = 1.07$ .

Using secondary data collected by the CDC from a nationally representative sample of households, we found that food/digestive

allergy predicts a proxy of loneliness (i.e., relational and emotional difficulties). Further increasing our confidence in the interpretation of the data, this loneliness proxy was related to several variables that previous research found were associated with loneliness: older age, lower income, learning disability, and a more recent year.

We note that being male was also associated with greater loneliness, consistent with other research finding that males are lonelier than females (Borys & Perlman, 1985), although this relationship disappeared when including presence of a learning disability in the analysis (males were significantly more likely to have a learning disability, 10.1% males vs. 6.1% females,  $\chi^2(1, N = 35,055) = 187.03$ ,  $p < .001$ ,  $\Phi = .07$ ). This study also found that being White was associated with greater loneliness, although there is mixed evidence for the association between ethnicity and loneliness (Schinka, van Dulmen, Mata, Bossarte, & Swahn, 2013).

The fact that this survey does not directly assess loneliness is interesting in itself. It possibly suggests lack of awareness of loneliness as a social problem and lack of awareness of the potential health and social circumstances (such as food restrictions) that cause it. With Studies 1–3 finding that food restrictions are related to loneliness, our next study examined whether this relationship is mediated by food worries.

## Study 4: Food Worries Mediate the Effect of Restriction on Loneliness

Study 4 tested what variables underlie the effect of food restriction using a mediation approach. We predicted that restricted individuals have heightened food worries—they are concerned about how others perceive them based on what they can or cannot eat, compared with unrestricted individuals. We predicted that greater food worries mediates the effect of food restrictions on loneliness.

This study also examined an alternative predictor of loneliness for food restricted individuals: inability to share food dishes. Although restricted individuals may not be able to share food on their plate as much as other diners in their group, we expected sharing plates would not predict loneliness. Unlike eating similar food, eating from shared (vs. separate) plates is less likely to affect the social bond (Woolley & Fishbach, 2019).

To further gain insights on the experience of those living with food restrictions, we asked restricted individuals the following exploratory items: 1. The voluntary nature of their restriction, 2. Frequency of the restriction limiting their ability to eat what others eat, or 3. Years living with the restriction. We tested whether each of these items predicted loneliness.

## Method

**Participants.** We opened the study for 500 participants on MTurk and 501 workers completed the survey for \$0.60. Seven participants chose “I prefer not to respond” to our measure of income, leaving 494 participants in the analysis ( $M_{\text{age}} = 37.28$ , 11.71; 43.5% female).

<sup>4</sup> This standardized measure had a  $M = .00$ ,  $SD = .78$ , range =  $-.54$  to  $4.27$ . To provide a robustness check for the observed effect, we separately regressed each individual item on the food/digestive allergy predictor variable, reported in online supplemental materials.

Table 4  
Study 3: Descriptive Statistics and Results of Regression Analysis Predicting Loneliness Proxy Including Covariates

Variables	Descriptives		Model			
	Mean/%	SD	$\beta$	$t$ -value	$p$ -value	95% CI
Food/digestive allergy	6.1%		.06	11.78	<.001	[.17, .23]
Age	10.80	4.10	.09	17.67	<.001	[.02, .02]
Female	48.4%		.003	.67	.506	[–.01, .02]
White	72.9%		.05	8.94	<.001	[.07, .10]
Income	1.86	.83	–.07	–12.63	<.001	[–.07, –.05]
Survey year	2.34	1.10	.03	5.02	<.001	[.01, .03]
Learning disability	8.1%		.28	53.42	<.001	[.77, .83]

Note. CI = confidence interval.

**Procedure.** Participants reported the presence of a food restriction as in Study 1. Overall, 29.8% of participants reported having a food restriction. They next completed a four-item measure, which we developed to capture food worries (averaged;  $\alpha = .88$ ;  $M = 2.04$ ,  $SD = 1.40$ ): 1. “When eating with others, I worry about having to tell others at the table that I don’t eat a certain food.” 2. “People tend to avoid inviting me to eat with them because of the food I can/can’t eat.” 3. “When eating with others, I find myself spending more time than others on choosing what to order because of what I can/cannot eat.” 4. “When eating with others, people make negative assumptions about me because of the food I can/can’t eat.” (1 = *not at all*, 7 = *very much*). These items assess negative cognitions about having to tell others that they do not eat a certain food, that choosing food is complicated and time consuming for them, and fear that others will reject them because of what they can or cannot eat.

To address the possibility that concern about not being able to share one’s food mediated the effect on loneliness, participants also rated: “When eating with others, I can always split an entrée with other diners” (1 = *not at all*, 7 = *very much*).

All participants then completed the three-item loneliness scale as in Study 1 (summed;  $\alpha = .90$ ;  $M = 5.08$ ,  $SD = 1.94$ , range = 3–9). For exploratory purposes, we asked restricted participants the following measures to examine whether these correlated with restricted individuals’ experience of loneliness: 1. “How frequently does your food restriction limit your ability to eat what others are eating?” (1 = *very rarely*, 7 = *very frequently*), 2 “How many years have you had this food restriction?” (open-response), and 3. “To what extent would you say that you “chose” to have this food restriction?” (1 = *not at all*, 7 = *very much*). Lastly, we measured all covariates from Study 1 (age, gender, marital status, relatives living nearby, friends living nearby, income, race/ethnicity, and education).

## Results and Discussion

First, we regressed loneliness on food restriction (present vs. absent). As predicted, having a food restriction predicted loneliness ( $M_{\text{restricted}} = 5.39$ , 95% CI [5.08, 5.71];  $M_{\text{unrestricted}} = 4.95$ , 95% CI [4.74, 5.15]),  $\beta = .11$ ,  $t(492) = 2.36$ ,  $p = .019$ , 95% CI [.08, .82]. This effect persisted when including all covariates in the model ( $M_{\text{restricted}} = 5.36$ , 95% CI [5.04, 5.68];  $M_{\text{unrestricted}} = 4.96$ , 95% CI [4.71, 5.21]),  $\beta = .09$ ,  $t(484) = 2.19$ ,  $p = .029$ , 95% CI [.04, .76] (see Table 5). As in Study 1 and its replication study (Supplemental Study 1), the restriction-loneliness association was of a similar magnitude as the unmarried-loneliness relationship.

Next, we regressed food worries on food restrictions. As predicted, food restrictions predicted food worries ( $M_{\text{restricted}} = 2.99$ , 95% CI [2.79, 3.20];  $M_{\text{unrestricted}} = 1.63$ , 95% CI [1.50, 1.77]),  $\beta = .44$ ,  $t(492) = 10.98$ ,  $p < .001$ , 95% CI [1.12, 1.60]. This effect persisted when including all covariates in the model ( $M_{\text{restricted}} = 3.07$ , 95% CI [2.86, 3.28];  $M_{\text{unrestricted}} = 1.81$ , 95% CI [1.64, 1.97]),  $\beta = .41$ ,  $t(484) = 10.52$ ,  $p < .001$ , 95% CI [1.03, 1.50].

We performed a mediation analysis to test our hypothesis that the relationship between food restriction and loneliness is mediated by food worries. We used a bootstrap procedure with 10,000 resamples (Preacher, Rucker, & Hayes, 2007). As predicted, food worries significantly mediated the effect of food restriction on

Table 5

Study 4: Descriptive Statistics and Results of Regression Analysis Predicting Loneliness Including Covariates

Variables	Descriptives		Model			
	Mean/%	SD	$\beta$	<i>t</i> -value	<i>p</i> -value	95% CI
Food restriction	29.8%		.09	2.19	.029	[.04, .76]
Age	37.28	11.71	-.08	-1.87	.062	[-.03, .00]
Female	43.5%		.08	1.91	.056	[-.01, .66]
White	78.1%		-.10	-2.17	.030	[-.86, -.04]
Education	3.18	1.33	.03	.65	.513	[-.08, .17]
Income	6.95	2.72	-.18	-3.84	<.001	[-.19, -.07]
Married	41.5%		-.07	-1.56	.119	[-.64, .07]
Relatives living nearby	23.9%		-.02	-.52	.605	[-.49, .29]
Friends living nearby	38.8%		-.23	-5.15	<.001	[-1.25, -.56]

Note. CI = confidence interval.

loneliness ( $\beta_{\text{indirect}} = .35$ ,  $SE = .10$ , 95% CI [.1584, .5665], with no significant direct effect (95% CI [-.31, .51], consistent with full mediation).<sup>5</sup>

We next examined an alternative explanation. Food restrictions may increase loneliness because those with food restrictions are unable to share food dishes with others at the table. There was a marginal association between food restriction and ability to share food ( $M_{\text{restricted}} = 4.12$ , 95% CI [3.82, 4.41];  $M_{\text{unrestricted}} = 4.44$ , 95% CI [4.24, 4.63]),  $\beta = -.08$ ,  $t(492) = -1.77$ ,  $p = .077$ , 95% CI [-.67, .03]. However, inability to share food dishes with others did not significantly predict loneliness ( $\beta = -.02$ ,  $t(492) = -.52$ ,  $p = .602$ , 95% CI [-.12, .07]).

In an exploratory analysis among restricted individuals, we found no significant correlation between loneliness and (1) Frequency of food restriction limiting ability to eat what others eat ( $M = 4.08$ ,  $SD = 1.89$ ),  $r = -.01$ ,  $p = .961$ ; (2) Years living with the restriction ( $M = 15.75$  years,  $SD = 14.57$ ),  $r = -.05$ ,  $p = .594$ ; or (3) Perception that the restriction was more (vs. less) voluntary ( $M = 2.82$ ,  $SD = 2.37$ ),  $r = .04$ ,  $p = .716$ .

Lastly, we note that the total number of restrictions a person had was positively associated with loneliness,  $\beta = .10$ ,  $t(492) = 2.28$ ,  $p = .023$ , 95% CI [.02, .28], which also held when including covariates,  $\beta = .11$ ,  $t(484) = 2.57$ ,  $p = .010$ , 95% CI [.04, .29].

Study 4 once again found that food restrictions predicted loneliness, and this effect was mediated by food worries. Those with food restrictions reported greater concerns about taking too long to make a food decision and fear that others avoid them or make negative assumptions about them based on their food choices and preferences, which drove the increase in loneliness.

While we found no significant association between the voluntary nature of food restriction and loneliness, we note that the distinction between voluntary and involuntary restrictions is not clear-cut. Possibly, cultural restrictions are self-imposed while health restrictions are externally imposed, yet this might not correspond to people’s experiences. For example, a religious person

<sup>5</sup> We do not find evidence for the reverse pathway; loneliness did not fully mediate the effect of food restriction on food worries as the direct effect remained significant when including loneliness as a mediator (direct effect: 95% CI [1.02, 1.51]).

may not experience her restriction as something she's choosing to do, whereas a lactose intolerant individual may feel she can still choose to eat some dairy (and take medicine to present side effects). The perceived severity and number of years of the restrictions did not predict loneliness. Only the number of restrictions did. We next sought to replicate the mediation results while testing for moderation by the ability to share the bond over similar food.

### Study 5: Moderation by Similar Food Consumption

Study 5 tested for moderation by ability to bond over a meal. We assigned restricted and unrestricted participants to recall either a group-dining experience when they ate similar food as other diners or a "typical" group-dining experience. We reasoned that a typical group meal for restricted (vs. unrestricted) individuals' is one where they are unable to eat similar food as other diners and, thus, are limited from bonding over the meal. As such, we predicted that when recalling a typical group-dining experience, restricted individuals would feel lonelier than unrestricted individuals, and that this would be mediated by food worries. However, when recalling a time they were able to eat what others ate and, thus, bond over consuming similar food, the association between food restriction and loneliness (as well as food worries) would attenuate.

### Method

**Participants.** We opened the study for 120 participants on MTurk and 121 workers completed the survey (25.6%,  $n = 31$  were restricted). At the same time, we invited 136 MTurk workers who previously reported "yes" to a question "Do you have a food restriction?" in other studies we conducted (58.1%;  $n = 79$  of recontacted participants completed the survey;  $n = 72$  confirmed having a food restriction).<sup>6</sup> In total, 200 participants completed this study for \$0.75 ( $M_{\text{age}} = 36.08$ ,  $SD = 11.42$ , 49.5% female; 51.5%  $n = 103$  had a food restriction; see Table S5 in online supplemental materials for additional details).

**Procedure.** This study used a 2 (food restriction: present vs. absent)  $\times$  2 (recalled dining experience: typical experience vs. similar food) between-subjects design. Participants first answered questions assessing whether they had food restrictions (identical to Studies 1 and 4). Participants were then asked to think about and respond to a prompt. In the typical-experience condition, participants wrote about "a typical experience dining out with others. How do your food preference/restrictions affect your experience dining with others?" In the similar-food condition, participants wrote about "an experience of dining out with several people who all ordered similar foods. Further, there was nothing on the table that you couldn't eat. In the space below, write a few sentences about how it made you feel to have all of you eating similar foods."

Three items assessed our main dependent variable of situational loneliness (averaged together;  $\alpha = .92$ ;  $M = 1.90$ ,  $SD = 1.48$ ): (1) "In this situation, I felt disconnected from the group," (2) "In this situation, I felt left out of the group," and (3) "I felt this was a missed opportunity to connect with others." Four items assessed food worries, adapted from Study 4 (averaged;  $\alpha = .87$ ;  $M = 1.94$ ,  $SD = 1.34$ ): (1) "In this situation, I worried about having to tell others at the table that I don't eat a certain food," (2) "In this situation, I found myself spending more time than others choosing what to eat or order because of what I could/couldn't eat," (3) "In

this situation, I worried about people avoiding interacting with me because of the food I could/couldn't eat," and (4) "In this situation, I worried people would make negative assumptions about me because of the food I could/couldn't eat." Lastly, we measured all covariates assessed in Studies 1 and 4 (age, gender, marital status, relatives living nearby, friends living nearby, income, race/ethnicity, and education).

### Results and Discussion

We conducted a two-way analysis of variance (ANOVA) of situational loneliness on restriction, recalled experience, and their interaction. This analysis revealed a significant effect of food restriction, with restricted individuals feeling more excluded than nonrestricted individuals ( $M_{\text{restricted}} = 2.16$ , 95% CI [1.89, 2.42];  $M_{\text{unrestricted}} = 1.65$ , 95% CI [1.38, 1.93]),  $F(1, 196) = 6.54$ ,  $p = .011$ ,  $\eta_p^2 = .032$ , and a significant effect of recalled experience, with those recalling a time they ate what others ate feeling less excluded than those recalling a typical dining experience ( $M_{\text{similar}} = 1.53$ , 95% CI [1.26, 1.81];  $M_{\text{typical}} = 2.27$ , 95% CI [2.00, 2.55]),  $F(1, 196) = 14.24$ ,  $p < .001$ ,  $\eta_p^2 = .068$ . We also found a Restriction  $\times$  Recalled Experience interaction,  $F(1, 196) = 9.03$ ,  $p = .003$ ,  $\eta_p^2 = .044$  (see Figure 1). As predicted, food restricted individuals recalling a typical dining experience felt more socially excluded than nonrestricted individuals ( $M_{\text{restricted}} = 2.82$ , 95% CI [2.43, 3.21];  $M_{\text{unrestricted}} = 1.73$ , 95% CI [1.33, 2.12]),  $F(1, 196) = 15.17$ ,  $p < .001$ ,  $\eta_p^2 = .072$ . However, the effect of food restriction on loneliness attenuated when recalling an experience in which participants were able to eat the same food as others ( $M_{\text{restricted}} = 1.49$ , 95% CI [1.12, 1.87];  $M_{\text{unrestricted}} = 1.58$ , 95% CI [1.19, 1.97]);  $F(1, 196) = .10$ ,  $p = .750$ ,  $\eta_p^2 < .01$ .<sup>7</sup> We found a similar pattern of results when including all covariates in the analysis (Restriction  $\times$  Recalled Experience interaction,  $F(1, 188) = 13.41$ ,  $p < .001$ ,  $\eta_p^2 = .067$ , simple effect of food restriction in the typical experience condition:  $F(1, 188) = 20.12$ ,  $p < .001$ ,  $\eta_p^2 = .097$ , which attenuated in the similar food condition:  $F(1, 188) = .25$ ,  $p = .616$ ,  $\eta_p^2 < .01$ ).

We next conducted a two-way ANOVA of food worry on Restriction  $\times$  Recalled Dining Experience. There was a significant effect of restriction, with restricted (vs. nonrestricted) individuals feeling greater food worry ( $M_{\text{restricted}} = 2.24$ , 95% CI [1.99, 2.48];  $M_{\text{unrestricted}} = 1.65$ , 95% CI [1.40, 1.90]),  $F(1, 196) = 11.04$ ,  $p = .001$ ,  $\eta_p^2 = .053$ , a significant effect of recalled experience, with those recalling a time they ate the same food as others (vs. a typical dining experience) reporting less food worry ( $M_{\text{similar}} = 1.55$ , 95% CI [1.31, 1.79];  $M_{\text{typical}} = 2.34$ , 95% CI [2.09, 2.58]),  $F(1, 196) = 20.12$ ,  $p < .001$ ,  $\eta_p^2 = .093$ , qualified by a significant Restriction  $\times$  Recalled Experience interaction,  $F(1, 196) = 4.25$ ,  $p = .041$ ,  $\eta_p^2 = .021$ . As predicted, those with a food restriction

<sup>6</sup> Excluding the seven participants who had reported having a food restriction in an initial study, but reported not having a food restriction in the current study, did not affect results.

<sup>7</sup> Within the subset of food restricted individuals, we also found an effect of recalled experience: recalling a typical meal led to greater loneliness ( $M_{\text{typical}} = 2.82$ ) than recalling a meal when they could eat the same food as others ( $M_{\text{similar}} = 1.49$ ),  $F(1, 196) = 23.67$ ,  $p < .001$ ,  $\eta_p^2 = .108$ . We replicated this pattern, that recalling a time one could (vs. could not) eat the same food as others increased loneliness, among food restricted individuals, in Supplemental Study 2.

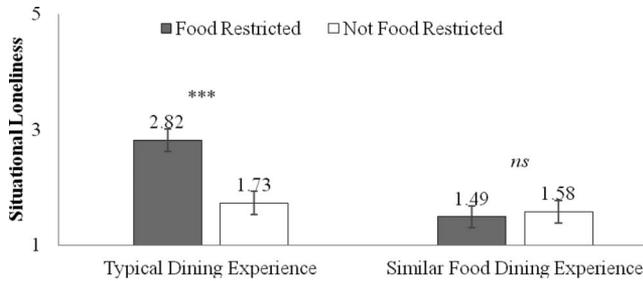


Figure 1. When recalling a typical dining experience, those with food restrictions felt more excluded than those without food restrictions. This effect attenuated when recalling a dining experience when participants ate the same food as other diners. Error bars represent the standard error around the mean. \*\*\*  $p < .001$ . *ns* = not significant.

recalling a typical dining experience reported greater food worries than those who did not have a food restriction ( $M_{\text{restricted}} = 2.81$ , 95% CI [2.46, 3.16];  $M_{\text{unrestricted}} = 1.86$ , 95% CI [1.51, 2.22]),  $F(1, 196) = 14.22$ ,  $p < .001$ ,  $\eta_p^2 = .068$ . However, the effect of food restriction attenuated when recalling a similar-food consumption experience ( $M_{\text{restricted}} = 1.66$ , 95% CI [1.32, 2.00];  $M_{\text{unrestricted}} = 1.44$ , 95% CI [1.09, 1.79]),  $F(1, 196) = .81$ ,  $p = .369$ ,  $\eta_p^2 < .01$ . We found a similar pattern of results when including all covariates in the analysis (Restriction  $\times$  Recalled Experience interaction,  $F(1, 188) = 7.82$ ,  $p = .006$ ,  $\eta_p^2 = .040$ , simple effect of food restriction in the control-condition:  $F(1, 188) = 19.82$ ,  $p < .001$ ,  $\eta_p^2 = .095$ , which attenuated in the similar-food condition:  $F(1, 188) = .48$ ,  $p = .489$ ,  $\eta_p^2 < .01$ ).

We conducted a moderated mediation analysis to examine whether food restricted (vs. unrestricted) individuals experience more food worries and, therefore, greater loneliness, when recalling a typical (vs. similar-consumption) dining experience. Our mediation model included food restriction as the independent variable, recalled experience as the moderator variable, food worry as the mediator variable, and social exclusion as the dependent measure (SPSS Macro PROCESS, Model 7; Preacher et al., 2007). Consistent with our hypothesis, we found a significant index of moderated mediation ( $\beta_{\text{index}} = -.68$ ,  $SE = .33$ , 95% CI [-1.31, -.02]; based on 10,000 bootstrap samples) with no significant direct effect (95% CI [-.28, .18]), consistent with full mediation. Conceptually replicating Study 4, when recalling a typical dining experience, food worry significantly mediated the relationship between food restriction and increased social exclusion ( $\beta_{\text{indirect}} = .88$ ,  $SE = .26$ , 95% CI [.37, 1.40]). However, this relationship was not significant when recalling a time when everyone ate the same food ( $\beta_{\text{indirect}} = .21$ ,  $SE = .21$ , 95% CI [-.20, .63]).<sup>8</sup>

Study 5 found that when recalling a typical dining experience, food restrictions were associated with greater loneliness, which was mediated by greater food worries. However, focusing participants on a time they were able to eat the same food as other diners attenuated this effect; restricted individuals felt less lonely because they experienced fewer food restrictions when they were able to bond with others over eating a meal of similar foods.

Although we used covariates to test for potential confounds that could explain the restriction-loneliness relationship, the data assessing the relationship between food restrictions and loneliness

across Studies 1–5 are inherently correlational and as such, do not test for causality. For example, although we are unaware of such research, it is possible that the association between loneliness and food restrictions runs in the opposite causal direction. Thus, our next study tested our hypothesis that food restrictions cause increased loneliness in an experimental design.

### Study 6: The Presence of Food Restrictions Increases Loneliness

In Study 6, to test for the causal effect of restrictions, we manipulated the presence of a food restriction in a controlled experiment. Unrestricted participants were brought into the lab and assigned to experience a restriction or not while taking part in a social interaction that could be construed as isolating. Specifically, participants who were restricted from consuming alcohol drank cider while playing a game of Cyberball (an ambiguously isolating experience) with confederates who participants believed either had an alcoholic beverage or cider. Although a brief exclusion experience in an experiment is rather different than a lifetime experience of being restricted, it allowed us to test whether experiencing a food restriction causes people to perceive they are more excluded from the social interaction.

### Method

**Participants.** A total of 83 undergraduate students at the University of Chicago participated in the study for \$2.00 ( $M_{\text{age}} = 19.72$ ,  $SD = 1.37$ ; 51.8% female). Although this sample was smaller than our previous online studies because of limitations of recruiting in the lab, a lab setting affords greater experimental control. This sample provided 80% power to detect a medium-sized effect.

**Procedure.** This study used a two-condition (restriction: present vs. absent) between-subjects design. An experimenter brought participants into the lab and confirmed they were undergraduate students. Participants were then presumably joined by two graduate student participants who had finished a different study in another room (in reality, these were confederates). The experimenter explained that the purpose of the study was to examine the association between drinking and multitasking.

In the unrestricted-condition, the experimenter told all three participants that they would drink sparkling cider, and poured everyone cider from a cider bottle. In the restricted-condition, the experimenter told the real participants that they would drink sparkling cider, and told the other two graduate-student participants (i.e., confederates) that they would drink wine, ostensibly because the lab could serve alcohol to graduate, but not undergraduate, students. The experimenter poured participants cider from a cider bottle, and poured confederates “wine” from a wine bottle (in reality, the wine bottle contained iced tea that appeared similar in color to white wine). Thus, in both conditions, participants believed confederates were graduate students (i.e., outgroup members), but only in the restricted condition did participants experience exclusion from the consumption experience.

<sup>8</sup> We do not find evidence for the reverse pathway; loneliness did not fully mediate the effect of food restriction on food worries as a function of recalled experience as the direct effect remained significant when including loneliness as a mediator (direct effect: 95% CI [.003, .41]).

The confederates and participants then began playing a three-person ball-passing game meant to simulate the Cyberball game paradigm (Williams, Cheung, & Choi, 2000). Participants and confederates received instructions to roll a ball on a table to each other during a 90-s period. They received instructions to multitask by drinking their beverages while rolling the ball and learned that the experimenter would observe and record the ball passes and RTs. Confederates passed the ball between themselves 76% of the time (38 out of 50 passes). As a result, participants all received the ball less than a third of the time. We incorporated the Cyberball paradigm to give participants the experience of potentially being excluded. That is, the procedure creates an ambiguous rejection experience, which we predicted would affect perceived social exclusion of restricted participants more than unrestricted ones.

After the ball-passing task, we assessed loneliness and perceived exclusion (averaged;  $\alpha = .70$ ;  $M = 3.54$ ,  $SD = 1.43$ ): “Rate how you felt in the study” (1 = *included/not lonely*, 7 = *excluded/very lonely*). We used these items to capture the situational (vs. chronic) experience of loneliness (in a pilot study—Supplemental Study 4 in online supplemental materials—we found no effect on chronic loneliness). In keeping with our cover story, we measured enjoyment of the beverage (1 = *not at all*, 7 = *very much*), which did not differ by condition,  $t = .59$ ,  $p = .556$ ,  $d = .14$ , 95%  $CI_{\text{effect size}} [-.31, .58]$ . Participants also completed a series of open-response measures as part of a filtered debriefing and reported any food restrictions that they had. No participants reported suspicions about the study. After the study ended, the experimenter fully debriefed participants.

## Results and Discussion

Assigning people to experience a food restriction significantly increased reported feelings of loneliness ( $M_{\text{restricted}} = 3.88$ , 95%  $CI [3.52, 4.25]$ ;  $M_{\text{unrestricted}} = 3.23$ , 95%  $CI [2.74, 3.71]$ ),  $t(81) = 2.14$ ,  $p = .035$ ,  $d = .47$ , 95%  $CI_{\text{effect size}} [.03, .91]$ .

These results indicate that even for unrestricted individuals, the presence of a food restriction increased loneliness. Students who experienced a food restriction when engaging in a social interaction reported feeling lonelier than students who did not experience such a food restriction. As such, Study 6 provided causal evidence for the observed relationship between food restrictions and loneliness in Studies 1–5. Expanding beyond this, we next tested whether restrictions have a similar effect when they naturally occur, for example, when a religious tradition creates a temporary restriction.

### Study 7: Food Restrictions Increase Loneliness Over the Passover Holiday

In Study 7, we capitalized on a naturally occurring manipulation of food restriction—the holiday of Passover, where Jewish observers refrain from eating chametz (leavened food). We surveyed observant Jewish participants who lived in a neighborhood where they were a minority (University of Chicago campus), and indeed, most reported eating meals with nonobservant people. We predicted that during Passover, when participants had a food restriction, they would feel lonelier than after Passover when they were no longer restricted.

At the same time that food restrictions can isolate an individual from others who are not restricted, sharing a food restriction can

bring restricted individuals closer together. Thus, we also measured how refraining from eating chametz influenced closeness to observant (restricted) and nonobservant (unrestricted) individuals during Passover compared with after Passover.

## Method

**Participants.** We collected data from as many observant Jewish participants as possible during Passover week in 2017 and 2018, recruiting participants for a survey offering a \$1.00 Amazon gift card at the campus Hillel center and at the Kosher section of the campus dining hall at the University of Chicago. We emailed all participants a follow-up survey 1-week later, after Passover ended, which participants could complete for a \$3.00 Amazon gift card. Anticipating attrition, we oversampled during Passover, aiming for a minimum final sample of 34 participants to have 80% power to detect a medium-sized effect. A total of 66 participants completed the initial survey during Passover. Only participants who completed both surveys during and after Passover were included in the final analysis ( $N = 41$ ;  $M_{\text{age}} = 26.90$ ,  $SD = 11.39$ , 41.5% female). Those who completed both surveys (included in the final sample) did not significantly differ in reported loneliness at Time 1 from those who completed only the first survey,  $t(64) = 1.10$ ,  $p = .274$ ,  $d = .28$ , 95%  $CI_{\text{effect size}} [-.22, .78]$ , suggesting our final sample did not significantly differ from our original sample.

**Procedure.** This study used a two-condition (restricted-during Passover vs. unrestricted-after Passover) within-subjects design. We surveyed participants first during Passover, and then again, after Passover ended, when participants were no longer restricted. During Passover, participants answered, “To what extent do you avoid chametz food during the week of Passover?” (1 = *do not avoid these foods*, 7 = *definitely avoid these foods*) and responded to an open response question asking “What are some of the foods that you like and typically eat, but that you avoid eating during Passover? Please list them below.” One-week later after Passover ended, we emailed participants a survey asking them, “What are some of the foods that you avoided eating during Passover week, but that you are able to eat now?” (e.g., responses included bread, pizza, pasta, beer, and corn). Thus, we reminded people that they were (vs. were not) restricted before measuring situational loneliness.

For both surveys, we assessed situational loneliness, measuring how lonely, excluded, and disconnected participants felt at that moment (for all three items: 1 = *not at all lonely; excluded; disconnected*, 7 = *very lonely; excluded; disconnected*), averaging across the items assessed during Passover (when they were restricted) and averaging across the items assessed after Passover ( $\alpha_{\text{restricted}} = .90$ ;  $\alpha_{\text{unrestricted}} = .82$ ). We also measured feelings of connectedness: (1) “How connected do you feel to others who are Jewish?” and (2) “How connected do you feel to others who are not Jewish?” (1 = *less connected*, 7 = *more connected*). Finally, we asked “In general, how often do you eat meals with people who are not Jewish?” (1 = *very rarely*, 7 = *very often*), confirming that participants in our sample ate most meals with non-Jewish people who could not have observed the food restriction ( $M = 4.90$ , 95%  $CI [4.35, 5.45]$ ),  $t(40) = 3.31$ ,  $p = .002$ ,  $d = .52$ , 95%  $CI_{\text{effect size}} [.19, .84]$ .

## Results and Discussion

We conducted a paired-sample *t* test comparing loneliness during and after Passover. As we predicted, when reminded of their restrictions, participants reported feeling significantly lonelier during Passover than after Passover ( $M_{\text{during}} = 2.66$ , 95% CI [2.20, 3.11];  $M_{\text{after}} = 2.04$ , 95% CI [1.76, 2.32]),  $t(40) = 2.75$ ,  $p = .009$ ,  $d = .43$ , 95% CI<sub>effect size</sub> [.16, 1.07].

We further conducted a repeated measures ANOVA of restriction (restricted-during vs. not-restricted after Passover) on connection to others (Jewish vs. non-Jewish), which resulted in a significant effect of connection to others ( $M_{\text{Jewish}} = 5.20$ , 95% CI [4.86, 5.53];  $M_{\text{non-Jewish}} = 4.11$ , 95% CI [3.87, 4.35]),  $F(1, 40) = 29.98$ ,  $p < .001$ ,  $\eta_p^2 = .43$ , 95% CI<sub>effect size</sub> [.19, .59], and no significant main effect of restriction,  $F(1, 40) = .12$ ,  $p = .735$ ,  $\eta_p^2 = .003$ , 95% CI<sub>effect size</sub> [.00, .11], qualified by the predicted Restriction  $\times$  Connection to others interaction,  $F(1, 40) = 30.98$ ,  $p < .001$ ,  $\eta_p^2 = .44$ , 95% CI<sub>effect size</sub> [.20, .59]. Participants felt more connected to Jewish people (some of whom shared the restriction) during Passover, when they were restricted, than after when they were not restricted ( $M_{\text{during}} = 5.76$ , 95% CI [5.35, 6.16];  $M_{\text{after}} = 4.63$ , 95% CI [4.20, 5.07]),  $F(1, 40) = 19.40$ ,  $p < .001$ ,  $\eta_p^2 = .33$ , 95% CI<sub>effect size</sub> [.10, .51], and they felt less connected to non-Jewish people (none of whom shared the restriction) during Passover than after ( $M_{\text{during}} = 3.61$ , 95% CI [3.18, 4.04];  $M_{\text{after}} = 4.61$ , 95% CI [4.34, 4.88]),  $F(1, 40) = 13.90$ ,  $p < .001$ ,  $\eta_p^2 = .26$ , 95% CI<sub>effect size</sub> [.06, .45].

These results provide further evidence that food restrictions increase loneliness. During Passover, reminding people of the food they were not able to eat increased feelings of loneliness compared with after Passover when participants no longer refrained from eating leavened foods. This occurred among participants who mainly ate meals with others who were not part of their religious community. Indeed, food restrictions during Passover contributed to social connection with the in-group, as reminders of the food restriction increased reported connection to Jewish people during (vs. after) Passover, and decreased connection to non-Jewish people during (vs. after) Passover. We note, however, that the holiday itself could also have contributed to increased social connection to Jewish (vs. non-Jewish) people during Passover, or that feeling Jewish during Passover could make one feel lonely in a community where one is a minority (although that may be less likely given holidays generally connect and that exclusion from a holiday is an isolating experience). For this reason, we focused participants specifically on the food consumption component of Passover, rather than other elements of the holiday.

## General Discussion

Across seven studies (and two direct replications reported in the online supplemental materials), we found that food restrictions predict loneliness.<sup>9</sup> People who are unable to eat what others eat, to some extent, are less able to bond with others over the meal. This was true for both children and adults, in self and observer reports, and in correlational and experimental studies, pointing to the causal role of food restriction on increased loneliness. Indeed, imposing food restrictions on unrestricted individuals in the lab and during Passover, increased loneliness.

The effect of food restrictions on loneliness was mediated by food worries; being unable to take part in the meal increased people's concerns about how others would perceive them, increas-

ing loneliness. As further evidence that dissimilarity in food consumption underlies this effect, those with food restrictions were no lonelier than those without after recalling a time they were able to eat what others at the meal ate. Together, these results make several theoretical contributions. First, we extend previous work, which focused on the other side of the coin—how similar food consumption facilitates social connection (Woolley & Fishbach, 2017). Our current findings are consistent with this research that found eating similar (vs. dissimilar) foods increases closeness and trust between strangers. Indeed, if similar food consumption did not connect, we would not expect food restrictions to isolate, or for reminders of eating similar food to attenuate the effect.

Second, these findings have implications for research in developmental psychology that highlights the importance of food in children's social relationships (Fawcett & Markson, 2010; Hamlin & Wynn, 2012; Shutts, Kinzler, & DeJesus, 2013). This prior research demonstrated that children are sensitive to social cues from family and friends when choosing what to eat. Indeed, peers exert a powerful influence on children's food preferences and choices (Duncker, 1938; Frazier, Gelman, Kaciroti, Russell, & Lumeng, 2012; Hendy & Raudenbush, 2000). Our Studies 2 and 3 found that food restrictions predict observers' reports of loneliness in children, suggesting children with restrictions are susceptible to increased loneliness.

However, whereas prior qualitative and survey research focused on the experience of food-restricted children and their families, an additional contribution of the current research is in identifying that the restriction-loneliness association extends beyond childhood, a finding that people appear not to be aware of. Indeed, the CDC survey we used to assess food restrictions for children in Study 3 did not even assess the presence of food restrictions when surveying adults about their health issues. We find that adults also experience loneliness because of food restrictions. As the rate of food restrictions increases, this effect of restriction on loneliness is likely to become an increasing concern.

Indeed, like food restrictions, loneliness is also on the rise. In American adults, reported loneliness increased from 20% in the 1980s to 40% 30 years later (Edmondson, 2010; Perissinotto, Stijacic Cenzer, & Covinsky, 2012). This worrisome trend has led to a call to action to make social connection a public health priority (Holt-Lunstad, Robles, & Sbarra, 2017). Although restricted individuals in our studies did not report experiencing clinical levels of loneliness, which is expected given we assessed loneliness in the general population, they were lonelier than their nonrestricted counterparts. As such, it is possible food restricted individuals are at a greater risk of experiencing the negative health outcomes resulting from loneliness (Victor, Scambler, Bowling, & Bond, 2005).

Lastly, this research underscores the role food plays in culture (Rozin, 2005). Cultures use food consumption and restrictions to signal group membership, forging bonds by regulating what people can and cannot eat (Kittler et al., 2017). In Study 7, we found that Jewish observers of Passover felt closer to other observers sharing

<sup>9</sup> We report six Supplemental Studies in the online supplemental materials (five of these studies supported our predictions). Together with the studies reported in the article, this encompasses all studies conducted for this project.

their restriction than those who were not restricted. However, because these restrictions limited people's ability to eat what the majority of others ate, they increased loneliness.

### Avenues for Future Research

The present research is an initial step toward understanding the relationship between food restriction and loneliness and research is needed to examine additional moderators of this effect. For example, it is likely that being excluded from bonding over a meal is only isolating to the extent that a person has the goal to affiliate with and connect to the group. Restricted individuals dining with strangers or people they do not want to affiliate with may experience fewer food worries (i.e., they are less motivated to care how the group perceives them), which could dampen the effect of food restriction on loneliness. Beyond an affiliation goal, situational cues could also moderate the effect. For example, as group size increases, food restricted individuals may experience greater food worries, which could increase the effect of food restriction on loneliness.

In addition, observability or salience of the restriction may moderate the effect. Public restrictions are potentially more isolating than private restrictions, because they elevate restricted individuals' worries. Yet, when restricted individuals choose to reveal or be outspoken about their restriction, this could suggest these individuals are more confident about their social acceptance than those who chose to hide their restrictions, such that these individuals do not feel lonelier because of the increased observability. Relatedly, if cultural norms increase the salience of the food restriction (i.e., everyone eats the food except the restricted individual), food worries may be greater, increasing loneliness in comparison to if everyone shares the food restriction (in which case the restriction is less salient and may not even appear as a restriction).

Beyond these factors, some restrictions may be more isolating than others. Our studies did not systematically compare the effect of different types of restriction on loneliness. In our data, as in the general population, there is an uneven distribution of restrictions (see Table S6 in online supplemental materials), which makes it statistically hard to detect meaningful effects by the type of restriction.

Different populations may also be more or less affected by feelings of loneliness that arise from having a food restriction. Whereas the current research focused on the social experience of children and adults, additional research could examine this pathway for older adults and can quantify this effect size across other populations. For one, older adults are more vulnerable to medically imposed dietary restrictions (Walls, Steele, Sheiham, Marcenes, & Moynihan, 2000), in addition to a host of cultural and ethical reasons that may lead them to self-impose restrictions. In addition, older adults are overrepresented in the growing segment of socially isolated adults (Demakakos, Nunn, & Nazroo, 2006; Luhmann & Hawkey, 2016). Given this, understanding the relationship between food restriction and loneliness among this vulnerable population is an important area for future research. Past research identified how social isolation can contribute to negative eating habits in the elderly (Bianchetti, Rozzini, Carabellese, Zanetti, & Trabucchi, 1990; Davis, Murphy, Neuhaus, & Lein, 1990; Walker & Beauchene, 1991).

Our research suggests the opposite pathway—that eating habits (in particular, restricted food) could contribute to older adults' experience of social isolation.

One remaining question not addressed by the current set of studies is whether there is a kernel of truth in feeling isolated when restricted from a meal: Do people actually exclude others who have food restrictions? We recently found this might be the case; in one study people preferred a partner with no food restrictions over one that expressed having a food restriction. This suggests food restricted individuals may be at least partially justified in their concern about how others will perceive them based on their food consumption; people might actually exclude those with food restrictions more.

This finding raises the question of whether people with food restrictions feel lonelier because they eat more of their meals alone, either because others avoid them, or they avoid others for fear of being rejected. First, we note that our experiments speak against this account; we randomly assigned people in Study 6 to experience a food restriction or not, and found similar effects as in our correlational studies, suggesting that our findings cannot be attributed to differences in frequency of eating alone. Further, in Studies 1, 4, 5, and Supplemental Study 1, those with food restriction were no more likely to report indicators of eating meals alone (i.e., those with food restrictions were not significantly more likely to be unmarried, lack friends nearby, or lack relatives nearby compared with those without food restrictions; see Table S7 in online supplemental materials), and in Study 2 it is likely the case that students eat with peers at school.

Although the finding that food restrictions increase loneliness seems bleak, there are reasons to believe that identifying the negative impact of food restrictions can help overcome barriers that exist for people unable to bond over a meal. Instead of focusing on substitutes for those with food restrictions, which highlight the differences between restricted and unrestricted individuals' meals, focusing on similarities in food consumption might increase connection. Indeed, perceived similarity may matter more for friendship outcomes than actual similarity (Selfhout, Denissen, Branje, & Meeus, 2009; West, Magee, Gordon, & Gullett, 2014), suggesting that food restricted individuals required to eat different foods can possibly emphasize the perceived similarity between theirs' and others' food. For one, categorizing food at a higher level (e.g., Mexican food instead of a burrito and a taco salad), could increase the perception that people eat similarly. Alternatively, food-restricted individuals can emphasize the use of other forms of similarity to increase social connection (Byrne, 1971; Hoyle, 1993; Tidwell, Eastwick, & Finkel, 2013). Additional research should examine ways people can overcome restrictions beyond simply eating the same food, which may not always be feasible.

Whereas we focused on a negative consequence of food restrictions, food restrictions may also lead to beneficial outcomes. For example, food restrictions that are self-imposed may also benefit people by allowing them to signal a unique identity (Berger & Heath, 2008). Finally, although food restrictions isolate from others who are not restricted, they appear to enable bonding between other restricted individuals, as we find in Study 7. This is likely to be true for restrictions selected for cultural or ideological reasons, where the food restriction signals something about the person's value system. For example, a

choice to be vegan could connect one to other vegans, which is an open question for future research.

## Conclusion

Both food restrictions and loneliness are societal problems on the rise; this research found they may be related epidemics. We call for developing interventions to facilitate social connections for restricted individuals. Doing so can enable restricted individuals to still share in the social bond.

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