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ORIGINAL ARTICLE

Population based study to assess prevalence and risk factors of gastroesophageal reflux disease in a high altitude area

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Abstract
Aim We did a population-based cross-sectional study to investigate the prevalence and risk factors of gastroesophageal reflux disease (GERD) in a high altitude area.
Methods An observational study using a validated questionnaire consisting of demographic, lifestyle and dietary characteristics was administered in an interview based format by two clinicians on a sample of adult population residing in urban area and rural high altitude areas of Ladakh. Presence of GERD was defined as a score of ≥4 using a previously validated symptom score based on the severity and frequency of heartburn and regurgitation. Other factors studied were body mass index (BMI), oxygen saturation levels by pulse oximetry and serum lipid profile. A multivariate analysis was done to find out risk factors for symptomatic GERD.
Results Of the 905 subjects analyzed, there were 399 (44.1%) men; 469 (51.8%) were from rural background and 722 (79.8%) lived in areas 3,000 m above sea level. Symptomatic GERD was present in 169 (18.7%) subjects. Regurgitation occurred once a week in 34.8% and heartburn occurred in 42.9% of subjects. Sixteen (9.5%) had moderate-severe disease activity while 153 (90.5%) had mild disease. Three hundred and eighty-eight (42.7%) and 315 (34.8%) subjects had symptom of heartburn and regurgitation (at least once a week), respectively. On multivariate analysis, risk factors for GERD were age ≤50 years (OR: 1.508, 95% CI: 1.028–2.213), sedentary lifestyle (OR: 2.78, 95% CI: 1.016–7.638), lower intake of salt tea (OR: 1.663, 95% CI: 1.014–2.726); whereas the protective factors were no intake of meat (OR: 0.841, 95% CI: 0.715–0.990), intake of fresh fruits ≥1/week (OR: 0.631, 95% CI: 0.409–0.973), and serum LDL ≤150 mg/dL (OR: 0.435, 95% CI: 0.218–0.868).
Conclusion This population-based study in a high altitude area in India suggests a high prevalence (18.7%) of GERD. A younger age group, sedentary lifestyle, serum LDL >150 mg/dL, high consumption of meat, low consumption of salted tea and low consumption of fresh fruits were significant risk factors for development of GERD.

Keywords High altitude · Prevalence · Risk factors

Gastroesophageal reflux disease (GERD) is a chronic, relapsing disorder, characterized by reflux symptoms like heartburn and regurgitation, esophageal injury (as reflux esophagitis) and various extra-esophageal symptoms [1]. It is considered to be an emerging digestive disease in Asia. Lower esophageal sphincter pathology seems to be responsible for the acid reflux in many patients. Dietary factors like shorter dinner-to-bed time [2], a high fat diet [3], obesity [4, 5] and smoking [3, 6] have been implicated in increasing the risk for GERD. Other lifestyle factors associated are stress [3, 7, 8], major life events [9, 10] and alcoholism. Furthermore, residents in rural areas and those with a positive family history are associated with a higher risk of GERD [8, 11]. Socioeconomic status and westernized diet though have been postulated as risk factors are not confirmed yet. GERD is responsible for sickness

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absenteeism [12], impaired health-related quality of life [7, 8, 11] and esophageal adenocarcinoma [13] which emphasizes the clinical significance of this entity.

While the approximate prevalence of GERD based on definition of at least weekly heartburn and/or acid reflux is 15–25% in Western countries. Based on same criteria, the prevalence of <5% is reported in the Asian countries. This apparent lower prevalence might be explained by the dearth of studies reporting the prevalence and incidence of GERD in Asian nations [13, 14]. Another reason for the discrepant prevalence rates could be the absence of a universally accepted diagnostic definition of GERD symptom severity and frequency for application in epidemiological studies and as a result definitions differ between studies [13]. In a recent systematic review of GERD in Asian population done in 2005, lack of sufficient epidemiological data from India is apparent [13]. Only two previous Indian studies [15, 16] on the prevalence of GERD were available. These studies gave a weekly prevalence of GERD symptoms in the range of 22–25%. Till date no study is reported which is directed towards evaluating the effect of high altitude on the prevalence or complications of GERD. The current study is an attempt to explore the public health burden of GERD in a high altitude region Ladakh (India) and to analyze the impact of high altitude, lifestyle and dietary risk factors.

Methods

Leh district of Ladakh, the highest plateau of the Indian state of Jammu and Kashmir with much of it being over 3,000 m (9,800 ft.) above sea level between the Kunlun mountain range in the north and the main Great Himalayas to the south. It lies between 32 and 36° North latitude and 75° to 80° East longitude. This was a community based cross-sectional study done from May 2007 to September 2007. The study on prevalence of GERD was part of Neurovascular Epidemiology Project being conducted in rural and urban areas of Leh district of Ladakh. In the Neurovascular Epidemiology Project, random clusters were taken from 9 urban blocks and 57 villages of Leh district of Ladhak.

A total of 905 adult residents (aged 18–70 years) were included in the study of which 436 were from urban and 469 from rural areas. The survey instrument consisted of a previously validated questionnaire that was completed by two trained doctors of the District hospital, Leh [17].

Definitions:

Urban:

(a) All places with a Municipality, Corporation or Cantonment or Notified Town Area.

(b) All other places which satisfied the following criteria:
   (i) a minimum population of 5,000.
   (ii) at least 75% of the male working population was non-agricultural.
   (iii) a density of population of at least 400 sq. Km. (i.e. 1,000 per sq. mile).

Ex-smokers were defined as those smokers who have quit smoking since 2 years prior to data collection.

Physical activity was assessed by asking closed-ended questions about their occupational, domestic, and leisure time. Sedentary physical activity was classified as persons whose job involved desk work or sitting most of the time in urban areas and not involved in agricultural activities in rural areas.

Non-sedentary: Standing all day working, housework such as cooking, cleaning in the house, gardening, agricultural work, walking long distances up and down hills, lifting heavy weights, construction work, manual labor and running.

Vegetarian: Persons who were consuming meat less than once per month. *Non-vegetarian*: Persons who were consuming meat more than once per month.

Salt tea (gur-gur tea) is made of yak butter added to boiling water mixed with salt, soda, milk and an infusion of tea-leaves, called *zarcha*. Butter is considered essential to keep the body warm in the cold climate.

Questionnaire

The questionnaire included 2 sections. The first section elicited the demographic and lifestyle factors and the second section evaluated the symptom score for GERD which was based on the presence and severity of heartburn and regurgitation in the past 1 month. These terms were thoroughly explained to the subjects by word description by the physicians well acquainted in local language.

The demographic details included data on age, sex, urban/rural habitat, income, body mass index (BMI) and waist-to-hip ratio. Lifestyle factors taken into account were information on smoking, alcohol consumption, physical activity and dressing. Dietary factors included intake of normal tea, salt tea, meat, barbequed meat, fresh fruits, and fresh vegetables. Each subject underwent pulse oximetry for SpO_2 and serum samples were analyzed for serum cholesterol, serum triglycerides and low density lipoprotein (LDL).

Assessment of symptom score

Heartburn was defined as a burning sensation behind the sternum in the anterior chest. *Regurgitation* was defined as a bitter or sour tasting fluid spontaneously coming in to the mouth. The severity and frequency of the individual symptoms was used to calculate a symptom score: no

symptoms were given the score of zero, mild symptoms with spontaneous remission not interfering with normal activity and sleep were given score of 1, moderate symptoms with spontaneous but slow remission and mild interference with normal activity and sleep were given score of 2 and severe symptoms without spontaneous remission and marked interference with normal activity and sleep were given score of 3; for the frequency of <2 times/week was given score of 1, 2 to 4 times per week was given score of 2 and more than 4 times per week was given score of 3 whereas absence of symptoms was given score of zero (Table 1). The final score for each symptom i.e. heartburn and regurgitation was obtained by multiplying the scores for severity and frequency [18]. The total score was obtained by adding the final scores of individual symptoms. Thus the final score ranged from 0 to 18. The presence of GERD was defined as a score ≥4 [17]. GERD was further classified as mild, moderate and severe based on the final symptom score range of 4–8, 9–13 and 14–18 respectively.

Determination of lipid profile

Two milliliters of venous blood were drawn from study subjects after a fasting of 12–14 h. Serum was separated by centrifugation at 2,000 rpm for 10 s by a laboratory technician at places of collection (in rural areas) using a portable centrifuge. It was transported in ice packs to Leh and handed over to SRL Ranbaxy Laboratory collection center at Leh for estimation of lipid profile by enzymatic kits and spectrophotometry.

Sample size and sampling

Prevalence of GERD in previous studies varied from 1.8 to 22%. We calculated our sample size according to expected prevalence 22% because it is nearest to 50% and a prevalence of 50% requires the largest sample size. We took precision of 5% presuming the prevalence lies between 10 and 90%. For a precision of 5%, the calculated sample size was 275.

It was proposed to involve adult population aged 20–80 years, of both genders stratified into age groups of 20–29; 30–39; 40–49; 50–59; 60–69; 70–80 years. A social worker from the town was entrusted to enlist total eligible population through house-to-house survey and the subjects were taken from this list by using a randomization table. Due to low density of the villages in all the three main divisions/blocks of District Leh in Ladakh, we considered village as a sampling unit and used cluster of villages in each block to make it as representative a sample as possible. However in each block, participants from smaller villages were invited in a single study center in the block.

Statistical analysis

Categorical variables are presented as frequencies and continuous variables as mean (standard deviation). Categorical variables were compared using chi-square test and continuous variables were compared using Student *t*-test. A univariate and multivariate analysis was done to evaluate for factors predictive of GERD.

Several potential risk factors for GERD symptoms were defined *a priori*: gender (male/female), habitat (rural/urban), age (≤50 yrs/>50 yrs), altitude (>3,500 m), income (<5,000/>5,000 INR/month) diet (vegetarian/non-vegetarian), meat intake (5 categories), barbecued meat (yes/no), SpO_2 (≤90%/>90%), BMI (≤25 kg/m^2/>25 kg/m^2), serum cholesterol (≤200 mg/dL/>200 mg/dL), serum triglycerides (≤150 mg/dL/>150 mg/dL), serum LDL (≤150 mg/dL/>150 mg/dL), waist-hip ratio (≤1/>1), physical activity (sedentary/non sedentary), alcohol intake (<1 per week/≥1 per week), normal tea (no intake/≤5 cups/day/>5 cups/day), salt tea (≤10 cups/day/>10 cups/day), dress (Ladakhi female dress/others), intake of fresh fruits (>1 per week/≤1/week) and intake of fresh vegetables (>1 per week/≤1/week). The dependent variable was symptomatic GERD (present=1/absent=2) and logistic regression models were used to identify the risk factors associated with the presence of GERD. Odds ratios (OR) were obtained and their 95% confidence interval (CI) were used to test the association of GERD with the respective independent variable. p-value<0.05

Table 1 Grading of severity and frequency of symptoms of gastroesophageal reflux disease

Grade	Severity of heartburn and regurgitation	Frequency of heartburn and regurgitation
0	None	Absent
1	Mild symptoms with spontaneous remission. No interference with normal activity and sleep	Occasional (<2 days in a week)
2	Moderate symptoms with spontaneous but slow remission and mild interference with normal activity and sleep	Frequent (2–4 days in a week)
3	Severe symptoms without spontaneous remission and marked interference with normal activity and sleep	Very frequent (>4 days in week)

was considered significant. Stata 10 statistical software (StataCorp LP, Texas USA) was used for analysis.

Results

Of the 905 subjects analyzed, 399 (44.1%) were men, 469 (51.8%) were from rural background and 722 (79.8%) lived in areas 3,000 m (range 2,200–4,000 m) above sea level. The mean age of study subjects was 49.7 (15.5) years and the mean BMI was 22.34 (3.5)kg/m^2.

Prevalence and severity of symptoms

Symptomatic GERD (as defined by GERD score of ≥4), was present in 169 (18.7%) subjects. Of these 169 subjects, 16 (9.5%) had moderate-severe disease activity while 153 (90.5%) had mild disease. One hundred and twelve (23%) of 469 study subjects from rural areas and 57 (13.1%) of 437 urban residents had symptomatic GERD (Fig. 1). Three-hundred and eighty-eight (42.7%) subjects had at least weekly heartburn, while 315 (34.8%) subjects had at least weekly regurgitation (Fig. 2).

Characteristics of patients with symptomatic GERD

In subjects with symptomatic GERD (Table 2), there were significantly more women (p=0.032), rural residents (p<0.001), had a higher serum cholesterol level (p=0.04), consumed barbecued meat (p=0.02), consumed fresh fruits less than once per week (p≤0.001) and fresh vegetables less than once per week (p=0.002) as compared to subjects without GERD respectively. The factors which showed a trend towards significance in GERD as compared to non GERD subjects were a sedentary lifestyle (p=0.07), a female Ladakhi dress which involves tying a tight mid waist band (p=0.052) (Table 3) and higher serum LDL (p=0.06).

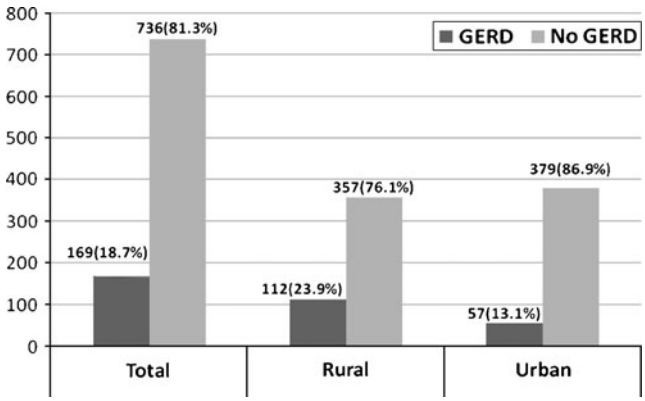

Fig. 1 Prevalence of gastroesophageal reflux disease (GERD) in the community and in rural and urban high altitude areas

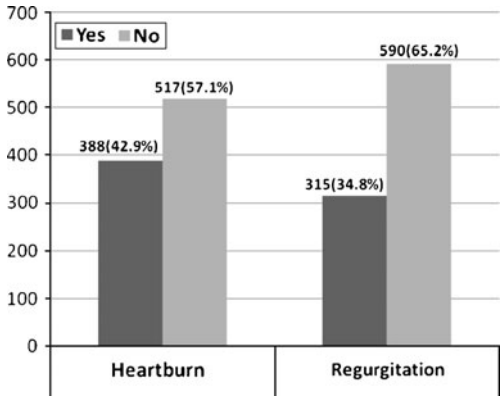

Fig. 2 Frequency of subjects with heartburn or regurgitation (at least once a week)

Factors associated with symptomatic GERD (Table 4)

Factors considered as potential risk factors for GERD on univariate analysis (gender, age, habitat, altitude, physical activity, BMI, waist-to-hip ratio, dress, meat, barbecued meat, fresh fruits, fresh vegetables, salt tea, serum LDL) were subjected to multivariate analysis. On multivariate analysis factors which were predisposing to GERD were age ≤50 years, sedentary lifestyle, lower intake of salt tea, and factors which were protective for symptomatic GERD were: no intake of meat and serum LDL ≤150 mg/dL and intake of fresh fruits >1/week.

Discussion

This is the first study conducted to measure the prevalence of GERD in high altitude areas. The Ladakh province is the highest plateau of the state of Jammu and Kashmir, India with much of it being over 3,000 m (9,800 ft). It spans the Himalayan and Karakoram mountain ranges and the upper Indus River valley. We found the prevalence of symptomatic GERD in this region to be 18.7%. The frequency of symptoms of at least once a week heartburn or regurgitation was as high as 42.9% and 34.8%, respectively. This suggests that Ladakh has a high prevalence of symptomatic GERD.

The prevalence of GERD in Ladhak is higher than the 5% prevalence in Asia shown in other studies in China, Japan and Malaysia [13, 19–22] and considerably higher than approximately 2% shown in Singapore and Iran [23, 24]. Roughly similar prevalence has been found in a recent data from Shiraz, Southern Iran [11] but less than the two previous Indian studies from Chennai [15] and Jaipur [16] which gave a weekly prevalence of 24.4% and 22%, respectively. The prevalence is comparable to the western data as in United States [9] and Finland [25] but is higher

Table 2 A comparison of demographic factors, and biophysical and lipid profile in patients with and without symptomatic gastroesophageal reflux disease (GERD)

	GERD (n=169)	No GERD (n=736)	p-value
Age (in years) Mean (SD) [95% CI]	49.3 (15.2) [46.9–51.6]	49.8 (15.6) [48.6–50.9]	0.69
Sex (female)	107 (63.31)	399 (54.21)	0.032
Rural habitat	112 (66.27)	357 (48.51)	<0.001
Altitude ≥3500 m	85 (50.30)	442 (60.05)	0.020
Income <5000 INR/month	125 (77.16)	514 (74.71)	0.51
BMI (kg/m^2)	22.2 (3.5) [21.65–22.72]	22.4 (3.5) [22.13–22.63]	0.51
Waist-to-hip ratio	0.867 (0.072) [0.856–0.878]	1.016 (3.341) [0.773–1.259]	0.56
Physical activity: Sedentary	7 (4.19)	13 (1.77)	0.07
SpO_2 (%)	89.19 (5.28) [88.38–90.01]	89.64 (4.55) [89.30–89.97]	0.26
Serum cholesterol (mg/dL)	176.98 (37.24) [171.28–182.70]	170.62 (36.43) [167.96–173.29]	0.04
Serum triglycerides (mg/dL)	118.05 (77.82) [106.12–129.97]	113.03 (61.29) [108.54–117.51]	0.36
Serum low density lipoprotein (mg/dL)	100.37 (31.02) [95.58–105.15]	95.50 (30.59) [93.26–97.74]	0.06

Data are as n (%), or mean (SD) [95% CI]

than that in Belgium and Italy [26, 27]. This difference in prevalence may be due to different case definitions of GERD in previous studies which defined GERD as heartburn/regurgitation occurring once [15, 16, 19], twice [20] or thrice [11] weekly. Only one study used symptom score [22] which was different from that used in this study. Moreover in that study, the final diagnosis was made on the basis of endoscopy and 24-hour pH monitoring. Moreover, none of the above studies were carried out on in high altitude areas. Hence, geographic differences cannot be ruled out.

This study was conducted in rural as well as urban representative population. An insignificantly higher number of rural residents had symptomatic GERD as compared to urban residents. Similar results have been found an Iranian study [11] and Chinese study [8]. An Australian study, however, found no difference between rural and urban regions [28].

Table 3 A comparison of lifestyle and dietary factors in patients with and without symptomatic GERD

		GERD (n=169)	No GERD (n=736)	p-value
Alcohol consumption	>1/week	127 (75.1%)	573 (77.8%)	0.47
Tobacco	Smoker	10 (5.92)	39 (5.30)	0.68
	Non-smoker	158 (93.49)	687 (93.34)	
	Ex-smoker	1 (0.59)	10 (1.36)	
Normal tea	No intake	18 (10.71)	72 (9.78)	0.88
	<5 cups/day	130 (77.38)	582 (79.08)	
	>5 cups/day	20 (11.90)	82 (11.14)	
Salt tea	≥10 cups/day	32 (18.93)	155 (21.06)	0.538
Diet (non-vegetarian)		150 (88.76)	665 (90.35)	0.53
Barbecued meat		15 (8.8)	34 (4.6)	0.02
Fresh vegetables	<1/week	12 (7.10)	28 (3.80)	0.002
	<4/week	61 (36.09)	369 (50.14)	
	>4/week	96 (56.80)	339 (46.06)	
Fresh fruits	<1/week	94 (55.62)	277 (37.64)	<0.001
	<4/week	63 (37.28)	388 (52.72)	
	>4/week	12 (7.10)	71 (9.65)	
Meat intake	Nil	18 (10.65)	70 (9.51)	0.161
	1–3/month	42 (24.85)	240 (32.61)	
	1–2/week	47 (27.81)	220 (29.89)	
	2–4/week	38 (22.49)	127 (17.26)	
	>4/week	24 (14.20)	79 (10.73)	
Dress style	Ladhaki/Indian female	90 (53.25)	331 (44.97)	0.052

Data are as n (%)

Table 4 Factors associated with symptomatic GERD on univariate and multivariate analysis

Category		Number (%)	Unadjusted Odds Ratio (95% CI)	Multivariate Adjusted Odds Ratio (95% CI)
Gender	Male	399 (44.1%)	0.686 (0.486–0.968)	0.726 (0.402–1.311)
	Female	506 (55.9%)	1	
Age	≤50 years	496 (54.81%)	1.404 (0.997–1.977)	1.508 (1.028–2.213)
	>50 years	409 (45.19%)	1	
Habitat	Rural	469 (51.8%)	2.086 (1.470–2.961)	1.782 (0.969–3.277)
	Urban	436 (48.2%)	1	
Altitude	≥3500 m	527 (58.2%)	0.673 (0.481–0.942)	1.001 (0.566–1.770)
	<3500 m	378 (41.8%)	1	
Physical activity	Sedentary	20 (2.2%)	1.159 (0.954–6.187)	2.786 (1.016–7.638)
	Non-sedentary	882 (97.8%)	1	
BMI	≤25 kg/m^2	738 (81.55%)	1.377 (0.867–2.187)	1.190 (0.719–1.968)
	>25 kg/m^2	167 (18.45%)	1	
Waist-to-hip ratio	≤1	852 (95.09%)	2.384 (0.841–6.756)	1.563 (0.527–4.640)
	>1	44 (4.91%)	1	
Dress	Ladhaki female	421 (46.5%)	1.394 (0.997–1.949)	1.106 (0.633–1.933)
	Others	484 (53.5%)	1	
Meat	Nil	88 (9.7%)	1	0.841 (0.715–0.990)
	1–3/month	282 (31.2%)	1.469 (0.796–2.712)	
	1–2/week	267 (29.5%)	1.204 (0.656–2.207)	
	2–4/week	165 (18.2%)	0.859 (0.457–1.617)	
	>4/week	103 (11.4%)	0.846 (0.424–1.689)	
Barbecued meat	Yes	49 (5.4%)	2.011 (1.069–3.784)	1.968 (0.813–4.764)
	No	856 (94.6%)	1	
Fresh fruits	>1/week	865 (95.6%)	0.482 (0.343–0.675)	0.631 (0.409–0.973)
	≤1/week	40 (4.4%)	1	
Fresh vegetables	>1/week	534 (59.0%)	0.517 (0.257–1.040)	1.249 (0.434–3.596)
	≤1/week	371 (41.0%)	1	
Salt tea	<10 cups/day	718 (79.3%)	1.142 (0.748–1.745)	1.663 (1.014–2.726)
	≥10 cups/day	187 (20.7%)	1	
Serum low density lipoprotein	≤150 mg/dL	835 (94.46%)	0.547 (0.287–1.043)	0.435 (0.218–0.868)
	>150 mg/dL	49 (5.54%)	1	
Serum cholesterol	≤200 mg/dL	714 (80.5%)	0.776 (0.516–1.166)	
	>200 mg/dL	173 (19.5%)	1	
Serum triglyceride	≤150 mg/dL	718 (80.95%)	0.894 (0.587–1.362)	
	>150 mg/dL	169 (19.05%)	1	

The study also evaluated the various risk factors associated with GERD in the region of Ladakh. The dietary factors associated with GERD included higher intake of meat, lower intake of fresh fruits and lower intake of salt tea. In addition a younger age group with a higher serum LDL levels and a sedentary lifestyle were associated with GERD.

In subjects with GERD, there were a higher number of women (63.1%) on univariate analysis. A higher prevalence in females has been seen in an Iranian study [11] and a study in Northwest China [8]. Another study in southern China showed no difference in the prevalence between males and females [7], as the other studies in west [9, 29, 30]. As against this, some western and Japanese studies showed higher prevalence in men [10, 31, 32].

There was no difference in GERD prevalence in residents staying at altitude ≥3,000 m and those staying at altitudes less than 3,000 m. However, relation of GERD with altitude cannot be ruled out as the subjects residing at the lowest altitude (2,200 m) are residing at a higher altitude relative to the general population of India.

Subjects with age <50 years were more likely to develop GERD. Age has been not found to be a risk factor for

GERD in many previous studies [20, 29, 33–36]. An Australian [28] and a Finnish [25] study had earlier shown increased prevalence with age. Elderly subjects may have severe endoscopic GERD without many symptoms [37–40]. Since the diagnosis of GERD is based on a symptom score, this study probably underestimated the frequency of GERD among elderly people.

The study does not show any relationship between BMI and GERD. Barring one cohort study conducted in New Zealand [41], all other studies have shown increased prevalence with higher BMI [10, 25, 29, 32, 34, 42–46]. Recently, an Iranian study [47] also showed no relationship between BMI and GERD. A sedentary lifestyle may predispose to GERD; previous studies have demonstrated protective effects of physical activity [48, 49]. Obese people have higher prevalence of asymptomatic GERD [50, 51]. Since the diagnosis of GERD is based on a symptom score, the present study may underestimate the frequency of GERD among people with high BMI.

Serum LDL level above 150 mg/dL was found to be a risk factor on multivariate analysis. High level of serum LDL suggests a diet rich in fat, which is a known risk factor for GERD [41]. Consumption of meat was found to be a significant risk factor for GERD confirming the results of a previous German study [49]. Higher fat content of meat may be responsible for this higher risk as fat delays gastric emptying and is a known risk factor. GERD prevalence was found to be higher with the consumption of barbecued meat on univariate analysis.

Increased consumption of fresh fruits progressively had a protective effect. Similar results were found in other studies [8, 10, 11, 32, 48]. The decreased risk of GERD may be related to increased scavenging of nitric oxide [48, 52, 53] (normally produced non-enzymatically in the acidic environment of stomach from the nitrites present in food [48, 54], by the dietary fiber present in fresh fruits). Nitric oxide is a potent relaxant of lower esophageal sphincter [55–57]. Hence, fresh fruits prevent reflux by preventing relaxation of LES.

Fresh vegetable consumption was not found to be a protective factor contrary to previous studies [11], and similar to a German study [49]. The negative result in our study may be attributed to the practice of cooking vegetables in oil-based medium in this part of world. Fat may overcome the protective effect of fiber present in vegetables.

No comparable study on salt tea (gur-gur tea) and its association with GERD could be found. However a study [48] on the effect of increased salt uptake showed contradictory findings with increased risk of GERD with salt consumption. No association has been shown with tobacco smoking or chewing. This is in contradiction with previous studies [25, 48, 49]. No association with alcohol consumption has been shown. Previous studies have given inconsistent results with a Norwegian study showing no association [48] consistent with our results whereas a German study showed alcohol to be a definitive and significant risk factor [49]. Since a large proportion of subjects consumed alcohol and tobacco, negative results to these variables might be related to small sample size of subjects not taking alcohol or tobacco. This limitation may compromise the reliability of the results pertaining to alcohol and tobacco consumption.

Since this is an epidemiological study, using invasive methods such as endoscopy for making the diagnosis of GERD was not feasible. The diagnosis was made on symptoms such as heartburn and acid regurgitation, which are known to be reliable indicators of the disease [58]. The main strength of this cross-sectional study is its interview-based design where the symptoms told by the patients are evaluated by a trained physician thereby reducing the chances of misreporting due to misinterpretation of symptoms by the patient. Moreover, interview based study protocol overcomes the barrier posed by high illiteracy in Asian communities.

Another strength of this study is the objective criteria, based on standardized GERD score, to diagnose the disease. GERD score has been shown to have a very high diagnostic accuracy for GERD [17]. Most other studies have recorded prevalence or quantified symptoms according to frequency and not to severity. The major limitation of our questionnaire was it did not take into account previous drug therapy for GERD or any lifestyle or dietary modification made if the subject had earlier been experiencing GERD.

In conclusion, this population based study in urban and rural areas of a high altitude region in India suggests a high prevalence of GERD. The prevalence was 18.7% when taking into account frequency as well as severity of heartburn and regurgitation every week. A high prevalence of individual symptoms was found. Regurgitation occurred once a week in 34.8% and heartburn occurred once a week in 42.9% of the population. A younger age group, sedentary lifestyle, serum LDL >150 mg/dL, high consumption of meat, low consumption of salted tea and low consumption of fresh fruits were significant risk factors for development of GERD.

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