Original Article

Association Between Erosive Esophagitis and the Anthropometric Index in the General Korean Population

Hyun Young Kim. Association Between Erosive Esophagitis and the Anthropometric Index in the General Korean Population

Hyun Young Kim

Department of Internal Medicine, Seoul National University Bundang Hospital, Seongnam-si, Korea

Address for Correspondence: Hyun Young Kim, Department of Internal Medicine, Seoul National University Bundang Hospital, Seongnam-si, Korea
Phone: +82-31-787-7008 e-mail: cecilup@naver.com

Received: 14 March 2018
Accepted: 10 December 2018

DOI: 10.4274/balkanmedj.2018.0523

Cite this article as:
Kim HY. Association Between Erosive Esophagitis and the Anthropometric Index in the General Korean Population. Balkan Med J

Background: An association between obesity and gastroesophageal reflux disease (GERD) has been reported. However, previous studies have focused on obesity or central obesity.
Aims: The aim of this study was to investigate the association of anthropometric index and endoscopic erosive esophagitis (EE) in health check-up of Koreans.
Study Design: Case-control study.
Methods: A total of 1,207 consecutive subjects (aged 40-80 years) during health checkup underwent upper endoscopy and bioelectrical impedance analysis. We collected anthropometric data by bioelectrical impedance analysis, which consisted of body mass index (BMI), percent body fat, muscle mass, and fat mass.
Results: Of 1,207 subjects who underwent upper gastrointestinal endoscopy (mean age, 50 55±9 years), 239 (19.8%) had endoscopic EE. In univariate analysis, the endoscopic EE group was more likely to be

men and had higher BMI, muscle mass, and fat mass. The multivariate OR for endoscopic EE was 1.354 (95% confidence interval: 1.206-1.405) for muscle mass (*P* = 0.027). The prevalence of EE detected during health check-up was 19.8% in Koreans aged 40 years or older.

Conclusion: In the anthropometric data subgroup analysis, muscle mass, but not BMI, percent body fat, and fat mass, was associated with endoscopic EE. Based on anthropometric data subgroup analysis, BMI is not a risk factor of EE. High muscle mass is an independent risk factor of EE.

Keywords: gastroesophageal reflux disease, erosive esophagitis, anthropometric index, body mass index

Gastroesophageal reflux disease (GERD) is caused by the reflux of gastric acid or food into the esophagus, which causes heartburn or reflux (1). GERD is classified into erosive esophagitis (EE) and non-erosive GERD. GERD can seriously impair quality of life and lead to Barrett's esophagus when left untreated and can cause esophageal ulcer, esophageal stricture, and tumor [1]. In Western Europe and North America, the rate of people experiencing gastroesophageal reflux symptoms at least once a week is as high as 20 to 30% of the population [2]. In Korea, the prevalence of GERD is 14.7-17.4%, and the prevalence of EE is 8.6-11.8%, which is lower than that of Western countries [3-5]. However, recently, GERD is on the rise because of the increase in life expectancy and the increase of Western-type diet and obese population in Asian countries. The prevalence of GERD is increasing in Korea, and the prevalence of reflux esophagitis was 1.3% in the 1980s, 2.1% in the early 1990s, 5.4% in 1997, 7.0% in 1999, 8.0% in 2006, and 8.8% in 2011 (2-5).

The exact reason why the prevalence rate is increasing is unknown, but it is likely that Western eating habits and an increase in the obese population have been influential. The mechanism of GERD are variously reported as lower esophageal sphincter (LES) function, abnormal esophageal motility, gastric hyperplasia, delayed gastric emptying, and reduced resistance of esophageal mucosa. The most important pathogenesis of GERD is believed to result from the temporary relaxation of the LES. In addition, anatomical deficits such as hiatal hernia, low pressure of the LES. Increased gastroesophageal pressure may increase gastroesophageal reflux. This may be caused by various factors such as increase of proximal pressure; however, especially when the amount of muscle is increased, the abdominal pressure is increased, and the proximal pressure of the gastroesophageal muscles is also increased.

The aim of this study was to investigate risk factors related to EE in the general Korean population.

Material and Methods

Anthropometric data

The study population consisted of all gastroscopies and anthropometric data performed in a single tertiary hospital. The target population enrolled in this study is mostly public office or company workers and families who are required to have a mandatory group screening program. This program includes tests that are not personally selectable and must be carried out mandatory, annually. For example, upper gastrointestinal endoscopy, anthropometric index, blood tests, abdominal ultrasound, electrocardiogram, chest X-ray examination.

The study group consisted of 1,207 subjects aged 40 to 80 years who had undergone a complete screening upper gastrointestinal endoscopy for an average risk for gastric cancer. Anthropometric data included height, weight, body mass index (BMI), percent body fat, fat mass, and muscle mass. Weight was measured to the nearest 0.1 kg. Height was measured to the nearest 0.1 cm. Weight was measured using Inbody S-10, and BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). All anthropometric results were based on a single-body measurement examination.

A single tertiary Hospital Health Promotion Center provided various screening packages of exams including upper gastrointestinal endoscopy. All screened subjects volunteered or were employer-sponsored to undergo upper gastrointestinal endoscopy regardless of age (even asymptomatic subjects in their 20s and 80s who were undergoing routine checkup). Study subjects with a history of gastrointestinal surgery or with a respiratory problem requiring current medication, or pregnant subjects were excluded. This study was approved by the Institutional Review Board (IRB No. B-1708-412-105). This study was retrospective design, waived written informed consent by the Institutional Review Board (IRB No. B-1708-412-105).

Endoscopy exam

upper gastrointestinal endoscopy was conducted on all study subjects by five expert gastroenterologists (>10 years of endoscopic performance) certified by the Korean Society of Upper gastrointestinal endoscopy using conventional white light videoscopy (GIF-H260 or GIF-H290; Olympus, Aizu, Japan). The grade of EE seen on upper gastrointestinal endoscopy was classified from A to D according to the Los Angeles (LA) classification (6). All endoscopic images of EE were stored as pictures on the hospital network, namely PACS system and were reviewed by a single well-trained gastroenterologist. All gastroenterologists participated in the meeting who agreed the consensus of EE findings.

Statistical analyses

Data were analyzed using SPSS software (version 21.0, SPSS Inc., Chicago, IL, USA). Continuous variables are expressed as mean ± standard deviation whereas the categorical variables, as absolute values and percentages. Medians and ranges are presented for continuous variables and percentages for categorical variables. Differences between variables were assessed by χ^2 tests. All P values were two sided, and $P < 0.05$ was considered statistically significant. To investigate the relations the various variables, we used multiple regression analysis. To assess the relation among age, gender, BMI, percent body fat, muscle mass, fat mass, and endoscopic EE, a binomial logistic regression analysis model was used with these 6 parameters, as independent variables.

Bioelectrical Impedance Analysis (BIA)

A multi-frequency bioelectrical impedance analyzer, InBody S5 Biospace device (Inbody Co, Ltd, Seoul, Korea/Model 720), was used according to the manufacturer's guidelines. BIA estimates body composition using the difference of conductivity of various tissues given different biological characteristics of the subjects. Conductivity is proportional to water content, and more specifically to electrolytes, and it decreases as the cell approaches a perfect spherical shape. Adipose tissue is composed of round-shaped cell and contains relatively little water than other tissues such as muscle; therefore, conductivity will decrease as body fat increases. In practice, electrodes are placed at six precise tactile points of the body to achieve a multi-segmental frequency analysis. A total of 30 impedance measurements are obtained using six different frequencies (1, 5, 50, 250, 500, and 1,000 kHz) at the five following segments of the body, namely right and left arms, trunk, and right and left legs.

Results

Clinical characteristics of the study subjects

This study included 1,207 health checkup subjects aged 40 years or more (mean age; 55±9 years) for screening upper gastrointestinal endoscopy at a single tertiary Hospital Health Promotion Center. The mean age of subjects was 55 years (SD ±9), and 62% were men. The prevalence of EE after 40 years of age was 19.8%. Barrett's esophagus was not observed in this study.

Table 1 and 2 show the differences in demographic and clinical characteristics between subjects with EE and those without EE groups. In the univariate analysis, the subjects with EE, when compared with those without EE, had higher prevalence of male (P<0.001), BMI (P<0.001), muscle mass (P<0.001),and fat mass (P<0.001). No significant difference in the prevalence of EE was found by age or percent body fat. Men subjects was higher in the group with EE than that without EE (180 vs. 59, respectively, P<0.001). BMI was higher in group with EE than that without EE (25.3±3.4 vs. 23.9±3.1, respectively, P=0.000). Muscle mass was higher in group with EE than that without EE (48.8±8.7 vs. 44.6±9.0, respectively, P<0.001), so did fat mass (19.3±5.8 vs. 17.7±6.1, respectively, (P<0.001).

Based on endoscopic exams, by LA classification, 239 subjects (19.8%) were found to have EE: 96 (40.2%) in LA-A, 127 (53.1%) in LA-B, and 16 (6.7%) in LA-C. The age and gender distribution of these 239 subjects with EE are shown in Table 3.

Associations of endoscopic EE with the components of anthropometric data

Results of multiple logistic regression analysis associations of EE and components of anthropometric data are shown in Table 4. Muscle mass remained an independent risk factor for EE after adjustment for age and gender. Higher muscle mass was associated with an increasing risk for EE (OR = 1.354, 95% CI: 1.206-1.405, P=0.027). No significant interactions were found between endoscopic EE and the components of anthropometric data, such as BMI, percent body fat, and fat mass.

Discussion

Until now, most studies have reported obesity as a risk factor of GERD. We found a positive correlation between EE and each of the following individual factors by analyzing the components of anthropometric data: male gender, high BMI, high muscle mass, and high fat mass. However, multivariate analysis revealed that only high muscle mass was associated with EE. This study found no correlation between EE and BMI or fat mass.

In a previous study, multivariate logistic regression analysis revealed that BMI, central obesity, waist circumference, or visceral fat area/subcutaneous fat area ratio is associated with EE. Whether obesity promotes gastroesophageal reflux is still under debate. GERD is known to have three mechanisms, namely, transient lower esophageal sphincter relaxation (tLESR), strain-induced increased intra-abdominal pressure, and deglutitive LES relaxation (7). Notably, the increase in intra-abdominal pressure due to obesity contributes to EE. Some studies have suggested that the risk of GERD or EE increases with increasing BMI (2, 8, 9). Many previous studies have used BMI as an index of obesity. However, BMI can reflect part of obesity, and it does not reflect all components of body composition. There are some reports that the correlation between EE and BMI is not positively correlated and considered to be influenced by various factors (8, 10).

Another type of obesity, also known as abdominal or central obesity, promotes gastroesophageal reflux which may be related to increased intra-abdominal pressure. One recent study had demonstrated that belt compression increased acid reflux following a meal (11). The mechanism is that waistbelt on vs. off causes a marked increase in gastroesophageal reflux, most evident after a meal. The effect of belt was marked close to the gastroesophageal junction (GEJ) where the pH of the distal esophagus lined, or normally lined, by squamous mucosal became similar to that of the proximal stomach. This combined high-resolution pH and manometry system could examine the mechanism of the increased esophageal acid reflux induced by the belt. These findings support the mechanism of the association between central obesity and GERD. In addition, Herregods et al. (12) examined the complex mechanisms of reflux during running by new technology HRM (simultaneous high-resolution manometry), and pH impedance in 10 healthy subjects after a meal includes transient lower esophageal sphincter relaxation (tLESR, aka “belch reflex”) and transient formation of hiatal hernia.

Early studies have shown a correlation between BMI and GERD based on stationary esophageal manometry and 24-h pH metry (13-15). Obesity measured by BMI increases intra-gastric pressure, same as intra-abdominal pressure. Furthermore, a rise in intra-abdominal pressure elevates LES pressure. Mid-term studies have shown a correlation between central obesity and GERD, classifying the central obesity as an external factor, and tightening the belt and intra-abdominal fat as internal factors (16, 17). Central obesity measured by abdominal visceral adipose tissue volume, but not BMI or waist circumference, was associated with EE. Recent studies have suggested that running or abdominal compression as a mechanical factor is correlated with GERD and the results of using a combined high-resolution pH measurement and manometry as a new device (11, 18).

In most clinical situations, the direct measurement of the intra-abdominal pressure is impractical, so a surrogate measure of intra-gastric pressure was chosen. Several studies have evaluated that BMI, waist circumference, and waist belt compression have a positive relationship with intra-gastric pressure and gastroesophageal pressure gradient (11, 13, 17, 19).

Surprisingly, no information is available on the effect of muscle mass on intra-gastric or intra-abdominal pressure. We hypothesized that trunk or abdominal muscles might cause gastroesophageal reflux by increasing intra-gastric or intra-abdominal pressure. In the present study, high muscle mass was associated with risk of endoscopic EE. Several possibilities have been formulated to explain how muscle mass can cause EE. These results suggest that high muscle mass may influence the intra-abdominal pressure and subsequent esophageal acid exposure. We were able to predict a significant correlation with abdominal muscle alone explains a relatively small part of the variance in mucosal breaks of the GEJ. The role of central muscle mass points to a mechanical rather than hormonal mechanism that influence the mucosal breaks of GEJ. Our study points to the importance of mechanical factors in the association between muscle mass and reflux esophagitis.

The current study does have strengths. This is the first study to investigate anthropometric data including BMI, percent body fat, muscle mass, and fat mass for endoscopic EE. In addition, all gastroscopies were performed by highly experienced endoscopists and obtained high-quality data. All endoscopic images were reviewed by one expert endoscopist for assessment of LA classification grades. It does minimize the intra-observer variation. To complement the reproducibility of the anthropometric data, one examiner performed two consecutive BIA measurements.

However, this study has some limitations. First, this study is the use of BIA, not computed tomography in measuring anthropometric data. There is still concerning of accuraty of BIA (20, 21). Second, we did not evaluate lifestyle factors, such as alcohol or smoking status.

In conclusion, anthropometric index, especially high muscle mass was positively correlated with endoscopic EE. Our findings may explain the mechanism by which non-obese patients developed EE.

References

1. Vakil N, van Zanten SV, Kahrilas P, Dent J, Jones R. The Montreal definition and classification of gastroesophageal reflux disease: a global evidence-based consensus. The American journal of gastroenterology. 2006 Aug;101(8):1900-20; quiz 43. PubMed PMID: 16928254. Epub 2006/08/25. eng.

2. Kim N, Lee SW, Cho SI, Park CG, Yang CH, Kim HS, et al. The prevalence of and risk factors for erosive oesophagitis and non-erosive reflux disease: a nationwide multicentre prospective study in Korea. Alimentary pharmacology & therapeutics. 2008 Jan 15;27(2):173-85. PubMed PMID: 17973646. Epub 2007/11/02. eng.

3. Kim KM, Cho YK, Bae SJ, Kim DS, Shim KN, Kim JH, et al. Prevalence of gastroesophageal reflux disease in Korea and associated health-care utilization: a national population-based study. Journal of gastroenterology and hepatology. 2012 Apr;27(4):741-5. PubMed PMID: 21916988. Epub 2011/09/16. eng.

4. Lien HC, Chang CS, Yeh HZ, Ko CW, Chang HY, Cheng KF, et al. Increasing prevalence of erosive esophagitis among Taiwanese aged 40 years and above: a comparison between two time periods. Journal of clinical gastroenterology. 2009 Nov-Dec;43(10):926-32. PubMed PMID: 19384245. Epub

2009/04/23. eng.
5. Seo GS, Jeon BJ, Chung JS, Joo YE, Kim GH, Baik GH, et al. The Prevalence of Erosive Esophagitis Is Not Significantly Increased in a Healthy Korean Population - Could It Be Explained?: A Multi-center Prospective Study. Journal of neurogastroenterology and motility. 2013 Jan;19(1):70-7. PubMed PMID: 23350050. Pubmed Central PMCID: PMC3548130. Epub 2013/01/26. eng.
6. Armstrong D, Bennett JR, Blum AL, Dent J, De Dombal FT, Galmiche JP, et al. The endoscopic assessment of esophagitis: a progress report on observer agreement. Gastroenterology. 1996 Jul;111(1):85-92. PubMed PMID: 8698230. Epub 1996/07/01. eng.
7. Mittal RK, Holloway RH, Penagini R, Blackshaw LA, Dent J. Transient lower esophageal sphincter relaxation. Gastroenterology. 1995 Aug;109(2):601-10. PubMed PMID: 7615211. Epub 1995/08/01. eng.
8. El-Serag HB, Graham DY, Satia JA, Rabeneck L. Obesity is an independent risk factor for GERD symptoms and erosive esophagitis. The American journal of gastroenterology. 2005 Jun;100(6):1243-50. PubMed PMID: 15929752. Epub 2005/06/03. eng.
9. Jacobson BC, Somers SC, Fuchs CS, Kelly CP, Camargo CA, Jr. Body-mass index and symptoms of gastroesophageal reflux in women. The New England journal of medicine. 2006 Jun 01;354(22):2340-8. PubMed PMID: 16738270. Pubmed Central PMCID: PMC2782772. Epub 2006/06/02. eng.
10. Corley DA, Kubo A. Body mass index and gastroesophageal reflux disease: a systematic review and meta-analysis. The American journal of gastroenterology. 2006 Nov;101(11):2619-28. PubMed PMID: 16952280. Epub 2006/09/06. eng.
11. Mitchell DR, Derakhshan MH, Wirz AA, Ballantyne SA, McColl KEL. Abdominal Compression by Waist Belt Aggravates Gastroesophageal Reflux, Primarily by Impairing Esophageal Clearance. Gastroenterology. 2017 Jun;152(8):1881-8. PubMed PMID: 28267445. Epub 2017/03/08. eng.
12. Carlson DA, Hirano I. Editorial: Reflux While Running: Something to Belch About. The American journal of gastroenterology. 2016 Jul;111(7):947-8. PubMed PMID: 27356820. Epub 2016/07/01. eng.
13. de Vries DR, van Herwaarden MA, Smout AJ, Samsom M. Gastroesophageal pressure gradients in gastroesophageal reflux disease: relations with hiatal hernia, body mass index, and esophageal acid exposure. The American journal of gastroenterology. 2008 Jun;103(6):1349-54. PubMed PMID: 18510603. Epub 2008/05/31. eng.
14. Pandolfino JE, El-Serag HB, Zhang Q, Shah N, Ghosh SK, Kahrilas PJ. Obesity: a challenge to esophagogastric junction integrity. Gastroenterology. 2006 Mar;130(3):639-49. PubMed PMID: 16530504. Epub 2006/03/15. eng.
15. Bredenoord AJ, Weusten BL, Timmer R, Smout AJ. Intermittent spatial separation of diaphragm and lower esophageal sphincter favors acidic and weakly acidic reflux. Gastroenterology. 2006

Feb;130(2):334-40. PubMed PMID: 16472589. Epub 2006/02/14. eng.
16. Nam SY, Choi IJ, Ryu KH, Park BJ, Kim HB, Nam BH. Abdominal visceral adipose tissue volume is associated with increased risk of erosive esophagitis in men and women. Gastroenterology. 2010 Dec;139(6):1902-11.e2. PubMed PMID: 20727886. Epub 2010/08/24. eng.
17. Derakhshan MH, Robertson EV, Fletcher J, Jones GR, Lee YY, Wirz AA, et al. Mechanism of association between BMI and dysfunction of the gastro-oesophageal barrier in patients with normal endoscopy. Gut. 2012 Mar;61(3):337-43. PubMed PMID: 21873737. Epub 2011/08/30. eng.
18. Herregods TV, van Hoeij FB, Oors JM, Bredenoord AJ, Smout AJ. Effect of Running on Gastroesophageal Reflux and Reflux Mechanisms. The American journal of gastroenterology. 2016 Jul;111(7):940-6. PubMed PMID: 27068716. Epub 2016/04/14. eng.
19. Robertson EV, Derakhshan MH, Wirz AA, Lee YY, Seenan JP, Ballantyne SA, et al. Central obesity in asymptomatic volunteers is associated with increased intrasphincteric acid reflux and lengthening of the cardiac mucosa. Gastroenterology. 2013 Oct;145(4):730-9. PubMed PMID: 23796455. Epub 2013/06/26. eng.
20. Buchholz AC, Bartok C, Schoeller DA. The validity of bioelectrical impedance models in clinical populations. Nutr Clin Pract. 2004;19.
21. Coppini LZ, Waitzberg DL, Campos AC. Limitations and validation of bioelectrical impedance analysis in morbidly obese patients. Curr Opin Clin Nutr Metab Care. 2005;8.

Table 1. Demographics and baseline characteristics of subjects (n = 1,207)

Variables	
Age (years) (mean ± SD), n, %	55.4 ± 8.7
40-49	333 (27.6)
50-59	519 (43.0)
60-69	262 (21.7)
≥ 70	93 (7.7)
Gender, n, %	
Male	742 (61.5)
Female	465 (38.5)
BMI (kg/m^2) (mean ± SD)	24.2 ± 3.2
< 23 (%)	424 (35.1)
23 ≤ < 25 (%)	325 (26.9)
≥ 25 (%)	458 (37.9)
Erosive esophagitis, n, %	
Yes/No	239 (19.8) /968 (80.2)
LA-A	96 (40.2)
LA-B	127 (53.1)
LA-C	16 (6.7)
LA-D	0
Percent body fat	26.9 ± 6.5
Muscle mass (kg)	45.5 ± 9.1
Fat mass (kg)	18.0 ± 6.1

BMI: body mass index

Table 2. Comparison of characteristics between subjects with endoscopic erosive esophagitis and those without

	Without erosive esophagitis (N = 968) (%)	With erosive esophagitis (N = 239) (%)	*P* value
Age (years)	55.5 ± 8.9	55.0 ± 7.9	0.361
40-49	270 (27.9)	63 (26.4)	
50-59	409 (42.3)	110 (46.0)	
60-69	206 (21.3)	56 (23.4)	
≥ 70	83 (8.6)	10 (4.2)	
Gender			<0.001
Male	562 (58.1)	180 (75.3)	
Female	406 (41.9)	59 (24.7)	
BMI (kg/m^2)	23.9 ± 3.1	25.3 ± 3.4	<0.001
<23	373 (38.5)	51 (21.3)	
23 ≤ < 25	253 (26.1)	72 (30.1)	
≥ 25	342 (35.3)	116 (48.5)	
Percent body fat	26.9 ± 6.6	26.9 ± 6.2	0.985
Muscle mass (kg)	44.6 ± 9.0	48.8 ± 8.7	<0.001
Fat mass (kg)	17.7 ± 6.1	19.3 ± 5.8	<0.001

BMI: body mass index

Table 3. Erosive esophagitis characteristics according to the Los Angeles classification by age and gender

Variables	LA-A (n = 96) (%)	LA-B (n = 127) (%)	LA-C or D (n = 16) (%)	Total (n = 239) (%)
Gender				
Male	62 (64.6)	102 (80.3)	16 (100)	180 (75.3)
Female	34 (35.4)	25 (19.7)	0	59 (24.7)
Total	96 (100)	127 (100)	16 (100)	239 (100)
Age (years)				
40-49	26 (27.1)	34 (26.8)	3 (18.8)	63 (26.4)
50-59	43 (44.8)	57 (44.9)	10 (62.5)	110 (46.0)
60-69	25 (26.0)	30 (23.6)	1 (6.3)	56 (23.4)
≥ 70	2 (2.1)	6 (4.7)	2 (12.5)	10 (4.2)
Total	96 (100)	127 (100)	16 (100)	239 (100)

Table 4. Logistic regression analysis of covariates for erosive esophagitis.

Associations of erosive esophagitis and the components of the anthropometric data

	Adjusted Odds Ratio	95% Confidence Interval	*P* value
Age (years)	1.000	0.981-1.020	0.969
Male	1.661	0.936-2.949	0.083
BMI (kg/m^2)	1.021	0.909-1.147	0.725
Percent body fat	1.040	0.968-1.117	0.283
Muscle mass (kg)	1.354	1.206-1.405	0.027
Fat mass (kg)	1.002	0.938-1.070	0.954

BMI: body mass index