Published in final edited form as:

Gut. 2009 February ; 58(2): 182–188. doi:10.1136/gut.2008.163360.

Race, ethnicity, sex and temporal differences in Barrett's oesophagus diagnosis: a large community-based study, 1994–2006

D A Corley^{1,2}, A Kubo¹, T R Levin¹, G Block³, L Habel¹, G Rumore⁴, C Quesenberry¹, and P Buffler³

1 Division of Research, Kaiser Permanente, Oakland, California, USA

2 Department of Medicine University of California, San Francisco, California, USA

3 School of Public Health University of California, Berkeley, California, USA

4 Kaiser Permanente, Oakland Medical Center, Oakland, California, USA

Abstract

Objective—To evaluate the demographics and incidence of Barrett's oesophagus diagnosis using community-based data.

Design—Observational study.

Setting—Kaiser Permanente, Northern California health-care membership, 1994–2006.

Patients—Members with an electronic diagnosis of Barrett's oesophagus.

Main outcome measures—Incidence and prevalence of a new Barrett's oesophagus diagnosis by race, sex, age and calendar year.

Results—4205 persons met the study definition for a diagnosis of Barrett's oesophagus. The annual incidence in 2006 was highest among non-Hispanic whites (39/100 000 race-specific member-years, 95% confidence interval (95% CI) 35 to 43), with lower rates among Hispanics (22/100 000, 95% CI 16 to 29), Asians (16/100 000, 95% CI 11 to 22), and blacks (6/100 000, 95% CI 2 to 12). The annual incidence was higher among men than women (31 vs 17/100 000, respectively, year 2006; $p < 0.01$). The incidence increased with age from 2 per 100 000 for persons aged 21–30 years, to a peak of 31 per 100 000 member-years for persons aged 61–70 years (year 2006). There was no increase in the incidence of new diagnoses until the last two observation years, which coincided with changes in data collection methods and may be due to bias. The overall prevalence among active members increased almost linearly to 131/100 000 member-years by 2006.

Conclusions—The demographic distributions of Barrett's oesophagus differ markedly by race, age and sex and were comparable to those for oesophageal adenocarcinoma. Thus, demographic disparities in oesophageal adenocarcinoma risk may arise partly from the risk of having Barrett's oesophagus, rather than from differing risks of progression from Barrett's oesophagus to cancer. There has been an almost linear increase in the prevalence of diagnosed disease.

Correspondence to: Dr D A Corley, Division of Research, Kaiser Permanente, 2000 Broadway, Oakland, CA 94612, USA; E-mail: Douglas.Corley@kp.org.

Competing interests: None.

Ethics approval: The study and analyses were approved by the Kaiser Permanente Institutional Review Board in August 2002

The incidence of oesophageal adenocarcinoma has increased over 500% within the United States during the last three decades, with similar increases noted in other countries. The rates vary substantially by race (more common among Caucasians), gender (more common among men), and geography and are not explained solely by changes in classification.^{1–6} The carcinogenic sequence may progress through several steps, from normal to Barrett's oesophagus to oesophageal adenocarcinoma. Barrett's oesophagus is a metaplastic change in the oesophageal lining that effectively identifies persons at markedly increased risk for oesophageal adenocarcinoma. The annual incidence of oesophageal adenocarcinoma among patients with Barrett's oesophagus is approximately 0.5%, a risk approximately 30- to 40-fold greater than that of the general population.^{7–10} A key question has thus become whether the increased cancer incidence is primarily from an increase in the prevalence of Barrett's oesophagus, from an increased risk of Barrett's oesophagus progressing to oesophageal adenocarcinoma, or whether other cancer pathways are involved.

There is relatively little detailed data on the demographic distribution of Barrett's oesophagus, its temporal changes in incidence, and its overall prevalence within large populations. Such data are challenging to obtain because this disorder is not routinely reported to established registries (unlike cancers) and it requires an upper endoscopy for diagnosis, the utilisation of which may vary by demographic group and over time. Existing studies have limitations, including a relatively small numbers of cases (usually fewer than 300 distributed over several years); the use of single centres or high-risk referral centres (which may not be representative of the general population); minimal information regarding the use of endoscopy (which provides opportunities for diagnosis); no information on the underlying population (needed to calculate incidence rates), or short time intervals for evaluation.^{11–15}

Thus, we analysed the annual incidence and sex/race distributions of new Barrett's oesophagus diagnoses within a large community-based population. These data can help evaluate whether the temporal and demographic differences in cancer incidence may at least be partially explained by demographic patterns of Barrett's oesophagus in the underlying population. Prevalence data would also inform healthcare providers and policy makers about the burden of diagnosed disease.^{16,17}

METHODS

Overview

We conducted a study within Kaiser Permanente, Northern California (KPNC), an integrated health services delivery organisation with a membership of approximately 3.3 million persons in 2007. Members receive almost all care at KPNC facilities and all inpatient and outpatient visits (and their corresponding diagnoses) can be identified electronically. The membership's demographics closely resemble the underlying census population of Northern California.¹⁸ We evaluated all diagnoses of Barrett's oesophagus among current KPNC members for the years 1994–2007 and calculated annual incidence and prevalence rates of a Barrett's oesophagus diagnosis.

Incidence of Barrett's oesophagus

The incidence of new diagnoses for a given year was the number of active members (in that year) with a new Barrett's oesophagus diagnosis divided by the number of person-years in the membership for that year. Each person with a "new diagnosis" met all of the following criteria: (1) no prior known Barrett's oesophagus diagnosis in the KPNC database; (2) at least 1 year of continuous membership in KPNC prior to the diagnosis date, during which time no Barrett's oesophagus diagnosis was recorded (to exclude diagnoses from persons who may have joined KPNC and had pre-existing diagnoses recorded by their primary care providers); (3) at least

18 years of age in the year of diagnosis; and (4) a Barrett's oesophagus diagnosis using the International Classification of Disease, 9th revision (ICD-9) codes 530.2 or 530.85 (which at KPNC were both uniquely coded as "Barrett's oesophagitis"), or the Systematized Nomenclature of Medicine (SNOMED) code 73330 ("Barrett's oesophagus"). Age, sex or race-specific calculations utilised only the person-years from members within each appropriate age, sex or race stratum.

Prevalence of Barrett's oesophagus

Prevalence was defined as the number of active KPNC members with a Barrett's oesophagus diagnosis in a given year divided by the number of person-years in the membership for that year. During 2002, for example, the numerator was the number of persons with the following criteria: a diagnosis of Barrett's oesophagus in 2002 or prior years; health plan member in 2002; and age 18 years or older. The denominator was the total number of person-years contributed to the membership in 2002 for persons aged 18 years or older. Age, sex or race-specific calculations utilised only person-years from members within each stratum.

Data sources

KPNC initiated deployment of an electronic medical diagnosis system for outpatient encounters in 1994; all medical centres were brought into this system by the end of 1995 with all pathology results by 1996. We report prevalence data starting in 1994 and 1995 from those centres with electronic reporting in those years. We report incidence data (new diagnoses of Barrett's oesophagus) starting in 1998, to provide approximately 3 years for the entry of prevalent Barrett's oesophagus diagnoses that predated 1995.

Electronic diagnoses were retrieved from outpatient and pathology encounters; diagnoses for each encounter were entered by physicians and pathologists, respectively. Incidence and prevalence calculations were adjusted for potentially inaccurate electronic diagnoses. A diagnosis of Barrett's oesophagus in the United States is currently defined as the presence of endoscopically visible oesophageal columnar metaplasia, combined with a biopsy demonstrating intestinal metaplasia. A prior detailed medical review of the endoscopy and pathology records for 2378 persons with an electronic diagnosis of Barrett's oesophagus at KPNC found that 61.9% of persons met this rigorous clinical definition. The definition of Barrett's oesophagus excluded patients with oesophageal columnar metaplasia without features of intestinal metaplasia on at least one pathology reading; patients without a biopsy of oesophageal origin; patients without adequate documentation on their endoscopy report of visible changes consistent with Barrett's oesophagus; and persons with biopsies of only a mildly irregular squamo-columnar junction (ie, an "irregular z-line"). Therefore, all incidence and prevalence data presented herein were adjusted by 0.619 to correct for potential diagnostic misclassification and to provide conservative estimates of the incidence and prevalence of Barrett's oesophagus within our population. Race and ethnicity is not recorded for all members. The current analyses utilised categories reported from a combination of sources (hospitalisations, disease registries, member surveys); in total, these provided race data for 81% of member-years ≥ 50 years of age (year 2006).

Bias and confounding

The increased use of endoscopy enhances the potential for a Barrett's oesophagus diagnosis; thus, the time trend analyses adjusted for the number of unique KPNC members receiving an endoscopy in any given year (using the number of persons receiving an upper gastrointestinal endoscopy per 1000 members in 1998 as the baseline rate). For an extreme example, if theoretically twice as many members per 1000 member-years in 2005 received an upper endoscopy (compared with 1998), then the adjusted incidence for 2005 would be half the crude incidence, to account for the increased opportunity for diagnosis that year. Additional adjusted

analyses utilised for reference categories non-Hispanic whites (for race-stratified analyses) and males (for sex-stratified analyses). We also present the number of members with a new Barrett's oesophagus diagnosis per 1000 unique members who received an endoscopy, to permit comparisons with other studies.

We evaluated whether demographic differences in screening for Barrett's oesophagus among groups at higher risk for Barrett's oesophagus (eg, patients with gastro-oesophageal reflux disease (GORD)) explained the disparities seen. We performed a manual review of endoscopy indications among 860 randomly selected patients with a diagnosis of GORD who were frequency matched by age and sex to subjects diagnosed with Barrett's oesophagus between October 2002 and September 2005. All patients with GORD had a prior GORD-related diagnosis code (ICD-9 codes 530.11 (reflux oesophagitis) or 530.81 (gastro-oesophageal reflux)); a prescription for at least 90 days supply of a histamine-2 receptor antagonist or a proton pump inhibitor in the previous year (using electronic pharmacy records); performance of an oesophagogastroduodenoscopy for any indication during the years 2002 through 2005; and no diagnosis of Barrett's oesophagus recorded in the electronic database or in the endoscopy report.

All analyses used Stata version 8.0 (College Station, Texas, USA). Analyses for temporal trends utilised Poisson regression weighted for annual person-year distributions by age, sex and race/ethnicity. Exact confidence intervals were calculated using the Poisson distribution.

19

RESULTS

Overview

A total of 6793 KPNC members received a new electronic diagnosis of Barrett's oesophagus between 1994 and 2006; after adjustment for potential misclassification, this provided 4205 persons who met the study definition for Barrett's oesophagus. An average of 16 387 members per year underwent an upper endoscopic examination between 1998 and 2006 (table 1).

Incidence

Age-specific incidence—The crude incidence of a new Barrett's oesophagus diagnosis increased steadily with age from 2 per 100 000 member-years for persons aged 21–30 years, to a peak of 56 per 100 000 member-years for persons aged 61–70 years (fig 2, year 2006). However, incidence rates adjusted for differences in endoscopy volume by age indicated an incidence of 7 per 100 000 member-years for persons aged 21–30 years, and 31 per 100 000 member-years for persons aged 61–70 years.

Race/ethnicity-specific incidence—The crude incidence rates in 2006 of a Barrett's oesophagus diagnosis were highest among non-Hispanic whites (39/100 000 race-specific member-years, 95% confidence interval (CI) 35 to 43), lowest among blacks (6/100 000 member-years, 95% CI 2 to 12) and Asians (16/100 000 member-years, 95% CI 11 to 22), with an intermediate incidence among Hispanics (22/100 000 member-years, 95% CI 16 to 29). There were no substantial race/ethnicity differences in endoscopy volume (eg, highest among whites 960/100 000 vs lowest among blacks 810/100 000 member-years in 2006) and adjustment for endoscopy volume did not substantially change the incidence estimates.

Sex-specific incidence—The crude incidence rates for a Barrett's oesophagus diagnosis were 31/100 000 sex-specific member-years among men (95% CI 28 to 34) and 17/100 000 member-years among women (95% CI 15 to 20). Women were slightly more likely than men to receive an upper endoscopy (712 women examined per 100 000 female members vs 602

men per 100 000 male members in 2006); adjustment for endoscopy volume only slightly changed the incidence for women to 16/100 000 member-years (using men as the reference group). The crude incidence among a high risk group (non-Hispanic white males aged 61–70; 91/100 000) was much higher than among a low-risk group (black women aged 61–70; 7/100 000).

Temporal incidence trends—The total number of new Barrett's oesophagus diagnoses increased from 298 in 1998 to 574 in 2006; accounting for membership growth, the crude incidence increased from 14.5 per 100 000 member-years in 1998 to 23.8 diagnoses per 100 000 member years in 2006 (p value for trend, <0.01) (table 1, fig 1). Figures adjusted for endoscopy volume increased from 14.5 to 22.9 per 100 000 member years (p value for trend, <0.01), although almost all of this increase occurred during the last 2 years of observation, 2005–2006, which coincided with changes in the method of data collection and may be due to bias (see Discussion).

Prevalence

The prevalence of diagnosed Barrett's oesophagus rose steadily throughout the study interval, reaching 131 per 100 000 member-years in 2006 (fig 3) for the adult population. The prevalence increased with age (440/100 000 member-years by ages 81–90 years in 2006) and it was much higher among men than among women (179 vs 87 diagnoses/100 000 sex-specific member years, respectively, $p < 0.01$ in 2006). The prevalence in 2006 among non-Hispanic whites was 2-fold higher than among Hispanic whites (247 vs 135/100 000 race-specific member-years, respectively, $p < 0.01$), and approximately 5-fold higher than among blacks (49/100 000 member-years, $p < 0.01$) and Asians (65/100 000 member-years, $p < 0.01$) (fig 4).

Cancer incidence by sex and race/ethnicity—A total of 744 patients with oesophageal adenocarcinoma were reported to the Kaiser Permanente, Northern California cancer registry during the study interval. The incidence for each demographic group was: male 4.2/100 000 person-years (95% CI 3.8 to 4.5); female 0.6/100 000 (95% CI 0.4. to 0.7); non-Hispanic whites 4.6/100 000 (95% CI 4.3 to 5.0); Hispanics 1.8/100 000 (95% CI 1.3 to 2.3); blacks 0.5/100 000 (95% CI 0.2 to 0.9). The incidence in the highest risk group (non-Hispanic white males) was 9.7/100 000 (95% CI 8.9 to 10.5) and in the lowest risk group (black females) was 0.2/100 000 (95% CI 0.0 to 0.7). These rates are almost identical to those previously reported from national cancer databases within the United States.⁴

Supplemental analyses

Analyses standardised for age, sex, and race distributions by year provided results for the incidence and prevalence almost identical to those described. The endoscopy volume/rate did not vary markedly between the different demographic groups; thus, changes in demographics over time and endoscopy use did not explain the differences seen.

We evaluated whether demographic differences in screening for Barrett's oesophagus among groups at higher risk for Barrett's oesophagus (eg, patients with GORD) explained the disparities seen. Among 860 patients with GORD undergoing endoscopy for any reason (see Methods), the frequency of a GORD-related indication for the examination was comparable between men and women (42% vs 43%, respectively), and between whites and blacks (40% vs 37%, respectively). These findings suggest that white male patients with GORD (those with the highest incidence of Barrett's oesophagus) did not receive more intensive endoscopic screening, and that demographic differences in screening were unlikely to substantially explain the demographic disparities seen.

DISCUSSION

In a large community-based study, there were several findings. First, the incidence rates for new diagnoses of Barrett's oesophagus and oesophageal adenocarcinoma were much higher among men than among women, and much higher among non-Hispanic whites than other race/ethnic groups, even after accounting for differences in endoscopy rates. Second, the incidence of Barrett's diagnoses has risen moderately over the last decade (adjusted for the use of endoscopy), although much of this increase occurred in the last 2 years of data (see limitations paragraph below). Third, the ongoing new diagnoses, combined with minimal losses of prior patients from death or ceasing enrolment, resulted in an almost linear rise in the prevalence and burden of disease from diagnosed Barrett's oesophagus.

The current data substantially extend existing knowledge about the frequency of new diagnoses of Barrett's oesophagus, demographic distributions of diagnosis, and the potential burden of disease for this condition in a large well defined population. There are few estimates of the true prevalence of Barrett's oesophagus. Among a recent random sample of 1000 persons in Sweden who consented to endoscopy, 16 persons had Barrett's oesophagus (1.6%, 95% CI 0.8 to 2.4).²⁰ An autopsy study in Olmsted County, Minnesota, estimated the prevalence of Barrett's oesophagus that was at least 3 cm in length at approximately 1%.¹² A study of 110 United States reflux-free veterans in a sigmoidoscopy screening programme who consented to an upper endoscopy found an unusually high prevalence (25%) of Barrett's oesophagus;²¹ in contrast, another study in 215 veterans found only one person (0.4%) with Barrett's oesophagus²² and similar small screening studies found proportions as low as 5.6%.^{23 24}

Prior studies have also estimated the frequency of diagnoses within fixed populations. A primary care database study in the Netherlands found 260 diagnoses of Barrett's oesophagus between 1996 and 2003, and reported the incidence increased from 14/100 000 person years in 1997 (95% CI 9 to 22) to 23/100 000 person years (95% CI 17 to 31) in 2002.¹⁵ A study in the same population, using a pathology database, also suggested an increase in the frequency of oesophageal biopsies with changes consistent with Barrett's oesophagus between 1992 and 2003.²⁵ Although the Dutch data did not directly adjust incidence for changes in endoscopy volume, the frequency of diagnosis per 1000 endoscopies also increased. An Australian study contrasted the frequency of diagnosis in 1990 and 2002, and suggested a 6.5-fold increase in the number of diagnoses per 1000 upper endoscopies.²⁶ It was unclear, however, whether such large increases in detection in the Dutch and Australian populations were due to true increases in incidence or changes in detection or classification. A study of 216 patients diagnosed with Barrett's oesophagus over a 7 year period in a mid-Western population in the United States suggested a stable incidence of 33 per 100 000 person-years (95% CI 27 to 38), although there were relatively few cases per year.²⁷

Sex and race differences in the risk of oesophageal adeno-carcinoma are well documented in population-based studies; in the United States, for example, incidence rates among non-Hispanic males are 4-fold higher than those of blacks, double those of Hispanic whites, and 7-fold higher than those of non-Hispanic females.¹⁻⁶ The current study described rates within our population very similar to these national figures. However, detailed demographic differences in the prevalence of Barrett's oesophagus are not well described within large populations. A university hospital study of patients referred for endoscopy found disproportionately more diagnoses of Barrett's oesophagus among non-Hispanic whites (48 patients) than among Hispanic whites (eight patients) or blacks (four patients).²⁸ A study using the Clinical Outcomes Initiative database suggested, among persons receiving an endoscopy for "dyspepsia", that Hispanics, Asians and blacks were less likely to have endoscopic changes suggestive of ≥ 2 cm of Barrett's oesophagus, though no pathology results were available.²⁹ In contrast, a similar study of 75 patients with Barrett's oesophagus found comparable

proportions of Caucasians and Hispanics (5.3% and 3.8%, respectively).³⁰ Case-control studies of approximately 150–300 patients have also suggested lower rates among blacks and women.^{31–33} Limitations of almost all these studies, however, included the lack of population data to calculate diagnosed incidence and prevalence, small numbers of subjects, and no data on demographic differences in access to care or use of endoscopy, which could alone explain the differences seen.

The demographic distributions of Barrett's oesophagus found in the current study, which utilised a large ethnically diverse population with access to care and comparable use of endoscopy across the demographic groups, are fairly comparable to the demographic distributions of oesophageal adenocarcinoma in our population.^{1–6} This finding suggests that the risk of oesophageal adenocarcinoma may be driven, to a large extent, by the distribution of Barrett's oesophagus, rather than primarily by different rates of neoplastic progression between the different demographic groups.

Little is known regarding when Barrett's oesophagus actually develops. The most common age for diagnosis in our population was approximately age 65 years; however, age-specific adjustment for endoscopy volume showed much less variation by age than did the crude results (fig 2). This suggests that a portion of the higher incidence of diagnosis at older ages is due to the larger number of endoscopy examinations among older persons and that many (if not most) persons with Barrett's oesophagus may develop it prior to 50 years of age. This finding has two implications. First, a substantial cohort of younger persons with Barrett's oesophagus may, in the future, enter the higher risk decades for cancer (over age 50). Second, if effective low-risk interventions are developed to decrease the risk of cancer progression, there may be many years or even decades in which persons with Barrett's oesophagus could be identified and treated prior to cancer development.

The main increase in the incidence of diagnosis occurred during the last few years of the observation period. First, a true rise in incidence may partially explain the results. The increasing risk of oesophageal adenocarcinoma and its risk factors (eg, abdominal obesity), might suggest that the incidence of Barrett's oesophagus might also increase. However, this does not explain the marked increase in incidence in the latter few years. Second, if more people with Barrett's oesophagus received an endoscopy, this would lead to an apparent increase in incidence from an ascertainment bias. Although recent surveillance guidelines may have increased awareness, no institutional guidelines have been recently initiated in our population and the figures were adjusted for endoscopy volume. Third, changes in the electronic diagnosis system might cause an artificial increase in the recording of diagnoses. Prior to 2004, each physician manually checked off visit diagnoses on a form with boxes; these data were then scanned into the database. A physician could check off single or multiple diagnoses. Starting in 2003–2004, the medical centres changed to a computer-based system wherein physicians checked off diagnosis boxes directly on a computer. As before, providers could check off single or multiple diagnoses; however, this change may have facilitated the provider's ability to more readily enter multiple diagnoses.

Thus, the rapid incidence rise in the later years may be some combination of a true rise, increased awareness/diagnosis, and increased recording of the diagnoses. There is no clear indication that any of the mechanisms described above, however, would bias estimates by age, sex or race to the magnitude noted.

There are several strengths of the current study. First, the large number of patients with Barrett's oesophagus (4205 subjects) is an order of magnitude larger than prior studies; this provided the power to evaluate rates by year, race, age and sex. Second, the population was community-based and captured all recorded diagnoses, not just diagnoses among persons receiving

screening examinations for GORD. This enhances the applicability of the findings to similar general populations. Third, KPNC members have comprehensive health insurance and member demographics closely parallel the census demographics of the region, which decreases potential diagnostic biases associated with demographics and access to care. Fourth, detailed medical record reviews on over 2300 subjects permitted adjustments for potential misclassification and information on indications for endoscopy. Finally, data allowed evaluation for differences in endoscopy volumes over time and between the different demographic groups, decreasing biases associated with the utilisation of endoscopy.

There are several limitations of our analyses. Most importantly, the data included only persons with a recorded diagnosis of Barrett's oesophagus; since an upper endoscopy is required for diagnosis a possibly substantial proportion of persons with Barrett's oesophagus who had not undergone endoscopy are not included. In addition, the data likely represent the minimum number of persons diagnosed with Barrett's oesophagus, given the strict classification criteria excluded patients without intestinal metaplasia or who only had an "irregular z-line". Some of these patients might be considered to have Barrett's oesophagus given sampling error for biopsies³⁴ or more inclusive classification systems for Barrett's oesophagus.^{35,36}

Since GORD is strongly associated with Barrett's oesophagus, if non-Hispanic whites or men with GORD were more likely to have an endoscopy done for GORD symptoms, an artifactually higher incidence of Barrett's oesophagus might be described in these groups. However, endoscopy rates did not vary markedly between the demographic groups and a manual review of endoscopy reports for indications among 860 patients with GORD suggested comparable proportions of the major demographic groups had GORD as an indication for their examination.

In conclusion, we found the demographic distributions of diagnoses of Barrett's oesophagus by race, ethnicity and gender are relatively comparable to those of oesophageal adenocarcinoma. One of the highest risk groups (non-Hispanic white males aged 61–70) had a 13-fold higher chance of being diagnosed with Barrett's oesophagus than a lower risk group (black women aged 61–70), a difference not explained by disparities in endoscopy rates or endoscopy indications. These findings suggest that cancer risk may be related to the chance of having Barrett's oesophagus, rather than mainly from differing risks of progression from Barrett's oesophagus to cancer within the different demographic groups. The incidence of new diagnoses of Barrett's oesophagus in our population had a possible upward trend, though most of this increase occurred during the last 2 years raising the possibility of a diagnostic bias. Nevertheless, the cumulative annual diagnoses of Barrett's oesophagus led to an almost continuous linear increase in the diagnosed prevalence among active members; this figure represents a rapidly increasing burden of diagnosed disease for patients and physicians. Further studies of the risk of Barrett's oesophagus progression by demographic group are needed to further elucidate potential points for intervention.

Acknowledgements

Funding: United States National Institutes of Health RO1 DK63616, the Kaiser Permanente Research Project on Genes, Environment and Health, and a Kaiser Permanente Community Benefits Grant. *Role of sponsor:* the sponsors reviewed the study design, but had no role in the collection, analysis or interpretation of the data, in the writing of the report, or in the decision to submit the report for publication.

References

1. Pohl H, Welch HG. The role of overdiagnosis and reclassification in the marked increase of esophageal adenocarcinoma incidence. *J Natl Cancer Inst* 2005;97:142–6. [PubMed: 15657344]
2. Corley D, Buffler P. Oesophageal and gastric cardia adenocarcinomas: analysis of regional variation using the Cancer Incidence in Five Continents database. *Intern J Epidemiol* 2001;30:1415–25.

3. Kubo A, Corley DA. Marked regional variation in adenocarcinomas of the esophagus and the gastric cardia in the United States. *Cancer* 2002;95:2096–102. [PubMed: 12412162]
4. Kubo A, Corley DA. Marked multi-ethnic variation of esophageal and gastric cardia carcinomas within the United States. *Am J Gastroenterol* 2004;99:582–8. [PubMed: 15089886]
5. Corley DA, Kubo A. Influence of site classification on cancer incidence rates: an analysis of gastric cardia carcinomas. *J Natl Cancer Inst* 2004;96:1383–7. [PubMed: 15367571]
6. Blot WJ, McLaughlin JK. The changing epidemiology of esophageal cancer. *Semin Oncol* 1999;26:2–8. [PubMed: 10566604]
7. Jankowski JA, Provenzale D, Moayyedi P. Esophageal adenocarcinoma arising from Barrett's metaplasia has regional variations in the west. *Gastroenterology* 2002;122:588–90. [PubMed: 11845805]
8. Reid BJ, Barrett MT, Galipeau PC, et al. Barrett's esophagus: ordering the events that lead to cancer. *Eur J Cancer Prev* 1996;5(Suppl 2):57–65. [PubMed: 9061296]
9. Shaheen NJ, Crosby MA, Bozyski EM, et al. Is there publication bias in the reporting of cancer risk in Barrett's esophagus? [see comments]. *Gastroenterology* 2000;119:333–8. [PubMed: 10930368]
10. Spechler SJ, Jain SK, Tendler DA, et al. Racial differences in the frequency of symptoms and complications of gastro-oesophageal reflux disease. *Aliment Pharmacol Ther* 2002;16:1795–800. [PubMed: 12269973]
11. Cameron AJ, Lomboy CT. Barrett's esophagus: age, prevalence, and extent of columnar epithelium [see comments]. *Gastroenterology* 1992;103:1241–5. [PubMed: 1397881]
12. Cameron AJ, Zinsmeister AR, Ballard DJ, et al. Prevalence of columnar-lined (Barrett's) esophagus. Comparison of population-based clinical and autopsy findings [see comments]. *Gastroenterology* 1990;99:918–22. [PubMed: 2394347]
13. Prach AT, MacDonald TA, Hopwood DA, et al. Increasing incidence of Barrett's oesophagus: education, enthusiasm, or epidemiology? [letter]. *Lancet* 1997;350:933. [PubMed: 9314878]
14. van Blankenstein M, Looman CW, Johnston BJ, et al. Age and sex distribution of the prevalence of Barrett's esophagus found in a primary referral endoscopy center. *Am J Gastroenterol* 2005;100:568–76. [PubMed: 15743353]
15. van Soest EM, Dieleman JP, Siersema PD, et al. Increasing incidence of Barrett's oesophagus in the general population. *Gut* 2005;54:1062–6. [PubMed: 15857935]
16. Devesa SS, Blot WJ, Fraumeni JF Jr. Changing patterns in the incidence of esophageal and gastric carcinoma in the United States. *Cancer* 1998;83:2049–53. [PubMed: 9827707]
17. Blot WJ, Devesa SS, Kneller RW, et al. Rising incidence of adenocarcinoma of the esophagus and gastric cardia [see comments]. *Jama* 1991;265:1287–9. [PubMed: 1995976]
18. Krieger N. Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. *Am J Public Health* 1992;82:703–10. [PubMed: 1566949]
19. Esteve, J.; Benhamou, E.; Raymond, L. Statistical methods in cancer research, volume iv: descriptive epidemiology. International Agency for Research on Cancer; Lyon, France: 1994.
20. Ronkainen J, Aro P, Storskrubb T, et al. Prevalence of Barrett's esophagus in the general population: an endoscopic study. *Gastroenterology* 2005;129:1825–31. [PubMed: 16344051]
21. Gerson LB, Shetler K, Triadafilopoulos G. Prevalence of Barrett's esophagus in asymptomatic individuals. *Gastroenterology* 2002;123:461–7. [PubMed: 12145799]
22. El-Serag HB, Petersen NJ, Carter J, et al. Gastroesophageal reflux among different racial groups in the United States. *Gastroenterology* 2004;126:1692–9. [PubMed: 15188164]
23. Ward EM, Wolfsen HC, Achem SR, et al. Barrett's esophagus is common in older men and women undergoing screening colonoscopy regardless of reflux symptoms. *Am J Gastroenterol* 2006;101:12–7. [PubMed: 16405528]
24. Rex DK, Cummings OW, Shaw M, et al. Screening for Barrett's esophagus in colonoscopy patients with and without heartburn. *Gastroenterology* 2003;125:1670–7. [PubMed: 14724819]
25. Post PN, Siersema PD, Van Dekken H. Rising incidence of clinically evident Barrett's oesophagus in The Netherlands: a nation-wide registry of pathology reports. *Scand J Gastroenterol* 2007;42:17–22. [PubMed: 17190757]

26. Kendall BJ, Whiteman DC. Temporal changes in the endoscopic frequency of new cases of Barrett's esophagus in an Australian health region. *Am J Gastroenterol* 2006;101:1178–82. [PubMed: 16771933]
27. Musana AK, Resnick JM, Torbey CF, et al. Barrett's esophagus: incidence and prevalence estimates in a rural mid-Western population. *Am J Gastroenterol* 2007;103:516–24. [PubMed: 17970839]
28. Abrams JA, Fields S, Lightdale CJ, et al. Racial and ethnic disparities in the prevalence of Barrett's esophagus among patients who undergo upper endoscopy. *Clin Gastroenterol Hepatol* 2008;6:30–4. [PubMed: 18063419]
29. Lieberman D, Fennerty MB, Morris CD, et al. Endoscopic evaluation of patients with dyspepsia: results from the national endoscopic data repository. *Gastroenterology* 2004;127:1067–75. [PubMed: 15480985]
30. Bersentes K, Fass R, Padda S, et al. Prevalence of Barrett's esophagus in Hispanics is similar to Caucasians. *Dig Dis Sci* 1998;43:1038–41. [PubMed: 9590419]
31. Kendall BJ, Macdonald GA, Hayward NK, et al. Leptin and the risk of Barrett's oesophagus. *Gut* 2008;57:448–54. [PubMed: 18178609]
32. Edelstein ZR, Farrow DC, Bronner MP, et al. Central adiposity and risk of Barrett's esophagus. *Gastroenterology* 2007;133:403–11. [PubMed: 17681161]
33. Anderson LA, Watson RG, Murphy SJ, et al. Risk factors for Barrett's oesophagus and oesophageal adenocarcinoma: results from the FINBAR study. *World J Gastroenterol* 2007;13:1585–94. [PubMed: 17461453]
34. Kim SL, Waring JP, Spechler SJ, et al. Diagnostic inconsistencies in Barrett's esophagus. Department of Veterans Affairs Gastroesophageal Reflux Study Group. *Gastroenterology* 1994;107:945–9. [PubMed: 7926484]
35. Murphy SJ, Johnston BT, Murray LJ. British Society of Gastroenterology guidelines for the diagnosis of Barrett's oesophagus: are we casting the net too wide? *Gut* 2006;55:1821–2. [PubMed: 17124164]
36. Playford RJ. New British Society of Gastroenterology (BSG) guidelines for the diagnosis and management of Barrett's oesophagus. *Gut* 2006;55:442. [PubMed: 16531521]

Figure 1.

Incidence of Barrett's oesophagus diagnosis per 100 000 member-years, crude and adjusted for endoscopic volume, by year of diagnosis, 1998–2006. *Endoscopy rate is the number of unique persons per 1000 member-years who received an upper endoscopy in each given year. Vertical bars represent 95% confidence intervals.

Figure 2.

Incidence of the diagnosis of Barrett's oesophagus per 100 000 member-years by age, crude and adjusted for endoscopic volume, year 2006. *Endoscopy rate is the number of unique persons per 1000 member-years within each age interval who received an upper endoscopy in 2006. Age points approximate the centre of each 10 year interval (eg, 65 is the centre of the interval for ages 61–70 years). Vertical bars represent 95% confidence intervals.

Figure 3. Prevalence of diagnosed Barrett's oesophagus per 100 000 member-years by year of diagnosis and sex, 1994–2006. The year 1994 is the first year electronic diagnoses were recorded. Vertical bars represent 95% confidence intervals.

Figure 4.

Prevalence of diagnosed Barrett's oesophagus per 100 000 member-years by year of diagnosis and race and race/ethnicity, 1994–2006. The year 1994 is the first year electronic diagnoses were recorded.

Incidence of Barrett's oesophagus crude and adjusted for endoscopy volume per year in the Kaiser Permanente, Northern California (KPNC) population, 1998–2006

Table 1

Year	Number of members receiving an upper endoscopy per year	Number of members receiving an upper endoscopy per 100 000 member- years	Number of new Barrett's oesophagus diagnoses per year (total)	Incidence of Barrett's oesophagus per 100 000 member- years*	Incidence of Barrett's oesophagus per 100 000 member-years (adjusted for endoscopy volume)	Barrett's oesophagus diagnoses per 1000 members receiving an upper endoscopy
1998	13 080	635	298	14.5	14.5	22.8 (20.27 to 25.55)
1999	14 392	676	291	13.7	12.9	20.2 (17.96 to 22.58)
2000	15 377	704	297	13.6	12.3	19.3 (17.18 to 21.64)
2001	16 585	730	310	13.6	11.8	18.7 (16.67 to 20.89)
2002	17 015	730	363	15.6	13.6	21.3 (19.20 to 23.65)
2003	18 688	795	396	16.8	13.4	21.2 (19.15 to 23.38)
2004	18 906	808	370	15.8	12.4	19.6 (17.63 to 21.67)
2005	17 508	736	478	20.1	17.4	27.3 (24.91 to 29.86)
2006	15 936	660	574	23.8	22.9	36.0 (33.13 to 39.09)

* Number of diagnoses and incidence adjusted for classification (see methods section for details). Confidence intervals for diagnoses per 100 000 member-years are presented in fig 1. CI, confidence interval.