

Research Article**Association of Plasma Ghrelin with Body Mass Index and Gastric Emptying Time in Patients with Chronic Gastritis**

Saleem Ullah Zaffar¹, Talha Bin Ayub², Bushra Mohyuddin³, Abdul Basit Zubair⁴, Naveeda Manzoor⁵, Muhammad Adnan Sadiq⁶

Affiliations:

¹ Consultant Gastroenterologist & Hepatologist, SIMS / Services Hospital, Lahore.

² Consultant Gastroenterologist & Hepatologist, Lahore Care Hospital.

³ Assistant Professor Medicine, Services Institute of Medical Sciences, Lahore.

⁴ Senior Registrar Medicine, Services Hospital, Lahore.

⁵ Professor Biochemistry, Al Nafees Medical College and Hospital.

⁶ Associate Professor Biochemistry, Rashid Latif Medical College, Lahore.

Corresponding author: Saleem Ullah Zaffar

Abstract: Ghrelin, a stomach-derived orexigenic peptide, may link gastric mucosal pathology, body mass index (BMI) and gastric motility in chronic gastritis. The present study aimed to investigate the association of fasting plasma ghrelin concentration with BMI and gastric emptying time among patients with chronic gastritis, and to assess whether altered ghrelin levels correspond to delayed gastric emptying in this population. A cross-sectional analysis was conducted in 120 adult patients diagnosed with chronic gastritis by endoscopy and histology. Fasting plasma ghrelin, BMI, and standardized gastric emptying scintigraphy (solid-meal $T_{1/2}$) were measured. Patients were stratified into two groups (normal emptying, delayed emptying) and by BMI category (normal, overweight/obese). Mean ghrelin levels differed significantly across groups: subjects with delayed gastric emptying had lower mean plasma ghrelin (320 ± 85 pg/mL) than those with normal emptying (410 ± 110 pg/mL; $p = 0.003$). BMI correlated positively with plasma ghrelin ($r = 0.42$, $p < 0.001$). In multivariate regression adjusting for age, sex and gastritis severity, ghrelin remained independently associated with faster gastric emptying ($\beta = -0.28$, $p = 0.01$) and higher BMI ($\beta = 0.35$, $p < 0.001$). These findings suggest that in chronic gastritis, diminished plasma ghrelin is linked with delayed gastric emptying and lower BMI, while higher ghrelin levels correspond to greater BMI and more efficient gastric clearance. The novel insight is the dual role of ghrelin as biomarker of both motility and nutritional status in gastritis. **Keywords:** ghrelin; gastric emptying; body mass index.

Introduction: Gastritis, particularly of a chronic nature, remains a common gastrointestinal condition characterised by ongoing inflammation of the gastric mucosa, with potential progression to mucosal atrophy, impaired secretory function and dysregulated motility. In such patients, symptoms such as early satiety, fullness, nausea and weight loss frequently reflect altered gastric physiology, yet the precise mechanisms linking mucosal injury, appetite regulation and gastric transport remain inadequately delineated. Among regulatory peptides secreted by the gastric mucosa, ghrelin has emerged in recent years as a key candidate bridging these processes.¹⁻⁴

Ghrelin is a 28-amino acid peptide hormone primarily produced by X/A-type endocrine cells (also referred to as P/D1 cells) located in the fundus and body of the stomach. It plays a central role in energy homeostasis through activation of the growth hormone secretagogue receptor (GHSR), stimulating appetite, promoting adiposity, and modulating gastrointestinal motility. Ghrelin levels typically rise prior to meals and fall post-prandially, aligning with its orexigenic and pro-motility actions. Evidence in both healthy humans and experimental models indicates that ghrelin accelerates gastric emptying and enhances gastrointestinal transit. For instance, administration of ghrelin in healthy volunteers shortened gastric half-emptying time and in diabetic gastroparesis patients improved gastric clearance. The motility-enhancing effect appears independent of growth hormone pathways and may involve direct vagal or enteric stimulation.⁵⁻⁹

In gastric mucosal disease, especially when associated with atrophic changes, secretory capacity of ghrelin-producing cells may be impaired. Several studies have shown that patients with a history of *Helicobacter pylori* infection or atrophic gastritis exhibit lower plasma ghrelin concentrations and reduced mucosal ghrelin cell numbers. In turn, lower circulating ghrelin has been associated with lower BMI and weight loss in these populations. Moreover, delayed gastric emptying has been documented in patients with gastritis and related mucosal and autonomic dysfunction. However, the inter-relationship between plasma ghrelin, BMI and objective gastric emptying time specifically in chronic gastritis remains inadequately explored in contemporary literature.⁹⁻¹²

Body mass index (BMI) is a widely accepted index of nutritional status, and in the context of chronic gastritis may reflect both caloric intake and absorption as well as hormonal regulatory influences. The interplay between ghrelin and BMI in gastritis warrants further investigation, as altered ghrelin may contribute both to diminished appetite and lean body mass loss. Furthermore,

slower gastric emptying may discourage intake, promote early satiety and reduce nutrient delivery, thus compounding the effect on BMI. Assessing all three variables—plasma ghrelin, gastric emptying time and BMI—in tandem offers potential to clarify a mechanistic pathway linking gastritis, hormonal dysregulation and nutritional/motility outcome.

Recent advances in gastrointestinal motility measurement (including scintigraphy and wireless motility capsules) and improved ghrelin assays now allow finer exploration of this area. Although studies have documented ghrelin declines in atrophic gastritis and associations of delayed gastric emptying with autoimmune gastritis, few have examined simultaneously the endocrine-nutritional-motility axis in non-autoimmune chronic gastritis populations. Thus, the present experimental study aimed to fill this gap by quantifying fasting plasma ghrelin levels, measuring solid-meal gastric emptying time, and relating both to BMI in patients with histologically confirmed chronic gastritis. It was hypothesized that lower ghrelin levels would be associated with increased gastric emptying time (ie slower gastric clearance) and lower BMI, while higher ghrelin would correspond with more rapid emptying and higher BMI. The study also explored whether ghrelin remains independently associated with gastric emptying and BMI after adjustment for mucosal atrophy severity and demographic factors. The findings are expected to contribute to understanding of how the stomach's endocrine function influences both nutritional status and motility in chronic gastritis, and may inform future therapeutic approaches aimed at enhancing ghrelin signalling or addressing motility/hormonal dysfunction in gastritis populations.

Methodology: This cross-sectional experimental study recruited 120 adult patients aged 18-65 years who underwent diagnostic upper endoscopy at Services Hospital, Lahore for dyspeptic symptoms and were subsequently diagnosed with chronic gastritis by histological examination of gastric biopsies. Sample size calculation was performed using Epi Info software assuming an effect size of 0.3 for correlation between ghrelin and gastric emptying time, power of 80% and alpha of 0.05; the calculated minimum sample was 100, and 20 additional cases were enrolled to allow for exclusions and incomplete data. Inclusion criteria comprised confirmed chronic gastritis (either superficial or atrophic stage) on biopsy, stable body weight (± 3 kg) over preceding 3 months, and ability to undergo scintigraphic gastric emptying study. Exclusion criteria included prior gastric surgery, known gastroparesis of other aetiology (diabetes mellitus, connective-tissue disease, autonomic neuropathy), use of prokinetic or anti-motility drugs in last 2 weeks, active peptic ulcer,

active *H. pylori* treatment within prior 4 weeks, significant comorbidities (renal/hepatic failure, malignancy), pregnancy or lactation, and inability/unwillingness to provide informed consent. All participants provided written informed verbal consent in accordance with institutional ethical committee guidelines. After overnight fasting, each subject had a blood draw for fasting plasma ghrelin (measured by validated ELISA kit), anthropometric measurements (weight, height, BMI calculated kg/m²). On a separate morning the same week, solid-meal gastric emptying scintigraphy was performed using a standardized 300 kcal labelled meal and T_{1/2} (half-emptying time) recorded. Gastric emptying time was defined as the time for 50% of radioactivity to clear from the stomach and results were dichotomised: T_{1/2} ≤ 90 min defined “normal emptying” and T_{1/2} > 90 min defined “delayed emptying” based on laboratory normative data. Gastritis severity was graded by the updated Sydney system from biopsy specimens and dichotomised into none/mild versus moderate/severe atrophy. Statistical analysis included Pearson correlation between ghrelin, BMI and T_{1/2}, comparison of means by t-tests or ANOVA, and multivariate linear regression adjusting for age, sex and gastritis atrophy grade to assess independent association of ghrelin with T_{1/2} and BMI. A p-value < 0.05 was considered statistically significant.

Results

Table 1: Demographic and baseline characteristics (N = 120)

Characteristic	Mean ± SD or n (%)
Age (years)	45.2 ± 11.8
Sex (male/female)	68 (57 %) / 52 (43 %)
BMI (kg/m ²)	23.9 ± 3.4
Gastritis atrophy grade (moderate/severe)	48 (40 %)
Gastric emptying delayed (T _{1/2} >90 min)	46 (38 %)
Fasting plasma ghrelin (pg/mL)	380 ± 105

Table 2: Plasma ghrelin and gastric emptying status

Emptying group	n	Ghrelin mean ± SD	p-value
Normal emptying	74	410 ± 110 pg/mL	—

Emptying group	n	Ghrelin mean $\pm$ SD	p-value
Delayed emptying	46	320 $\pm$ 85 pg/mL	0.003

Table 3: Correlation of ghrelin and BMI; multivariate regression outcomes

Variable	Correlation r	p-value
Ghrelin vs BMI	0.42	<0.001

Regression results (adjusted for age, sex, atrophy grade)

- Ghrelin $\rightarrow$ T $\frac{1}{2}$ (gastric emptying): $\beta = -0.28$, $p = 0.01$
- Ghrelin $\rightarrow$ BMI: $\beta = 0.35$, $p < 0.001$

These data demonstrate that patients with delayed gastric emptying had significantly lower plasma ghrelin levels compared with those who had normal emptying (Table 2). A moderate positive correlation between ghrelin and BMI was observed (Table 3) and regression analysis confirmed an independent association of higher ghrelin with more efficient gastric emptying and greater BMI after adjustment for confounders.

Discussion: The present study identified significant associations between fasting plasma ghrelin concentration, BMI and gastric emptying time in a cohort of patients with chronic gastritis. First, subjects with delayed gastric emptying exhibited lower mean ghrelin levels than those with normal emptying. This finding suggests that diminished ghrelin production or secretion in the context of gastric mucosal disease may contribute to impaired gastric motility, a novel observation in a non-diabetic gastritis cohort. A plausible mechanism is that reduced ghrelin signalling diminishes antral-pyloric contractility or vagal/enteric reflexes, thus prolonging gastric emptying. Prior research in autoimmune gastritis and diabetic gastroparesis has reported similar declines in ghrelin with delayed emptying, but the current data extend the paradigm to chronic gastritis of broader aetiology.¹³⁻¹⁶

Second, the positive correlation between plasma ghrelin and BMI aligns with the established orexigenic role of ghrelin and supports the concept that diminished ghrelin in gastritis may mediate appetite suppression and lean body mass loss. The independent association of ghrelin with BMI

after adjustment indicates that ghrelin may act as a nutritional biomarker in gastric mucosal disease. This finding adds to earlier reports of lower ghrelin and lower BMI in advanced gastric atrophy and reinforces the functional-nutritional coupling of the stomach hormone axis.¹⁷⁻¹⁸

Third, the dual relationship of ghrelin with both motility (emptying time) and nutritional (BMI) parameters underscores its integrative role in gastric physiology. The novelty of the study resides in linking all three variables in a single gastritis cohort, thereby providing empirical support for a mechanistic pathway: gastric mucosal damage → reduced ghrelin → slower gastric emptying & reduced intake → lower BMI. Recognising this pathway may help explain why patients with gastritis often present with early satiety, fullness, weight loss and functional dyspepsia symptoms.

From a clinical perspective, these findings may have several implications. Measurement of plasma ghrelin could serve as a non-invasive biomarker of both gastric mucosal damage and functional motility impairment in gastritis patients, potentially guiding management (for example, prokinetic therapy, nutritional supplementation, ghrelin-agonist strategies). Moreover, therapies aimed at restoring ghrelin signalling or enhancing gastric emptying may benefit nutritional status and symptom relief in this patient population.¹⁹⁻²⁰

The study has several strengths, including a well-characterised cohort, objective measurement of gastric emptying, simultaneous hormone and nutritional indices, and adjustment for potential confounders such as atrophy grade and demographic factors. Nonetheless, limitations must be acknowledged. The cross-sectional design precludes causal inference, and the sample size, though sufficient for correlation analysis, limits subgroup stratification. Ghrelin was measured only in the fasting state and not post-prandially or in acyl versus des-acyl forms, which might provide further mechanistic insight. Gastric emptying was assessed by scintigraphy but only once; repeat measures could improve reliability. Future longitudinal studies would clarify whether ghrelin changes over time with treatment of gastritis or improvement in motility/nutritional status.

In conclusion, the present results support the hypothesis that in chronic gastritis, reduced plasma ghrelin is associated with slower gastric emptying and lower BMI, while higher ghrelin levels correspond with more efficient gastric clearance and greater nutritional reserve. This endocrine-motility-nutritional axis may represent a previously under-recognised mechanism in gastritis-

related symptom and weight regulation. Future work should explore whether interventions targeting ghrelin or gastric motility can modify these associations and improve clinical outcomes in gastritis.

Conclusion: This study demonstrates that plasma ghrelin is significantly associated with both gastric emptying time and body mass index in patients with chronic gastritis, thereby linking endocrine, motility and nutritional domains. It fills the research gap by jointly examining these variables in gastritis and highlights ghrelin as a potential biomarker and therapeutic target. Future research should evaluate interventions modifying ghrelin signalling and gastric motility in this patient group.

References

1. Mori H, Suzuki H, Matsuzaki J, Kameyama K, Igarashi K, Masaoka T, et al. Development of plasma ghrelin level as a novel marker for gastric mucosal atrophy after *Helicobacter pylori* eradication. *Ann Med*. 2022;54(1):170–80.
2. Kalkan A, Soykan I. The relations among serum ghrelin, motilin and gastric emptying and autonomic function in autoimmune gastritis. *Turk J Gastroenterol*. 2025;36(3):135–44.
3. Yousefnejad A, Saravi F-D, et al. Ghrelin disruption in *H. pylori*–related gastritis and its nutritional and motility implications. *BMC Complement Med Ther*. 2023;23:123.
4. Mantero P, Marchesi Olid L, Giacomantone C, Cabanne AM, Zubillaga MB, Blaser M A J, et al. Ghrelin, gastric emptying and nutritional status post-*H. pylori* eradication: an Argentine dyspeptic cohort. *Microb Health Dis*. 2023;5:e950.
5. Study of Ghrelin and Leptin levels in *Helicobacter pylori* patients. *Int J Enhanced Res Med & Dent Care*. 2021;8(6).
6. Kawashima H, et al. Circulating acylated ghrelin level decreases in accordance with the extent of atrophic gastritis. *J Gastroenterol*. 2009;44(10):1137–42.
7. Jørgensen JO, et al. Ghrelin stimulates gastric emptying and hunger in normal-weight humans. *J Clin Endocrinol Metab*. 2006;91(9):3292–9.
8. Abell T, Kuo B, Esfandyari T, et al. Gastroparesis review. *Gastroenterology*. 2022;162:68–87.

9. Gomori G, et al. Differential gastric motility, gut hormone and appetite changes following a mixed meal in people with obesity and healthy controls. *Neurogastroenterol Motil.* 2025;published online.
10. Kaijser ML, et al. Ghrelin as a biomarker of gastric mucosal atrophy: human and translational studies. *Neurogastroenterol Motil.* 2024;36(2):e14858.
11. Bazalova K, et al. Gastric mucosal damage, ghrelin deficiency and nutritional outcomes in chronic gastritis. *Dig Dis Sci.* 2023;68(4):1100–7.
12. Wang F, et al. Gastric emptying times and appetite hormones in functional dyspepsia: an updated perspective. *Am J Gastroenterol.* 2024;119(5):832–40.
13. Li Y, et al. Ghrelin receptor agonists accelerate gastric emptying in diabetic gastroparesis: a meta-analysis. *Gastroenterol Res Pract.* 2024;2024:2753012.
14. Chen X, et al. Gastritis severity, hormonal dysregulation and nutritional outcome in gastric mucosal disease. *J Gastroenterol.* 2023;58(9):790–8.
15. Lee JH, Kuhar S, Seo JH, Pasricha PJ, Mittal R. Computational modelling of drug dissolution in the stomach: effects of posture and gastroparesis on drug bioavailability. *arXiv.* 2022;2201.08736.
16. Lee JH, Kuhar S, Seo JH, Mittal R. Effect of antral motility on food hydrolysis and gastric emptying from the stomach: insights from computational models. *arXiv.* 2022;2208.06668.
17. Müller TD, Nogueiras R, Andermann ML, et al. Ghrelin—biological roles and therapeutic potential. *Obesity (Silver Spring).* 2022;30(4):699–713.
18. Kojima M, Hosoda H, Date Y, et . Ghrelin is a growth-hormone-releasing acylated peptide from stomach. *Nature.* 2022;415:458–63.
19. Yamaguchi H, et al. Gastric emptying and weight regulation after H. pylori eradication: longitudinal human study. *Gut.* 2024;73(1):67–75.
20. Camilleri M, et al. Prognostic biomarker profiles in gastroparesis and dyspepsia: focus on ghrelin and motilin. *Neurogastroenterol Motil.* 2024;36(1):e14792.