ORIGINAL ARTICLE

Assessment the relationship between reflux and body mass index with comparing different regression models

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ABSTRACT

Aim: The aim of this study was to determine whether there is relation between body mass index and symptoms of gastro-esophageal reflux disease in our community using Logit, Probit and Complementary log-log models.
Background: The most frequent statistical tool to address the relationship among a dichotomous response and other covariates is logistic regression. However logistic regression is familiar for researchers, some other models with similar results are favorable to assess such relationship like as Probit and Complementary log-log.
Patients and methods: We carried out a population-based study to estimate the strength of the association between body mass and reflux symptoms. During interview, participants completed a valid Gastro-esophageal Reflux Questionnaire. The coefficients calculated by logistic, Probit and Complementary log-log regression with multivariate adjustments for covariates.
Results: Reflux symptoms at least once a week over the last three months were reported by 522 (9.1%) of the 5733 interviewees. There were no evidence in all models to address the significant relation between Reflux and BMI and all models derived in same efficacy.
Conclusion: Our results showed that the choice of the link function in this analysis is not the most important issue but still a user could also look forward to some other link functions like Probit and Complementary log-log.

Keywords: Gastro-esophageal reflux, body mass index, Logit, Probit, Complementary log-log.
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Introduction

The most frequent statistical tool to address the relationship among a dichotomous response and other covariates is logistic regression. In statistics, logistic regression is modeled with a Logit link that is used for prediction of the probability of the occurrence of an event by fitting data to the logistic curve. It makes use of several predictor variables that may be either numerical or categorical. Although logistic regression may be familiar to some researchers in the field of

medicine, some other mathematical tools, with similar uses, are also of value in the assessment of relationships. An alternative to logistic regression analysis is Probit analysis. The term 'Probit' was coined in the 1930's by Chester Bliss and stands for probability unit. These two analyses; Logit and Probit, are very similar to one another. Logit analysis is based on log odds while Probit uses the cumulative normal probability distribution (1).

Complementary log-log models represent a third alternative to logistic regression and Probit analysis for binary response variables. Complementary log-log models are frequently used when the probability of an event is very small or very large. Unlike Logit

and Probit the Complementary log-log function is asymmetrical (1).

Gastroesophageal reflux disease (GERD) is a major clinical problem in Western countries. GERD is a common disorder that has been linked to obesity. Recently the prevalence of obesity and GERD have been rapidly increasing world wide, particularly in western societies (2-6).

A possible aetiological association between obesity and GERD has been extensively investigated (7-12). A recent study conducted by Corley et al in the United States showed that the association between BMI and reflux-type symptoms was partially mediated through abdominal diameter and there was a consistent association between abdominal diameter and reflux-type symptoms in the white population, but no consistent associations in the black population or Asians (11). It is not known whether an association persists among Asian origin after adjusting for other known GERD risk factors. To our knowledge there is very few published investigation from developing or underdeveloped countries in Asia, in which a rigorous epidemiological approach has been used to address this question. Iran is remarkable in that it has higher prevalence of *H.pylori* (13), esophageal cancer (14), and reflux esophagitis (15) compared with the findings of non-Iranian studies.

The aim of this study was to determine whether there is relation between body mass index and symptoms of gastro-esophageal reflux disease in our community using Logit, Probit and Complementary log-log models, conducted a comparison among those models and compare our results with those similar acquired by western countries.

Materials and Methods

This study was designed as a cross sectional and population-based interview study that was conducted from May through December 2006 in Firoozkouh city and Damavand city, both of these cities are located in northeast region of Tehran province, Iran, where approximately 25000 families with nearly 100000 members reside. We selected a total of 6325 subjects randomly, aged between 10 and 80 yr, on the basis of the number of their health dossiers. Each year over 60% of these cities population is seen at either health center or by the other major local care provider. During any given 4-year period, over 95% of local residents will have had at least one local health care contact. An important feature of the local health provider system is that each of these providers employs a single dossier or unit record system, whereby all medical information for each individual is accumulated in a single record. This system supported a high rate of response in both of the first and second interview. Postal codes and addresses were recorded in the dossiers. Our trained health personnel referred to the houses of all of these 6325 subjects, door to door and face to face, and asked them to participate in the first interview according to the first part of our questionnaire. The questionnaire included two parts, the first part which was conducted by our trained health personnel, consisted of 22 questions, in which personal and family characteristics such as age, gender, occupation, educational level and household income, socio-demographic, health relevant life style, clinical factors and several general questions were inserted. In addition to that our trained health personnel asked about 11 gastrointestinal symptoms including; abdominal pain and distress, constipation, diarrhea, bloating, heartburn and regurgitation, proctalgia, nausea and vomiting, fecal incontinence, existence of blood in the stool or black stool, weight loss or anorexia, and difficulty in swallowing.

Those who reported at least one of the 11 gastrointestinal (GI) symptoms mentioned, in the first part of the questionnaire were selected by our

trained health personnel for participating in the second interview according to the second part of our questionnaire. The second part of our questionnaire consisted of 40 questions about different gastrointestinal disorder on basis of Rome III criteria. The second interview was conducted by our experienced gastroenterologists. Patients who did not complete the questionnaire were excluded as well.

The survey instrument was a standardized questionnaire in Persian designed by a working group in Iran Society of Gastroenterology.

Before the interview survey, the interviewer explained the purpose of these questions to all eligible individuals and requested their participation. The individuals were informed that attending the interview was not compulsory. Informed consent for enrolment was obtained, and patient anonymity was preserved. The research protocol was approved by the Ethics Committee of Research Institute for Gastroenterology and Liver Diseases, Shahid Beheshti Medical University.

Gastro-esophageal reflux disease was defined as a subject who had heartburn and/or acid regurgitation at least once a week for the last three months.

Body mass index (BMI), a validated measure of body mass independent of height (16), was calculated as body weight divided by the square body height in meters (kg/m2). Finally we collected detailed information on potential confounding factors which were categorized as follows: age, sex (male/female), tobacco smoking (non-smokers, and current-smokers of cigarettes, cigars, and pipes), alcohol use (grams of pure alcohol per week with respondents categorized into four classes), and physical activity during leisure time and at work (with respondents categorized into four classes).

To qualify as members of the control group, respondents could not have experienced any upper and gastrointestinal (GI) symptom including; heartburn and/or acid regurgitation over the last

three months and did not use any GI medication during the last three months. In our study, we selected the members of control group who did not have any GI complaints and did not use any GI medication during the last year of this survey.

The relation between the explanatory BMI variables and the dependent dichotomous reflux variable was modeled using logistic, Probit and log-log Complementary regression, estimated by the maximum likelihood method (17) and the basic beta parameters and their P-values. In the baseline model, adjustments were made for all four covariates including; age, sex, tobacco smoking, and physical activity. All P-value were tow-tailed with the level of statistical significance specified at 0.05. For the aim of comparison among models we used Akaike Information Criterion (AIC). The AIC proposed in Akaike (1974), is a measure of the goodness of fit of an estimated statistical model. It is grounded in the concept of entropy. The AIC is an operational way of trading off the complexity of an estimated model against how well the model fits the data (18).

Results

Among the selected 6325 population based subjects, 5733(90.6%) participated in the first interview. Non-participation was due to unwillingness in 556(8.7%), physical or mental disorders prohibiting an interview in 9 (0.1%), and incorrect addresses in 27(0.4%). The interviewer deemed the quality of the answers about reflux symptoms and body measures to be uncertain in five (0.1%) and 15 (1.8%) respondents, respectively. Mean age of subjects was 34.8 years (standard deviation [SD] =16.61; range, 10-80); 2798 (48.8%) were women. Subject characteristics of the 522 who reported recurrent reflux symptoms were compared with those of the 536 individuals who did not. These 536 individuals were selected among those who had not any gastrointestinal symptom and did not use any GI medication during the last year. There were no

differences in the frequency of tobacco smoking or alcohol consumption, marital status, income, and educational level between these groups, age and sex distributions were also similar (table 1). There were only three subjects who consumed alcohol regularly, they did not have any gastro-esophageal reflux symptom and were not a member of the control group.

Table 1. Characteristics of subjects by reflux symptom status

	Reflux symptoms at least once a week for 3 months or more	
	Yes	No
Number	442	444
Median age (year)	50.0	44
Mean age (year)	50.7	45.6
No of females (%)	279(63.1)[*]	292(65.8)
Ever Tobacco smokers	27(6.1)	26(5.8)
Physical activities	20(4.5)	34(7.6)
Income ≥ 1500000 Rials / month	247(55.9)	256(57.6)

[*] Figures in the parentheses represent percent.

We found no statistically significant association between BMI and gastrosophageal reflux in the analyses and all models arrived at the same conclusions with similar AIC and deviance (table 2).

Table 2. Association of body mass index with risk of gastroesophageal reflux adjustments were made for age, sex, tobacco smoking, and physical activity.

	Coefficients	P value	Deviance	AIC
Logit	0.007	0.63	997	1271
Probit	0.004	0.63	997	1271
Complementary log-log	0.005	0.62	997	1271

Discussion

Logit, Probit and Complementary models are special cases of general linear models to better treat the case of dichotomous and categorical variables.

Although Probit is a variant of Logit modeling based on different data assumptions, results of Probit analysis are rarely reported in the original units. Logit is the more commonly used, based on the assumption of equal categories. Probit may be the more appropriate choice when the categories are assumed to reflect an underlying normal distribution of the dependent variable, even if there are just two categories (1).

Our results showed that the choice of the link function in this analysis is not the most important issue. Sometimes the Complementary link offer some advantage, as it is more sensitive at detecting correlations, but when the rate of an event in dichotomous response is rare the Probit link remains the best option (1). The results from all models revealed no evidence of an association between BMI and gastro-esophageal reflux symptoms. Our findings were consistent with the results of four previous studies in massively obese subjects (19-22). One showed no differences in oesophageal pH compared with normal weight subjects (19) and the other found no improvement in reflux symptoms or oesophageal pH after weight reduction (20). In another study conducted by Lagergren et al. in a Swedish population-based and nationwide case control study, no association between BMI and severity or duration of reflux was found (21). On the other hand, our results were in conflict with many previous studies (7-12), two of them were case series consisting of patients referred for endoscopy (23-24). In these investigations the average BMI was significantly higher among patients with reflux esophagitis than in those without, and the other studies indicated a significant relationship between body mass index and prevalence of gastro-esophageal symptoms in different communities. Each of the above studies considered several variables as potential confounders. Age, sex, smoking, alcohol use, meal size, physical activity, hiatal hernia, life stress, high cholesterol diet, and frequency of consumption of various foods such as chocolates, coffee, onions, citrus fruits, tomatoes, and mints were known as potential confounder (7-12). Very few studies considered all of the above variables

as potential confounders in their surveys (9, 11). In our study, subjects with a history of hiatal hernia were excluded and the only three individuals who were alcohol consumer were not in those with GERD symptoms and control group. The subjects in our study were frequently matched for age and sex to subjects of control group. In addition to that, our data were adjusted for age, sex, smoking, alcohol use, physical activity.

An important strength of the study is derived from the fact that this is not a clinical based sample, these were not people seen in Gastroenterology practices, but people identified at random from the community who in turn agreed to participate. We also used a well validated questionnaire to identify our cases and controls and our control group was fully free of any GI sign and symptom over the last year. Hence, we conducted three different link function analysis, all of them indicated same results and adjusted for potential confounders in the analyses. So bias should have been minimal. In conclusion there was no association between BMI and gastro-esophageal reflux symptoms in Iranian community based on Logit, Probit and Complementary Log-Log analysis.

Acknowledgements

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