

## Is obesity associated with gastropharyngeal reflux disease?

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### Abstract

**AIM:** To examine the association between obesity and gastropharyngeal reflux disease (GPRD) as well as gastroesophageal reflux disease (GERD)

**METHODS:** We conducted a cross-sectional study of consecutive patients undergoing ambulatory 24-h dual-probe pH monitoring from July 2003 to December 2006. The association between body mass index (BMI) and parameters about gastroesophageal or gastropharyngeal reflux was examined in univariate and multivariate analyses.

**RESULTS:** A total of 769 patients (307 men and 462 women; mean age 50.7 years) were finally enrolled. Most variables showing gastroesophageal reflux was higher in the obese patients than the patients with normal BMI. There was no difference in all the variables showing gastropharyngeal reflux according to the BMI. After adjustment for age, sex, alcohol intake and smoking, obese patients demonstrated an about 2-fold increase in risk of GERD compared with patients with normal BMI (OR, 1.9; 95 CI, 1.3-2.9), but overweight patients did not demonstrate increased risk of GERD (OR, 1.2; 95 CI, 0.8-1.7). Both obese patients and overweight patients did not demonstrated increased risk of GPRD compared with patients with normal BMI (OR, 1.1; 95 CI, 0.8-1.7; and OR, 0.9; 95 CI, 0.6-1.3, respectively).

**CONCLUSION:** Obesity is not associated with GPRD reflux while it is associated with GERD.

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### INTRODUCTION

The worldwide prevalence of being overweight and obesity has been increasing at an alarming rate over the last decade, indiscriminately affecting populations of both higher and lower middle income countries<sup>[1]</sup>. The rise in obesity coincides with rising prevalence of gastroesophageal reflux disease<sup>[2,3]</sup>, and gastroesophageal reflux disease is a common disorder that has been linked to obesity.

Obesity is a postulated risk factor for gastroesophageal reflux disease, although individual studies have conflicting results<sup>[4-8]</sup>. Some studies suggest that an increased body mass index (BMI) is associated with increased esophageal acid exposure<sup>[9]</sup> and with an increased risk of hospitalization for esophagitis<sup>[10]</sup>. In contrast, other studies, including one of the largest population-based studies to date, have found no association between BMI and gastroesophageal reflux disease<sup>[11-13]</sup>. Potential explanations for the disparate results include a true lack of an association between BMI and gastroesophageal reflux disease, differences in definitions or methodology, dissimilar study populations, or a lack of power to detect an effect in some studies. Additionally, many studies assessing the relationship between gastroesophageal reflux disease and obesity are symptom-based and lack objective tests to confirm this association.

Gastropharyngeal reflux, also called laryngopharyngeal reflux, is a term used to describe esophageal acid reflux into the laryngeal and pharyngeal areas. It causes extraesophageal manifestations (e.g., chronic cough, hoarseness, asthma, globus sensation, chronic sinusitis, or other pulmonary or otorhinolaryngologic diseases). Currently, the best way to demonstrate gastropharyngeal reflux is ambulatory 24-h dual probe pH monitoring<sup>[14]</sup>. Up to present, there are few reports on the association between BMI and gastropharyngeal reflux disease<sup>[15]</sup>.

Therefore, we conducted this cross-sectional study to

examine the association of BMI and gastropharyngeal reflux disease as well as gastroesophageal reflux disease by using the ambulatory 24-h dual probe pH monitoring.

## MATERIALS AND METHODS

### Study design

We conducted a cross-sectional study of consecutive patients who underwent ambulatory 24-h dual-probe pH monitoring from July 2003 to December 2006 at the motility laboratory in Pusan National University Hospital (Busan, Korea). The indications for ambulatory 24-h dual-probe pH monitoring were globus sensation (sensation of a lump, something sticking in the throat), hoarseness, chronic cough, halitosis, throat clearing and laryngeal pathology such as vocal polyp. We did not enroll patients who had history of gastric surgery, were diagnosed as scleroderma or achalasia, or were on anti-reflux medications at the time of the study.

This study was reviewed and approved by the Institutional Review Board at Pusan National University Hospital.

### Evaluation of body mass index

Body mass index (BMI) was calculated as body weight (kg) divided by the square of standing height (m). The BMI was categorized into 3 levels according to the WHO for the Western Pacific region<sup>[16]</sup>: normal weight-BMI < 23 kg/m<sup>2</sup>, overweight-BMI  $\geq$  23 kg/m<sup>2</sup> and  $\leq$  25 kg/m<sup>2</sup>, obese-BMI > 25 kg/m<sup>2</sup>.

### Esophageal manometry

All antisecretory and prokinetic medications were discontinued at least 7 d before testing. Esophageal manometry was performed, after an overnight fast, using an eight-lumen catheter (Synetics Medical Co., Stockholm, Sweden) with side holes 3, 4, 5, 6, 8, 13, 18, and 23 cm from the catheter tip and a water-perfused, low-compliance perfusion system (Synetics Medical Co., Stockholm, Sweden), according to a standard protocol. Briefly, the manometry protocol included the following: first, a station pull-through was performed through the lower esophageal sphincter (LES) to determine the end-expiratory resting pressure, LES length, and location relative to the nares. Then the catheter was positioned with the most-distal side-hole 2 cm below the upper margin of the LES. Ten 5-mL water swallows were given to evaluate peristalsis; only esophageal body contractions measured at 3, 8, and 13 cm above the LES were recorded for data analysis. Then the catheter was pulled through the upper esophageal sphincter (UES) in the same manner (station pull-through) to determine the resting UES pressure, length, and location relative to the nares. Esophageal manometric abnormalities were classified as achalasia, diffuse esophageal spasm, nutcracker esophagus, isolated hypertensive LES, ineffective esophageal motility, or nonspecific esophageal motility disorder<sup>[17]</sup>.

### Ambulatory 24-h dual-probe pH monitoring

Ambulatory 24-h dual-probe pH monitoring was

performed immediately after esophageal manometry, with using a single-use monocrystalline antimony dual-site pH probe (Zinetics 24, Medtronic Inc., Minneapolis, USA) with electrodes placed at the tip and 15 cm proximal to the tip. A cutaneous reference electrode placed on the upper chest was also used. All the electrodes were calibrated in buffer solutions of pH 7 initially and then pH 1. The pH catheter was introduced transnasally into the stomach and withdrawn back into the esophagus until the electrodes were 5 cm above the proximal margin of the LES. The subjects were encouraged to eat regular meals with restriction for intake of drink or food with a pH below 4. All the subjects recorded their meal times (start and end), body position (supine and upright), and any symptoms in a diary. The data was collected using a portable data logger (Digitrapper Mark III, Synetics Medical Co., Stockholm, Sweden) with a sampling rate of 4 s, and was transferred to a computer for analysis using "Polygram for Windows release" 2.04 (Synetics Medical Co., Stockholm, Sweden). For both sites, a decrease in pH below 4, which was not induced by eating or drinking, was considered the beginning of a reflux episode, and the following rise to pH above 4 was considered the end of such an episode. To be accepted as a gastropharyngeal reflux event, the decrease at the proximal probe had to be abrupt and simultaneous with the decrease in the esophagus, or to be preceded by a decrease in pH of a similar or larger magnitude in the distal probe. Thus, acid episodes induced by oral intake, aero-digestive tract residue and secretions, proximal probe movement, or loss of mucosal contact in which the proximal pH decline may precede the esophageal pH drop were not included as gastropharyngeal reflux episodes.

The variables assessed for gastroesophageal reflux in the distal probe were the total percentage of time the pH was < 4, the percentage of time the pH was < 4 in the supine and upright positions, the number of episodes the pH was < 4, the number of episodes the pH was < 4 for  $\geq$  5 min, the duration of the longest episode the pH was < 4 and the DeMeester composite score<sup>[18]</sup>.

The variables assessed for gastropharyngeal reflux in the proximal probe were the total percentage of time the pH was < 4, the percentage of time the pH was < 4 in the supine and upright positions, and the number of episodes the pH was < 4.

For the diagnosis of gastroesophageal reflux disease (GERD) in the distal probe, two different aspects were analyzed<sup>[19,20]</sup>: (1) total reflux time: the total proportion of the recorded time with pH < 4; a value of > 4 was considered abnormal; (2) number of reflux episodes: the total number of pH episodes with pH < 4 during the recording; a value of > 35 episodes was considered abnormal.

For the diagnosis of gastropharyngeal reflux disease (GPRD) in the proximal probe, we considered more than 0.1 for the total, 0.2 for the upright, and 0 for the supine time of pH < 4 to be pathological. For the number of reflux episodes, more than 4 reflux episodes were considered pathological<sup>[21,22]</sup>.

### Assessment by endoscopy

The presence or absence of reflux esophagitis,

Table 1 Patient profiles and the endoscopic findings according to the body mass index

	Body mass index (kg/m <sup>2</sup> )			P value
	< 23 (n = 344)	23-25 (n = 231)	> 25 (n = 194)	
Age (yr, mean ± SEM)	48.4 ± 0.7	51.5 ± 0.7	53.8 ± 0.8	< 0.001
Gender (%)				0.077
Men	123 (35.8)	104 (45.0)	80 (41.2)	
Women	221 (64.2)	127 (55.0)	114 (58.8)	
Alcohol intake	66 (19.2)	50 (21.6)	55 (28.4)	0.048
Smoking	42 (12.2)	31 (13.4)	33 (17.0)	0.295
Indication for pH monitoring (%)				0.210
Globus	156 (45.3)	100 (43.3)	86 (44.3)	
Hoarseness	76 (22.1)	60 (26.0)	54 (27.8)	
Coughing	54 (15.7)	46 (19.9)	26 (16.4)	
Others <sup>1</sup>	58 (16.9)	25 (10.8)	28 (14.4)	
Endoscopic findings (%)				
Reflux esophagitis <sup>2</sup>	32/291 (11.0)	19/204 (9.3)	32/166 (19.3)	0.009
Hiatal Hernia	15/291 (5.2)	19/204 (9.3)	12/166 (7.2)	0.199
Endoscopically suspected esophageal metaplasia	18/291 (6.2)	18/204 (8.8)	16/166 (9.6)	0.348

<sup>1</sup>Other indications were halitosis, throat clearing and laryngeal pathology such as vocal polyp; <sup>2</sup>Los Angeles classification grade.

endoscopically suspected esophageal metaplasia and hiatal hernia were determined by two endoscopists (G.H. Kim, G.A. Song), who were blind to the information of the ambulatory 24-h pH monitoring.

### Reflux esophagitis

If esophagitis was present, it was graded according to the Los Angeles classification<sup>[23]</sup>.

### Hiatal hernia

Hiatal hernia was defined as a circular extension of the gastric mucosa above the diaphragmatic hiatus greater than 2 cm in the axial length.

### Endoscopically suspected esophageal metaplasia (ESEM)

The presence or absence of ESEM<sup>[24]</sup> was examined in the lower portion of the esophagus, including the esophagogastric junction, during inflation of the esophagus before inserting the endoscope into the stomach. The esophagogastric junction was defined as the oral side end of the fold, which exists continuously from the gastric lumen<sup>[25]</sup>, as well as the end of the anal side of the fine longitudinal vessel, because the veins in the lower part of the esophagus were distributed uniformly, running parallel and longitudinally in the lamina propria<sup>[26,27]</sup>. The squamo-columnar junction was defined by a clear change in the color of the mucosa. ESEM was defined as the area between the squamo-columnar junction and the esophagogastric junction.

### Statistical analysis

Data were expressed as mean ± SE unless otherwise noted. The differences in gender, alcohol intake, smoking, indication for pH monitoring, reflux esophagitis, hiatal hernia, ESEM, manometric diagnosis, GERD and GPRD according to the BMI were assessed using the  $\chi^2$  test. The one-way ANOVA was used to assess statistical significance for age, parameters of esophageal manometry and parameters of ambulatory pH monitoring according to the

BMI and post-hoc analysis was performed using the Tukey's HSD. Multiple logistic regression analyses were used to examine association of the two primary outcomes (GERD, GPRD) with the main predictor variable, BMI. GERD and GPRD was adjusted for age, sex, alcohol intake and smoking. For all models, the number of covariates examined was determined by the number of outcome events with 10 events required for one covariate<sup>[28]</sup>. Patients with normal BMI constituted the reference group in comparisons between BMI levels. Odds ratios (ORs) and their 95 confidence intervals (CIs) were used to assess the association between BMI and GERD or GPRD, defined by ambulatory pH monitoring. A  $P < 0.05$  was considered statistically significant. Statistical calculations were performed using the SPSS version 12.0 for Windows software (SPSS Inc., Chicago, IL, USA).

## RESULTS

A total of 769 patients were enrolled in the study: 307 men and 462 women, and their mean age was 50.7 years. Of them, 661 patients underwent the upper endoscopy. Obese patients were more likely to be older and alcohol drinker. There was no difference in the hiatal hernia and ESEM according to the BMI. Reflux esophagitis was higher in the obese patients than the patients with normal BMI and the overweight patients ( $P < 0.05$ ) (Table 1).

There was no difference in the proximal esophageal amplitude, LES pressure and LES length according to the BMI. But the distal esophageal amplitude was higher in the obese patients than the patients with normal BMI and the overweight patients ( $P < 0.05$ ). There was no significant difference in esophageal motility abnormalities according to the BMI (Table 2).

There was no difference in all the variables showing gastropharyngeal reflux in the proximal probe according to the BMI. The total and upright time of pH below 4, the number of reflux episodes, and the DeMeester composite score was higher in the obese patients than the patients with normal BMI ( $P < 0.05$ ) (Table 3).

Table 2 Results of esophageal manometry according to the body mass index (mean  $\pm$  SE)

	Body mass index (kg/m <sup>2</sup> )			P value
	< 23 (n = 344)	23-25 (n = 231)	> 25 (n = 194)	
Proximal esophageal amplitude (mmHg)	59.6 $\pm$ 1.7	60.1 $\pm$ 2.0	62.1 $\pm$ 2.4	0.650
Distal esophageal amplitude (mmHg)	75.1 $\pm$ 2.0	79.5 $\pm$ 2.9	90.2 $\pm$ 3.1 <sup>a</sup>	< 0.001
LES pressure (mmHg)	20.9 $\pm$ 0.4	20.3 $\pm$ 0.5	20.6 $\pm$ 0.6	0.711
LES length (cm)	3.3 $\pm$ 0.0	3.3 $\pm$ 0.0	3.3 $\pm$ 0.0	0.636
Peristalsis (%)	96.5 $\pm$ 0.6	95.2 $\pm$ 0.8	96.1 $\pm$ 0.7	0.640
Manometric diagnosis				0.440
Normal	143	80	84	
Diffuse esophageal spasms	4	1	1	
Nutcracker esophagus	16	15	17	
Hypertensive LES	2	2	2	
Ineffective esophageal motility	103	74	52	
Nonspecific esophageal motility disorder	76	59	38	

Post hoc analysis using Tukey's HSD: <sup>a</sup>P < 0.05 vs BMI < 23 and BMI 23-25.

Table 3 Results of ambulatory 24-h dual probe pH monitoring according to the body mass index (mean  $\pm$  SE)

	Body mass index (kg/m <sup>2</sup> )			P value
	< 23 (n = 344)	23-25 (n = 231)	> 25 (n = 194)	
Proximal probe				
Time pH < 4 (total)	0.7 $\pm$ 0.2	0.5 $\pm$ 0.1	0.5 $\pm$ 0.1	0.502
Time pH < 4 (upright)	0.8 $\pm$ 0.1	0.7 $\pm$ 0.1	0.8 $\pm$ 0.1	0.809
Time pH < 4 (supine)	0.6 $\pm$ 0.3	0.2 $\pm$ 0.1	0.1 $\pm$ 0.0	0.245
No. of reflux episodes	11.1 $\pm$ 1.8	8.4 $\pm$ 1.0	9.5 $\pm$ 1.1	0.452
Distal probe				
Time pH < 4 (total)	2.7 $\pm$ 0.2	3.7 $\pm$ 0.5	3.8 $\pm$ 0.3 <sup>a</sup>	0.038
Time pH < 4 (upright)	3.9 $\pm$ 0.3	5.8 $\pm$ 0.9	5.6 $\pm$ 0.5 <sup>a</sup>	0.021
Time pH < 4 (supine)	1.4 $\pm$ 0.3	2.2 $\pm$ 0.6	2.1 $\pm$ 0.3	0.211
No. of reflux episodes	39.1 $\pm$ 2.3	46.1 $\pm$ 3.1	59.4 $\pm$ 4.9 <sup>a,b</sup>	< 0.001
No. of reflux episodes $\geq$ 5 min	1.6 $\pm$ 0.2	1.6 $\pm$ 0.2	2.0 $\pm$ 0.3	0.477
Longest reflux episode (min)	8.6 $\pm$ 1.3	11.3 $\pm$ 2.4	11.1 $\pm$ 0.9	0.385
DeMeester composite score	11.0 $\pm$ 0.9	14.5 $\pm$ 1.7	15.7 $\pm$ 1.2 <sup>a</sup>	0.016

Post hoc analysis using Tukey's HSD: <sup>a</sup>P < 0.05 vs BMI < 23; <sup>b</sup>P < 0.05 vs BMI 23-25.

Table 4 Association of body mass index with gastroesophageal reflux disease and gastropharyngeal reflux disease, defined by ambulatory pH monitoring

	Body mass index (kg/m <sup>2</sup> )			P value
	< 23 (n = 344)	23-25 (n = 231)	> 25 (n = 194)	
Gastroesophageal reflux disease (%)				0.001
Absent	203 (59.0)	121 (52.4)	82 (42.3)	
Present	141 (41.0)	110 (47.6)	112 (57.7)	
Gastropharyngeal reflux disease (%)				0.162
Absent	143 (41.6)	103 (44.6)	69 (35.6)	
Present	201 (58.4)	128 (55.4)	125 (64.4)	

The frequency of GERD defined by the ambulatory pH monitoring was higher in obese patients, not in overweight patients than in the patients with normal BMI. There was no significant difference in the frequency of GPRD defined by the ambulatory pH monitoring according to the BMI (Table 4).

After adjustment for age, sex, alcohol intake and smoking, obese patients demonstrated an about 2-fold increase in risk of GERD defined by the ambulatory pH monitoring compared with patients with normal BMI (OR, 1.9; 95 CI, 1.3-2.9), but overweight patients did not demonstrate increased risk of GERD (OR, 1.2; 95 CI,

0.8-1.7). Both obese patients and overweight patients did not demonstrated increased risk of GPRD defined by the ambulatory pH monitoring compared with patients with normal BMI (OR, 1.1; 95 CI, 0.8-1.7; and OR, 0.9; 95 CI, 0.6-1.3, respectively) (Table 5).

## DISCUSSION

In present study, we evaluated GERD and GPRD by objective mean (ambulatory 24-h dual-probe pH monitoring) in a large group of 769 patients. Obese patients demonstrated an about 2-fold increase in risk

**Table 5** Multivariable analysis: unadjusted and adjusted analyses for relationships of the body mass index with gastroesophageal reflux disease and gastropharyngeal reflux disease, defined by ambulatory pH monitoring

	Body mass index (kg/m <sup>2</sup> )		
	< 23	23-25	> 25
Gastroesophageal reflux disease			
Unadjusted OR (95 CI)	1	1.3 (0.9-1.8)	2.0 (1.4-2.8)
Adjusted OR (95 CI) <sup>1</sup>	1	1.2 (0.8-1.7)	1.9 (1.3-2.9)
Gastropharyngeal reflux disease			
Unadjusted OR (95 CI)	1	0.9 (0.6-1.2)	1.3 (0.9-1.9)
Adjusted OR (95 CI) <sup>1</sup>	1	0.9 (0.6-1.3)	1.1 (0.8-1.7)

<sup>1</sup>Adjusted for age, sex, alcohol intake and smoking.

of GERD defined by the ambulatory pH monitoring compared with patients with normal BMI, but overweight patients did not demonstrate increased risk of GERD. Also, most variables showing gastroesophageal reflux was higher in the obese patients than in the patients with normal BMI, but not in overweight patients than in the patients with normal BMI. These results were in accord with the previous report that all measures of esophageal acid exposure were observed only for obesity, but not for overweight when compared to normal BMI<sup>[29]</sup>. In addition, we analyzed the endoscopic findings according to the BMI. Reflux esophagitis was higher in the obese patients than in the patients with normal BMI and the overweight patients.

The mechanism by which obesity promotes GERD remains unclear. One potential mechanism is related to mechanical factors whereby an increase in abdominal fat leads to an increase in intragastric pressure<sup>[9,30,31]</sup>, and increased frequency of transient lower esophageal sphincter relaxation<sup>[32]</sup>. Obese patients may have an increased risk for hiatal hernia, which has a role in initiating and promoting gastroesophageal reflux<sup>[33,34]</sup>. On the other reports<sup>[35,36]</sup>, there was not statistically significant association between BMI and hiatal hernia, similar to our results.

We also assessed the degree of gastropharyngeal reflux according to the BMI. There was no difference in all the variables showing gastropharyngeal reflux in the proximal probe according to the BMI. Also, obese patients did not demonstrated increased risk of GPRD defined by the ambulatory pH monitoring compared with patients with normal BMI. These results were consistent with the only previous report<sup>[15]</sup> about the association of BMI and GPRD. In that report, the authors showed that obesity was not associated with the pharyngeal reflux events but had a significant association with esophageal reflux events. But they simply compared the mean pharyngeal and esophageal reflux numbers between 195 non-obese patients and 90 obese patients. Even though we demonstrated the similar result that GPRD was not associated with BMI, we included much more patients, categorized them into 3 levels (normal, overweight, obesity) and performed the multiple logistic regression analysis after adjustment for age, sex, alcohol intake and smoking. Also, our results were consistent with a prospective study<sup>[37]</sup> that obesity was not risk factors for the occurrence of extraesophageal disorders after multivariate analysis, although the presence

of extraesophageal disorders was assessed by only a questionnaire.

The prevalence of esophageal motility abnormalities according to the BMI is not yet unknown. In present study, there was no significant difference in esophageal motility abnormalities according to the BMI. Hong *et al.*<sup>[38]</sup> showed the increased distal esophageal amplitude in 33 of morbidly obese patients and they suggested that this might be due to the presence of a high intraabdominal-thoracic pressure gradient in morbidly obese patients. This would cause a functional outflow obstruction of the esophagus, creating a high-pressure zone within the esophagus. In response to this chronic high-pressure zone, the distal esophagus would have to produce high amplitude contractions for passage of oral contents into the stomach. Similarly, in present study, the distal esophageal amplitude was higher in the obese patients than in the patients with normal BMI and the overweight patients. There was no difference in the LES pressure and LES length according to the BMI, which is consistent with previous reports<sup>[9,39]</sup>.

Much more controversy exists about the location of the proximal probe. The recording of the pH in the hypopharynx is technically difficult. Acid exposure in the hypopharynx can easily be missed because of the relatively large space within the hypopharynx<sup>[21]</sup>. On the contrary, placement of the proximal probe in or below the upper esophageal sphincter allows a more permanent contact with the mucosa during the 24-h period resulting in fewer artifacts<sup>[21,22]</sup>. We used the dual-site pH probe with electrodes placed at the tip and 15 cm proximal to the tip, and we could not choose the exact location of proximal probe. But in most cases (72.7, 559/769), the proximal probe was located in the upper esophageal sphincter. So, for the diagnosis of GPRD, we used the criteria proposed by Smit *et al.*<sup>[21,22]</sup>.

There were some limitations in this study. First, ambulatory pH monitoring can be subjected to measurement errors related to placement of the probe and instrument calibration. However, all procedures were conducted using a similar technique with single-use pH probe. Another limitation is the absence of systematic collection of GERD symptoms. Because our main focus was to examine objective evidence of GERD (i.e., ambulatory pH monitoring) according to the BMI, we did not administer structure questionnaire. Nevertheless, this study had several advantages including the prospective design including the measurement of weight, height, alcohol intake and smoking, the consecutive enrollment to reduce the impact of selection bias and the large sample size. In addition, numerous patients (661/769) underwent the upper endoscopy and we could analyze the endoscopic findings according to the BMI.

Why is obesity not associated with GPRD despite of the association with GERD? First, acid refluxed into esophagus is usually cleared by gravity and peristaltic contractions. In obese patients, the esophageal peristaltic contraction is not impaired compared with patients with normal BMI. On the contrary, the distal esophageal amplitude is increased. This fact would play some role in preventing the refluxed acid extending to the upper level. Second, the amount of acid refluxed into esophagus is

increased in obese patients, so it is easily assumed that the amount of acid refluxed into the upper level would be increased by a secondary phenomenon. The refluxed acid is neutralized by esophageal submucosal secretions and swallowed salivary secretions, so it becomes non-acid reflux material. Therefore, even though this non-acid refluxate would reach to the upper level, the proximal pH probe cannot detect it. To solve this problem, a prospective study using a combined multichannel intraluminal impedance and pH measurement which is able to detect both acid and non-acid reflux, as well as the proximal extent of the refluxate, will be needed.

In summary, this is the largest study to evaluate GERD and GRPD simultaneously according to the BMI by using the ambulatory 24-h dual-probe pH monitoring. Obesity is associated with GERD but is not associated with GPRD. Further studies using a combined multichannel intraluminal impedance and pH measurement will be needed.

## COMMENTS

### Background

Obesity is a postulated risk factor for gastroesophageal reflux disease, although individual studies have conflicting results. Some studies suggest that an increased body mass index (BMI) is associated with increased esophageal acid exposure and with an increased risk of hospitalization for esophagitis. In contrast, other studies have found no association between BMI and gastroesophageal reflux disease. Gastropharyngeal reflux is a term used to describe esophageal acid reflux into the laryngeal and pharyngeal areas. It causes extraesophageal manifestations such as chronic cough, hoarseness, asthma, globus sensation, chronic sinusitis, or other otorhinolaryngologic diseases. This study was to examine the association of BMI and gastropharyngeal reflux disease as well as gastroesophageal reflux disease.

### Research frontiers

The research front in this area is focused on the association of BMI and gastropharyngeal reflux disease as well as gastroesophageal reflux disease. There have been many debates about the association of obesity with gastroesophageal reflux disease. Up to present, there are few reports on the association between BMI and gastropharyngeal reflux disease. This study has examined the association of BMI and gastropharyngeal reflux disease as well as gastroesophageal reflux disease by using the ambulatory 24-h dual-probe pH monitoring. Obesity was associated with increased risk of gastroesophageal reflux disease but was not associated with increased risk of gastropharyngeal reflux disease.

### Innovations and breakthroughs

There are few reports on the association between BMI and gastropharyngeal reflux disease. Most previous studies about the association of obesity with gastroesophageal reflux disease are symptom-based and lack objective tests such as ambulatory 24-h pH monitoring. This study is the largest study to evaluate gastroesophageal reflux disease and gastropharyngeal reflux disease simultaneously according to the BMI by using the ambulatory 24-h dual-probe pH monitoring.

### Applications

Obesity is associated with GERD but is not associated with GPRD. Further studies using a combined multichannel intraluminal impedance and pH measurement will be needed.

### Terminology

Esophageal acid reflux into the laryngeal and pharyngeal areas causes extraesophageal manifestations such as chronic cough, hoarseness, asthma, globus sensation, chronic sinusitis, or other otorhinolaryngologic diseases. This condition is called as gastropharyngeal reflux disease.

### Peer review

This manuscript describes a well-designed GPRD. The classification of obesity

is much higher in the United States and Europe, so this may be an issue that warrants attention. Nonetheless, this is important research.

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