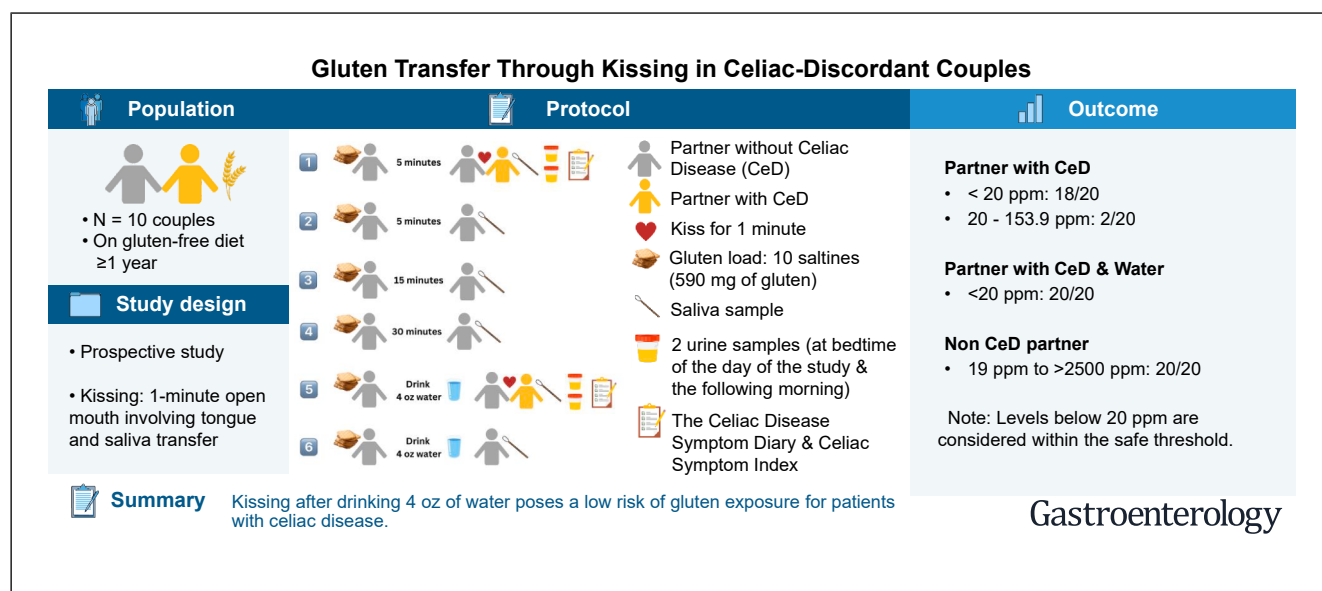


A Prospective Study of Gluten Transfer Through Kissing in Celiac-Discordant Couples

Anne R. Lee,¹ Zhijun Chen,² Jackie Jossen,¹ Jessica Lebovits,¹ Benjamin Lebwohl,¹ Suzanne K. Lewis,¹ Suneeta Krishnareddy,¹ Randi L. Wolf,^{1,2} Luke Emerson,³ and Peter H. R. Green¹

¹Celiac Disease Center, Department of Medicine, Columbia University, New York, New York; ²Teachers College, Columbia University, New York, New York; and ³Bia Diagnostics, Colchester, Vermont



BACKGROUND & AIMS: Current management of celiac disease (CeD) depends on a restrictive gluten-free diet (GFD). Studies have reported CeD patients' anxiety about gluten transfer via kissing, but data to support this concern are lacking. **METHODS:** To assess the transfer of gluten through kissing, the non-CeD partner consumed a gluten load (10 crackers with 59,107 ppm or 590 mg gluten). In 2 protocols, after consuming the gluten load, the non-CeD partner kissed the partner with CeD. In the first kissing protocol, the non-CeD partner waited 5 minutes before kissing, and in the second, the non-CeD partner drank 4 oz of water and then immediately kissed the partner with CeD. Saliva was collected from the partner with CeD immediately after the kiss. Gluten in saliva was assessed by R-5 enzyme-linked immunosorbent assay test method and in the urine by GlutenDetect (Glutenostics, Inc). **RESULTS:** Gluten was detectable in the saliva of the non-CeD partner in all protocols (80 ppm to >25,000 ppm). The amount detected in the saliva of those with CeD varied from <5 ppm to 153.9 ppm. Only 2 of the 20 gluten exposures tested >20 ppm gluten, the level defined as gluten free. None of the saliva samples tested >20 ppm when the non-CeD partner drank 4 oz of water after eating the gluten load. **CONCLUSIONS:** There was not an increased risk of significant gluten transfer when kissing. Drinking 4 oz of water

before kissing further reduces the risk. These results should guide our clinical practice and should be shared with our patients to help reduce the burden of the diet.

Keywords: Celiac Disease; Gluten Free Diet; Kissing; Gluten Exposure.

Currently, the only treatment for celiac disease (CeD) is strict lifelong avoidance of gluten.¹ Maintaining a strict gluten-free diet (GFD) requires vigilant monitoring of food labels, avoidance of chance gluten exposure, constant meal planning, and detailed questioning when eating out. The behaviors and attitudes that are important components of strict GFD management may result in an unhealthy emphasis on food and dysfunctional eating patterns.²⁻⁴

Abbreviations used in this paper: CeD, celiac disease; CSI, Celiac Symptom Index; GFD, gluten-free diet; GIP, gluten immunogenic peptides; QOL, quality of life.

WHAT YOU NEED TO KNOW**BACKGROUND AND CONTEXT**

Celiac disease management depends on lifelong adherence to a restrictive gluten-free diet. Studies have reported celiac disease patients' anxiety about gluten transfer via kissing.

NEW FINDINGS

Gluten detected in the saliva of those with celiac disease varied from <5 ppm to 153.9 ppm. No samples tested >20 ppm when the partner without celiac disease drank 4 oz of water.

LIMITATIONS

The study had a small sample of adults who were willing to risk potential gluten transfer through kissing; therefore, the results may not be generalizable to the overall celiac population.

BASIC RESEARCH RELEVANCE

Gluten is detectable in saliva after kissing (<5 ppm to 153.9 ppm). Drinking 4 oz of water reduced the amount of gluten to <20 ppm in the partner with celiac disease.

CLINICAL RESEARCH RELEVANCE

These results should inform our counseling of celiac patients on the risk of gluten exposure in kissing in particular. Sharing these results will help reduce the burden of the diet.

Recent studies have indicated a negative impact of the GFD on the quality of life (QOL) of individuals with CeD.⁵ Most negatively impacted is the social domain of an individual's life.⁶⁻¹⁰ One study revealed individuals would avoid dining out, travel, and social events.⁷ Subsequent studies investigated the dietary adherence, eating behaviors, and patterns of individuals with CeD and found an increased hypervigilance to the diet associated with a concurrent decreased QOL score.^{5,8,10}

A recent study focused on dating¹¹ revealed decreased QOL scores, hesitancy to be intimate, and concerns of gluten exposure through kissing despite the lack of formal testing of this risk. In this study, we quantified the amount of gluten present in saliva after participants without CeD ate a gluten load that transferred through kissing to participants with CeD. We also assessed gluten absorption through urine analysis of gluten immunogenic peptides (GIP)¹² and recorded gastrointestinal symptoms.

Methods

We performed a prospective study of 10 couples recruited from the Celiac Disease Center at Columbia University in New York City.

Recruitment

We recruited 10 couples: 1 partner with CeD and 1 without, to test the potential of gluten content in saliva after kissing. Inclusion criteria was an age ≥ 21 years, duodenal biopsy specimen-confirmed diagnosis of CeD, currently following a GFD for at least 1 year, being in a relationship with

a partner who does not have CeD, and having a negative GlutenDetect (Glutenostics, Inc) GIP^{12,13} urine test sample at baseline screening.

Gluten Load

To assess the potential transfer of gluten through kissing, the non-CeD partner consumed a prescribed gluten load. The gluten load of 10 saltine crackers was chosen to provide a single ingredient (wheat) gluten load because the only ingredients are enriched wheat flour, soybean oil, salt, and corn syrup.

To establish a gluten load that would be detectable with a GIP urine measurement, 2 samples of 10 crackers each were sent to Bia Diagnostics to evaluate the amount of gluten. One sample contained 56,730.2 ppm and the second sample contained 61,484.2 ppm. The average gluten content of the samples was therefore 59,107 ppm, or 59 mg. Because each cracker weighs approximately 1 g, the dose of 10 crackers would yield at least 590 mg of gluten. This exceeds the sensitivity threshold for urine GIP measurement, and therefore, the saltine crackers were an appropriate single ingredient choice for test food.

Gluten Exposure

Each exposure or experiment is termed, for this study, a protocol. The details of the 6 different protocols are detailed in Figure 1.

In 2 protocols, the non-CeD partner consumed the gluten load and then kissed the partner with CeD (with an open mouth for 1 minute involving tongue and saliva transfer). In the first kissing protocol, the non-CeD partner consumed the gluten load and then waited 5 minutes before kissing. In the second kissing protocol, conducted on a separate day, the non-CeD partner consumed the gluten load, drank 4 oz of water, and then immediately kissed the partner with CeD. Saliva was collected from the partner with CeD immediately after each kiss.

Bia Diagnostics Laboratory tested the saliva samples for gluten content using the R 5 enzyme-like immunosorbent assay methodology, with results reported in ppm of gluten in each saliva sample, accounting for the dilution of saliva in the buffer. The partner with CeD used GlutenDetect urine GIP test kits to assess for any gluten absorption each evening of the study days and the following morning after each kissing exposure.

To assess the potential amount of transferable gluten in the saliva of the non-CeD partner, saliva was collected from the non-CeD partner in 4 additional protocols after consuming the gluten load, including after waiting 5, 15, and 30 minutes, and drinking 4 oz of water.

The partner without CeD was required to brush their teeth and rinse their mouth between each gluten exposure to prevent against gluten carrying over from the previous exposure.

Outcome Measurements

The amount of gluten was measured in the saliva of the CeD participants and in the saliva of their non-CeD partners. Saliva was collected by having the participants spit into a sterile tube (6-mL tube with 2 mL buffer solution). The saliva samples were packed in a thermal metallic bubble mailer

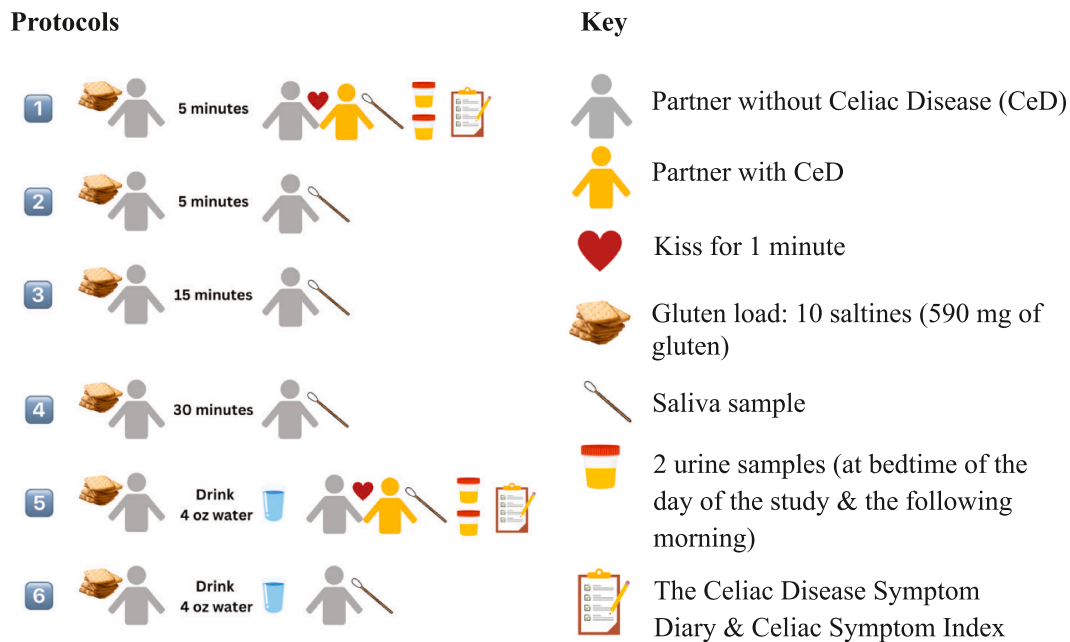


Figure 1. Description of study protocols: protocols 1 to 4 on day 1 and protocols 5 and 6 on day 2.

(Zebra Packs MBM 11) with a medical grade frozen ice pack (Nordic Ice; NOR 1036 8-oz gel pack) and shipped via Federal Express/United Parcel Service priority overnight delivery. Bia Diagnostics¹⁴ tested saliva samples for gluten content by R5 enzyme-linked immunosorbent assay methodology, with results reported in ppm of gluten in each saliva sample.

Urine samples of the CeD participants were collected after each gluten exposure (kiss), the evening of the kiss, and the following morning, according to the GlutenDetect protocol. GlutenDetect is a self-monitoring kit used to detect gluten exposure. GIPs are fragments of gluten that are not digested and are eliminated in the urine. The GIP urine test is a lateral flow immunoassay that reports results as positive or negative for gluten detected. A positive reading on the lateral flow test strip indicates ingestion of gluten. The test kit is >96% specific to gluten and has a 90% to 95% sensitivity. The kit can measure gluten in urine when the individual has ingested as little as 2 bites of bread (500 mg gluten).^{15,16}

We also measured CeD-related symptoms in CeD participants after each visit using the Celiac Symptom Index (CSI)¹⁴ The CSI was completed by the partner with CeD in the evening after the potential exposure. CSI is a self-administered 36-item survey that queries CeD-specific symptoms, including abdominal pain, nausea, bloating, headaches, and overall health. Items are on a 5-point Likert scale with a score of <30 suggesting fewer symptoms.¹⁷

Results

Partner Without Celiac Disease

The amount of gluten in the saliva of the participants without CeD who consumed the gluten load was measurable and varied greatly across the 4 exposure scenarios when waiting 5 minutes, 15 minutes, 30 minutes, or drinking 4 oz of water. The amount of gluten in the saliva of the partner without CeD ranged from 19 ppm to >25,000

ppm. The amount of gluten for each protocol is described in Table 1. Surprisingly, in contrast to the results for the partner with CeD, drinking 4 oz of water was not associated with a reduction in the amount of gluten in the saliva of the partner without CeD. Only 4 of the saliva samples from the partner without CeD had decreased amounts of gluten compared with ingesting gluten and waiting 5 minutes.

Partner With Celiac Disease

The amount of gluten detected in the saliva of the partner with CeD is reported for the 2 kissing protocols in Table 2. The results varied from <5 ppm to 153.9 ppm. Only 2 of the 20 exposures (10%) exposures tested >20 ppm gluten, the level defined as gluten free for food. These values were from the saliva of 2 different participants. Both were in the protocol where the non-CeD partner ingested the gluten load and waited 5 minutes before kissing, which we would expect to be the highest-risk scenario.

Drinking 4 oz of water had a significant impact on the amount of gluten in the saliva of the partner with CeD after kissing. We found that when the non-CeD partner ingested the gluten load, drank 4 oz of water, and then kissed the partner with CeD, there were no gluten level results >20 ppm. In fact, 60% of exposures after drinking the water were under the level of detection of gluten (<5 ppm).

The only positive GIP urine test was found in the evening test after protocol 1 (waiting 5 minutes before kissing after the gluten load) had been completed in CeD participant 9 who had the elevated saliva concentration of 153.9 ppm. (The GIP urine test result for the same participant was negative on the following morning). Of note, participant 9 with the highest saliva concentration and the only participant with a positive GIP disclosed their partner from out of state was visiting during the first visit and dining out more frequently. Thus, the elevated GIP could be from

Table 1. Concentration of Gluten in the Saliva of the Partner Without Celiac Disease

Participant w/o CeD	Concentration of gluten by protocol (ppm)			
	Protocol 2; waiting 5 minutes	Protocol 3; waiting 15 minutes	Protocol 4; waiting 30 minutes	Protocol 6; drinking 4 oz of water
1	>80	54.9	78.2	> 80
2	> 80	> 80	> 80	> 80
3	> 160	72.8	113.8	>160
4	>160	14.86	12.24	106
5	>160	136.5	80.6	119.2
6	67	780.6	197.7	754.9
7	134.7	113.9	>1312	1152.2
8	>25,840	12,893.7	89.9	20,349
9	>3224	625.5	410.3	>2704
10	23.4	19.1	179	>124.8

other sources not the sole exposure through kissing. All other GIP urine tests results were negative for all other 19 potential exposures for the individuals with CeD.

CSI scores ranged from 17 to 29 on CSIs completed on the evening after the potential exposure through kissing. The scores were <30, indicating minimal symptoms and good dietary adherence.

Sex and length of time on the GFD were not associated with gluten content in the saliva of the partner with CeD. However, it is interesting to note that the 3 highest gluten

content levels were found in the 3 youngest participants who were either not married or engaged.

Clinical Research Relevance

This is the first study to quantify the amount of gluten an individual with CeD is exposed to through kissing. There are many recommendations on the internet on how to avoid gluten exposure when kissing, which are not backed by any evidence-based studies, including having the non-CeD partner wash their face, brush their teeth, and order

Table 2. Concentration of Gluten in the Saliva of the Partner With Celiac Disease After Kissing

Participant with CeD	Concentration of gluten (ppm)		Marital status	Age (y)	Sex	Length of time since diagnosis (y)
	Protocol 1: crackers ingested by non-CeD partner, then kiss after 5 minutes	Protocol 5: crackers ingested by non-CeD partner, followed immediately by 4 oz water, followed immediately by kiss				
1	7.9	<5	Married	27	Female	9
2	10.6	<5	Married	40	Female	5
3	6.3	<5	Married	35	Female	3
4	<5	<5	Married	44	Male	13
5	<5	<5	Married	29	Female	14
6	<5	<5	Married	31	Female	2
7	16.1	19.7	Engaged	26	Female	1.2
8	41.1	15.2	Single	23	Male	12
9	153.9	16.8	Engaged	29	Female	7
10	8.4	11.3	Married	60	Female	1.25

only gluten-free food and beverages.¹⁷ One site even recommends carrying toothpaste, a toothbrush, and mouth wash to be ready for the non-CeD partner to use.¹⁸ These concerns over kissing were reported in the study by Lebovits et al¹¹ as they found there was great concern among participants over potential gluten exposure through kissing. In fact, 39% of participants reported that they were hesitant to kiss their partner due to concern of gluten exposure.

The results of the present study suggest that although gluten is detectable in the saliva of the non-CeD after ingestion of a gluten load, significant transfer of gluten through mouth kissing is unlikely and poses a low risk. The risk can be minimized further by the non-CeD partner drinking water before the kiss.

We found that transfer of gluten through mouth kissing is possible, but the amount was usually <20 ppm, which is considered a safe level. There were 2 saliva samples from the partner with CeD that were >20 ppm. Of interest, if we assume the kiss transferred a significant amount of saliva (10 mL), then the 2 participants with concentrations >20 ppm (41.1 and 153.9 ppm) would still only ingest a negligible amount of gluten (0.4 and 1.5 mg, respectfully). Further, we found that drinking a glass of water greatly reduced the transfer of gluten. In most of the samples, the level of gluten in the saliva from the partner with CeD after kissing was below the level of detection <5 ppm when the non-CeD partner drank 4 oz of water. It is important to note that while there was gluten detected in the saliva of the partner with CeD after kissing the non-CeD partner, the level of gluten was <20 ppm in 90% of the samples and further reduced to <20 ppm in 100% of the samples when the non-CeD partner drank 4 oz of water before kissing.

These results have the potential to improve the QOL of individuals with CeD. As noted in the study by Wolf et al,⁸ participants reported concerns of chance gluten exposure when socializing and dining out. There were hypervigilant behaviors in the teens surrounding eating, socializing, and eating outside of their own home. These feelings of anxiety and hypervigilance may impact one's ability to enter into a relationship due to the fears of gluten exposure.

The aim of this study was to identify potential gluten transfer through kissing and assess the risk to individuals with CeD. The results of this study can ease the anxieties of patients with CeD. The goal is for them to live life as normally as possible and preserve their QOL and relationships. We can now inform patients about the quantitative risk of gluten exposure through kissing so that they can pursue relationships and intimacy without the fear of the unknown.

Strengths of this study include the prospective study design, with a standard gluten load and measurement of the saliva content of gluten at multiple time points in the partner without CeD in addition to measurement of the gluten content in the saliva from the partner with CeD after kissing with and without additional water. Measurement of symptoms and gluten absorption added to the clinical significance of our findings.

Limitations include the question of generalizability; given that these volunteers were willing to kiss after their

partner's gluten exposure, they may not be representative of all CeD patients with regard to risk tolerance or symptom development. Additionally, as the participants were allowed to kiss in private, the actual kiss was not timed, and therefore, there may be some variability in the length of time with each kiss.

Conclusion

We found that transfer of gluten through mouth kissing can occur but is unlikely and can be minimized further by a glass of water before the kiss. These results should guide our clinical practice and should be shared with our patients to help reduce their burden of having CeD and following the GFD. We hope this can alleviate some of the social anxiety, especially as it relates to physical intimacy.

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Received July 3, 2025. Accepted January 28, 2026.

Correspondence

Address correspondence to Anne R. Lee, EdD, Columbia University Medical Center, Medicine/Celiac Disease Center, 180 Fort Washington Avenue, Harkness Pavilion, Room 936, New York, New York 10032. e-mail: arl2004@cumc.columbia.edu.

CRedit Authorship Contributions

Anne R. Lee, EdD (Conceptualization: Lead; Investigation: Lead; Methodology: Equal; Project administration: Lead; Writing – original draft: Lead)
 Zhijun Chen, PhD, EdM, RD (Investigation: Supporting; Writing – review & editing: Supporting)
 Jackie Jossen, MD (Investigation: Equal; Writing – review & editing: Equal)
 Jessica Lebovits, MS, RD (Investigation: Equal; Methodology: Equal; Writing – review & editing: Equal)
 Benjamin Lebwohl, MS, MD (Supervision: Equal; Writing – review & editing: Equal)
 Suzanne K. Lewis, MD (Writing – review & editing: Equal)
 Suneeta Krishnareddy, MD (Writing – review & editing: Equal)
 Randi L. Wolf, PhD (Writing – review & editing: Equal)
 Luke Emerson, MS (Formal analysis: Lead; Methodology: Equal; Writing – review & editing: Equal)
 Peter H.R. Green, MD (Supervision: Equal; Writing – review & editing: Equal)

Conflicts of interest

The authors disclose no conflicts.

Author names in bold designate shared co-first authorship.