

Incidence and Risk Factors for Self-reported Peptic Ulcer Disease in the United States

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Incidence and risk factors for peptic ulcer disease in the United States have not been well defined. During the 1989 National Health Interview Survey, a population-based sample of 42,392 individuals responded to questions regarding doctor-diagnosed ulcers with confirmation by either an upper gastrointestinal series or endoscopy. Ulcers present during the previous 12 months were considered either incident ulcers if diagnosed during this period or chronic active ulcers if diagnosed more than 12 months before the interview. The incidence of ulcers over the year prior to the interview was 5.27 per 1,000 adults. Whereas incident duodenal ulcer cases represented only 2.4 percent of all persons with a history of duodenal ulcer, the corresponding value for gastric ulcer was 8.7 percent. Risk factors for incident ulcers included increasing age, lower income and educational attainment, and musculoskeletal pain or headache. These were similar to risk factors for chronic active ulcers, except smoking was an additional important risk factor for chronic active ulcers. Thus, incident peptic ulcers are common in the United States but represent a small proportion of persons with a history of ulcer disease. Smoking may be a stronger risk factor for chronic ulcers than for new ulcers. *Am J Epidemiol* 1998;147:529–36.

duodenal ulcer; incidence; peptic ulcer; risk factors

Peptic ulcer is a common disease found worldwide. In the United States, ulcers are a major cause of morbidity and lost productivity (1). Concepts of peptic ulcer disease have undergone radical change over the last 20 years, particularly following the recognition that *Helicobacter pylori* infection was a major contributing factor. Despite greatly expanded knowledge of the pathogenesis and treatment of ulcers, much remains unknown about their occurrence, natural history, and risk factors, particularly on a population or national basis. Incidence and prevalence numbers for peptic ulcer disease in the United States have largely been generated from healthcare plans and have not, strictly speaking, been population based. We have used a digestive disease supplement to the National Health Interview Survey (NHIS) to examine the incidence and risk factors for peptic ulcer disease in the United States.

MATERIALS AND METHODS

Data sources

All data for the present analysis were retrieved from public use data tapes provided by the National Center for Health Statistics that conducts the yearly NHIS. The national sample of the 1989 NHIS was composed of 45,711 households containing 116,929 persons. One randomly selected adult per household was administered a detailed questionnaire on digestive diseases; 42,392 individuals responded to this supplemental questionnaire, of whom 40,729 provided information on ulcers for use in incidence calculations. Respondents answered questions about the time of onset of ulcers, the type of ulcer, the means of diagnosis, and treatment (2). Because the validity of the questionnaire could not be assessed by medical record data, the present analysis was restricted to responses indicating that the ulcer had been diagnosed by a physician with either an upper gastrointestinal series or an upper endoscopy or gastroscopy. If necessary, the following descriptions of these procedures were read. "For an upper gastrointestinal series, you drink a chalky white liquid called barium, and then x-rays are taken. For an upper endoscopy or gastroscopy, a long flexible tube with a light on the end is inserted down the throat so that the lining of the stomach and the upper intestine can be examined."

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Abbreviations: NHIS, National Health Interview Survey; NSAID, nonsteroidal antiinflammatory drug.

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Types of peptic ulcer

Peptic ulcer disease was categorized as follows: 1) gastric or stomach ulcer, 2) duodenal ulcer, 3) unspecified peptic ulcer, and 4) any ulcer (which comprised all types). Ulcers present during the 12 months preceding the interview were further broken down into two types: *incident* ulcers (peptic ulcers that occurred for the first time during this period) and *chronic active* ulcers (active ulcers that relapsed during the 12 months preceding the interview in patients with previously diagnosed ulcer disease). *Prevalent ulcers* equaled the sum of incident and chronic active ulcers. Distinct from prevalent ulcers were *past ulcers*, which were peptic ulcers that had been diagnosed at any point in life but that were not present during the 12 months prior to the interview. There were 204 persons with incident ulcers and 924 with chronic active ulcers, which totaled 1,128 with prevalent ulcers. These and the 2,171 persons with past ulcers gave a total of 3,299 with *any* history of ulcer. Persons who gave no history of ulcers totaled 37,430.

Statistical analyses

The incidence of peptic ulcer was expressed as the number of persons with an ulcer diagnosed in the previous 12 months per 10,000 US adults with no other history of ulcers. Rates were calculated by the PROC DESCRIPT procedure of SUDAAN, which provided estimates of the standard error by incorporating the sample weights and characteristics of the complex sampling design used in the NHIS (3). As a means of accounting for the different age distributions among the various at risk groups, the rates were adjusted to the age distribution of the surveyed population by direct standardization using six age groups (18–34, 35–44, 45–54, 55–64, 65–74, and 75 years and older). Survey sample weights were used to extrapolate the number of respondents to an estimate of US residents with the condition.

For multivariate logistic regression, the PROC LOGISTIC procedure within SUDAAN was used (4). PROC LOGISTIC considers the NHIS weights and the sample design for estimating the variances and covariance in the calculation of odds ratios and their confidence intervals. In all analyses, the occurrence of peptic ulcer served as the outcome variable; modifier variables included age, sex, ethnicity, education, family income, marital status, military service (veteran status), doctor-diagnosed diabetes, body mass index in kg/m², musculoskeletal pain or headache, and cigarette smoking. These potential risk factors were suggested from other studies or were found to be of importance in an examination of prevalent ulcers in

this survey (2). Pain served as a proxy for nonsteroidal antiinflammatory drug (NSAID) use and included a positive response to any of the following four questions. “In the past 12 months have you had a lot of trouble with pain in the joints, pain in the arms or legs other than the joints, backaches, or headaches?” “A lot of trouble” was described to the participant as talking to a doctor or other health professional about the pain, taking medication for the pain more than once, or the pain’s interfering with the participant’s life or usual activities. The influences of the individual modifier variables were expressed as odds ratios and their 95 percent confidence intervals. Smoking status was known for only 50 percent of the respondents who answered a separate supplement regarding diabetes. As a means of avoiding loss of precision from a smaller sample, the logistic regression was performed first for the whole population without including smoking as an independent variable. In a second run, the logistic regression was repeated in the subset of subjects whose smoking status was known.

RESULTS

During 1989, an estimated 52.7 per 10,000 US adults or 840,000 persons reported an incident peptic ulcer (table 1). Of these ulcers, gastric ulcers comprised 32.1 percent, duodenal ulcers 11.8 percent, and the remaining ulcers were unspecified as to type. Persons with incident ulcers represented 6.3 percent of persons with any history of ulcers with a 95 percent confidence interval 5.4–7.3 (figure 1). This proportion differed according to ulcer type; that is, persons with incident gastric ulcers represented 8.7 percent of persons with any history of gastric ulcer (95 percent confidence interval 6.7–11.5), but persons with incident duodenal ulcers represented only 2.4 percent of persons with any history of duodenal ulcer (95 percent confidence interval 1.7–3.5). Similarly, persons with incident duodenal ulcers constituted a smaller fraction of prevalent duodenal ulcers (8.3 percent) than the

TABLE 1. Ulcer incidence in the United States, estimated from the 1989 National Health Interview Survey

| Type of ulcer | Incident cases (× 1,000) | 95% confidence interval (× 1,000) | Incidence (per 10,000) | 95% confidence interval (per 10,000) |
|---------------|--------------------------|-----------------------------------|------------------------|--------------------------------------|
| Any ulcer | 840* | 719–980 | 52.7* | 45.1–61.5 |
| Gastric | 272 | 203–363 | 17.0 | 12.7–22.7 |
| Duodenal | 98 | 67–145 | 6.1 | 4.2–9.0 |
| Unspecified | 485 | 400–591 | 30.4 | 25.1–36.8 |

* A few persons reported more than one type of ulcer. Thus, the total of the individual ulcer types was 855,000, and their incidence total was 53.6/10,000.

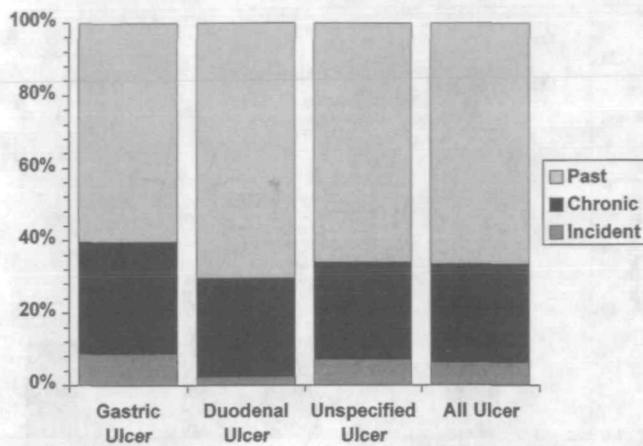


FIGURE 1. Proportions of self-reported gastric, duodenal, unspecified, and all ulcers that were reported as incident, chronic active, or past in the United States, 1989 National Health Interview Survey.

corresponding percent with incident gastric (22.0 percent) or unspecified (21.2 percent) ulcers.

Ulcer risk factors

Subsequent analyses of risk factors were for all ulcers together because of the small numbers of site-specific ulcers. Age was strongly associated with ulcer incidence, increasing from 38.8 per 10,000 at age 18–24 years to 107.7 per 10,000 at age 75 and older (figure 2). Therefore, the incidence of ulcers for other factors was age standardized. Lower socioeconomic status, as represented by low family income (figure 3) and lower educational attainment (figure 4), was strongly associated with incident ulcers. For example, persons who had not attended high school had 4.7 times the incidence of persons who had attended graduate school. Incidence by family income showed a clear separation at \$20,000, with persons having a lower family income having about twice the incidence of ulcers as persons with a family income greater than \$20,000. Participants who reported musculoskeletal pain or headache characteristic of NSAID use had 3 times the incidence of ulcers as did participants without such pain (figure 5). No other factor was strongly related to ulcer incidence. Persons with diabetes (figure 6) and of Hispanic ethnicity (figure 7) both had high incidence relative to their referent groups, but the sample sizes for these groups were relatively small, leading to large standard errors for the incidence estimates. Of note, smokers did not have a higher incidence than did nonsmokers nor was there an association of amount smoked and incidence (figure 5). In contrast, a strong relation was seen for smoking and age-standardized prevalence of chronic active ulcers: 1.8 percent among nonsmokers, 3.0 per-

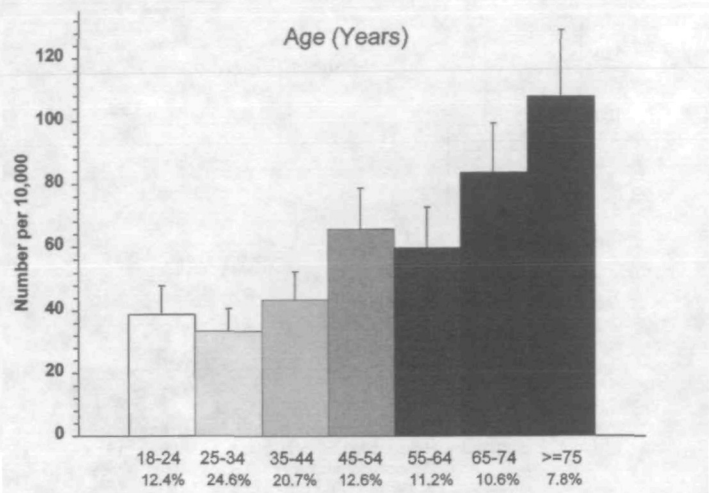


FIGURE 2. Age-specific incidence rates of peptic ulcer in the United States, 1989 National Health Interview Survey. Below each age group is the proportion of respondents at risk in that group.

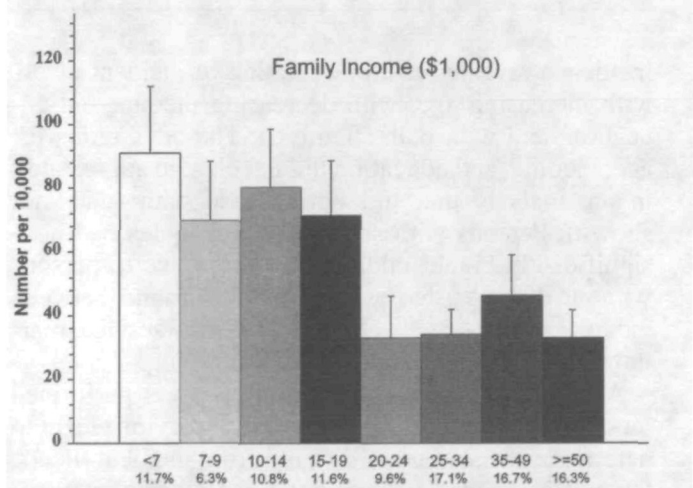


FIGURE 3. Age-adjusted incidence rates of peptic ulcer in the United States, according to yearly family income, 1989 National Health Interview Survey. Below each label is the proportion of respondents at risk in that group.

cent among smokers of less than a pack per day, 3.9 percent among smokers of a pack per day, and 5.3 percent among smokers of more than a pack per day (data not shown).

Multivariate analysis

Further analysis of risk factors was performed with multiple logistic regression analysis in which the outcome variable was incident ulcer versus no history of ulcer. For this analysis, family income was evaluated for persons reporting less than \$20,000 relative to persons with higher income. The only other coding differences from the age-adjusted analysis were that age and body mass index were analyzed as continuous variables. The logistic regression analysis for ulcer

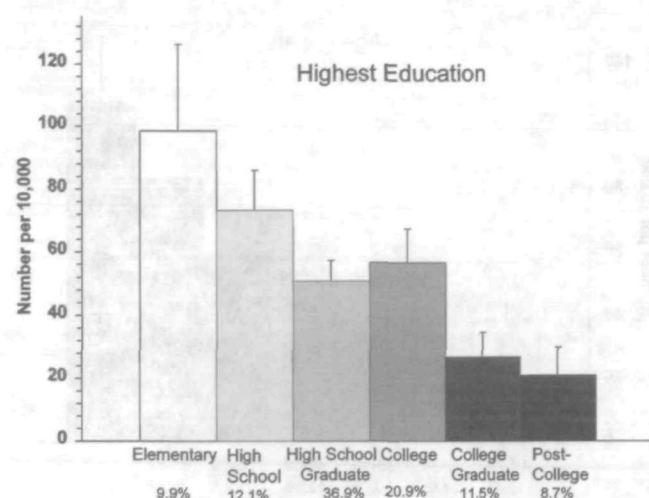


FIGURE 4. Age-adjusted incidence rates of peptic ulcer in the United States, according to educational attainment, 1989 National Health Interview Survey. Below each label is the proportion of respondents at risk in that group.

incidence revealed a strong relation of incident ulcers with increasing age, with decreasing income and education, and with pain (figure 8). The odds ratios for age, income, and education did not change appreciably in an analysis that did not include pain (data not shown). Persons with self-reported diabetes had non-significantly higher odds of ulcers relative to persons without diabetes. No association was found between incident ulcer and sex, ethnicity, military service, marital status, body mass index, and smoking.

An additional multivariate analysis was performed on chronic active ulcers versus no history of ulcers to determine if risk factors differed from incident ulcers. Several important associations were of similar direction and magnitude in these two analyses (figure 8). In particular, age, education, income, and musculoskeletal pain or headache were associated with both incident and chronic active ulcers. Also seen were associations in the multivariate analysis of chronic active ulcers that were not observed in the similar analysis of incident ulcers. These included positive associations for smoking and military service and negative associations for men and Hispanic ethnicity. To evaluate statistically whether the risk factors differed for incident and chronic active ulcers, a further multivariate logistic regression analysis was restricted to persons with prevalent ulcers, meaning incident plus chronic active ulcers (table 2). In this analysis, an odds ratio significantly greater than 1 indicated that a risk factor was found more commonly among persons with incident ulcers than among persons with chronic active ulcers. Only smoking was found to be clearly significant; that is, smokers were much less likely to have incident ulcers than chronic active ulcers relative to

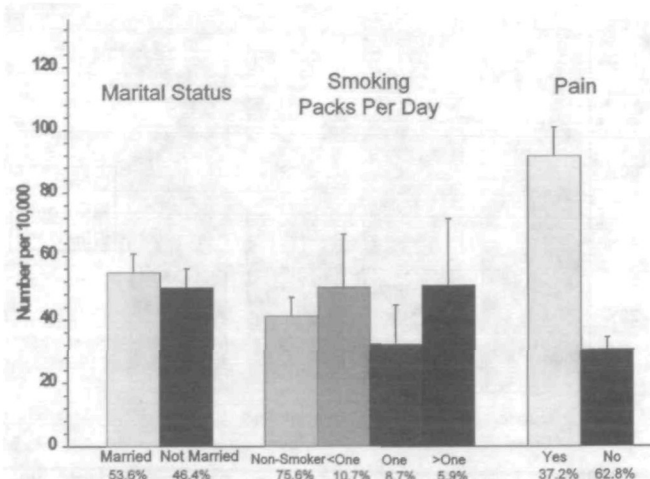


FIGURE 5. Age-adjusted incidence rates of peptic ulcer in the United States, according to marital status, smoking in packs per day, and presence of musculoskeletal or headache pain, 1989 National Health Interview Survey. Below each label is the proportion of respondents at risk in that group.

nonsmokers ($p = 0.006$). Indeed, among persons with prevalent ulcers, heavy smokers (greater than 1 pack per day) were about a third as likely as nonsmokers to have incident ulcers. Thus, there was an increasing likelihood that prevalent ulcers were chronic as the amount smoked increased. In addition, there was a tendency for Hispanic participants to have incident rather than chronic active ulcers when compared with non-Hispanic whites ($p = 0.09$).

DISCUSSION

Most studies of the incidence of peptic ulcer disease have been conducted in northern Europe, many of which have been summarized by Rosenstock and Jorgensen (5). Rates are difficult to compare because of different methods of ascertainment, small number of ulcers, and different age distributions across populations. The estimate of 5.27 per thousand population in the current study was somewhat higher than that found in Denmark in two studies of about 1.6 per thousand and 2.2 per thousand (5–7). In the United States, two incidence studies have been conducted by Kurata et al. in southern California, one among members of a health maintenance organization (8) and the other among Seventh-day Adventists (9). These studies found an annual incidence of peptic ulcer of 1.7 per thousand over 3 years in the Seventh-day Adventists and 0.86 per thousand over 4 years in health maintenance organization members. Other studies have found rates closer to the those in this report. In a population in northern Norway, peptic ulcer incidence was approximately 5 per 1,000 person-years for persons aged 20–54 years (10), although another Norwe-

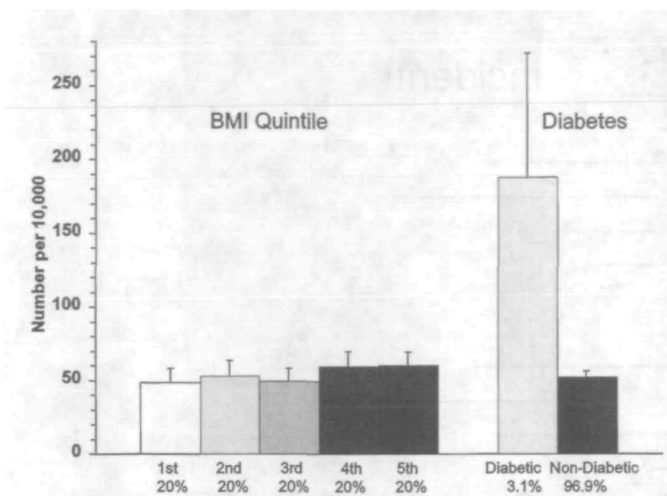


FIGURE 6. Age-adjusted incidence rates of peptic ulcer in the United States, according to quintile of body mass index (BMI) and presence of diabetes, 1989 National Health Interview Survey. Below each label is the proportion of respondents at risk in that group.

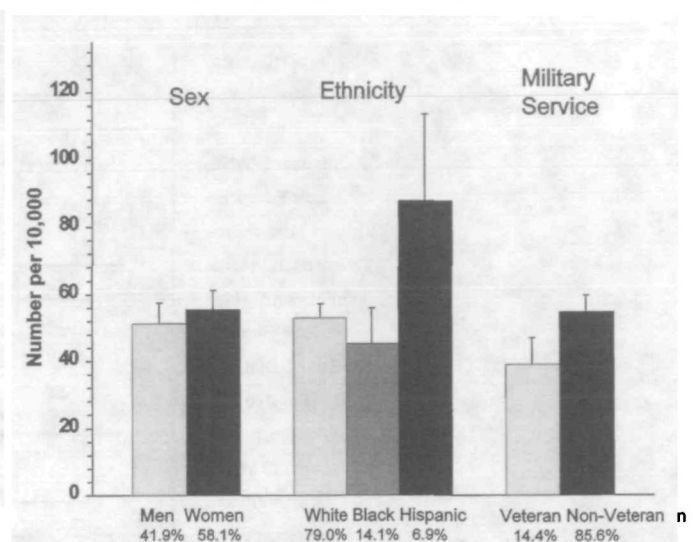


FIGURE 7. Age-adjusted incidence rates of peptic ulcer in the United States, according to sex, ethnicity, and military service, 1989 National Health Interview Survey. Below each label is the proportion of respondents at risk in that group.

gian study covering the same age range found an incidence of 2.1 per 1,000 person-years (11). In an Italian cohort study of persons with dyspepsia but without ulcers at initial esophagogastroduodenoscopy, the subsequent incidence rate of duodenal ulcer was 6.7 per 1,000 person-years (12). In the Faroe islands the annual incidence in 1981–1983 was reported as 3.3 per thousand (13).

Our method of identifying incident ulcers was different from those of other studies. The current study's estimates were based on self-report, whereas most other studies have been based on diagnoses from medical records. To accept a case, we required that the ulcer be physician diagnosed with either a gastrointestinal barium study or upper endoscopy. Nevertheless, we do not know the reliability of the diagnoses because they could not be confirmed by chart review. However, a community-based study of ulcers in Denmark asked nearly identical questions as those of the current study regarding diagnostic procedures and then reviewed endoscopic and radiologic procedure reports of persons who reported ulcer disease (5). Twenty-nine of 35 persons who reported ulcers confirmed by endoscopy or radiology did in fact have a documented diagnostic confirmation of ulcers, for a positive predictive value of 83 percent (S. Rosenstock, Fredericksberg Hospital, Copenhagen, personal communication, 1997). Another potential source of error was reliance on the subject's report for the previous 12 months, which may have led to misclassification of the time of ulcer diagnosis. However, no systematic bias was anticipated in the reporting of the diagnosis of an ulcer present during the prior year. Finally, incidence was determined by retrospective data collection. Persons with incident ulcers who subsequently died or

were hospitalized at the time of the interview would not have been assessed. However, because ulcer mortality rates and the likelihood of hospitalization for ulcer at a given point in time are low, underascertainment for these reasons should have been minimal. We attribute the lack of specificity in ulcer localization (over 50 percent did not specify a site) to not forcing a choice of gastric or duodenal ulcer in the questionnaire. Based on medical care data of about 5 years previous to this survey, it would have been expected that a majority of the unspecified ulcers would have been duodenal ulcers (1).

Persons with incident duodenal ulcers were found to be a small proportion of persons with any history of duodenal ulcer (2.4 percent), particularly when compared with the proportion of any gastric ulcers that were incident cases (8.7 percent). In addition, the incidence of duodenal ulcers was only about a third that of gastric ulcers, whereas, historically, the rate of duodenal ulcers has been higher than that of gastric ulcers (1). Such a pattern would be expected if the incidence of duodenal ulcers had declined substantially relative to gastric ulcers, resulting in a larger reservoir of persons with past duodenal than past gastric ulcers relative to the incidence of these two conditions. The more dramatic decline in medical care for duodenal than for gastric ulcers over the last two decades gives some credence to this inference (1, 14).

The current study also provides insight into risk factors for incident ulcers. The finding that age was a risk factor for incident ulcers is significant because many studies that have found an association of age with ulcers have not separated chronic active from

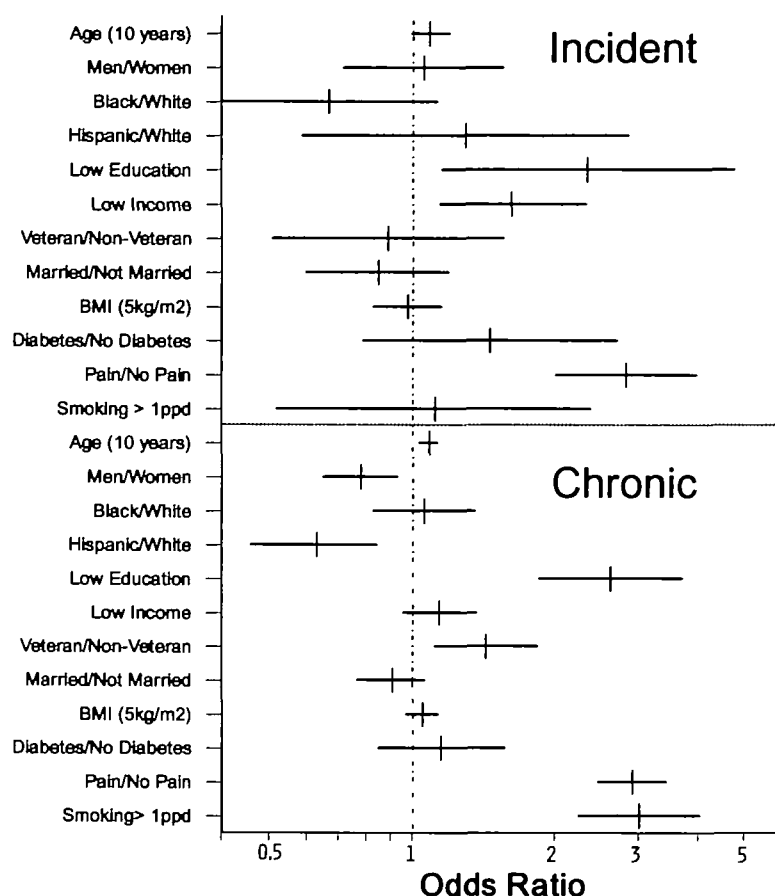


FIGURE 8. Multivariate odds ratios and 95% confidence intervals for risk factors for incident (top) and chronic active (bottom) self-reported peptic ulcer in the United States, 1989 National Health Interview Survey. BMI, body mass index; ppd, pack per day.

incident ulcers. For the oldest age group, age 75 years and older, more than 1 percent of persons reported an incident ulcer in the previous year. This high risk of ulcer in the elderly is particularly important because of the high morbidity associated with ulcers in this age group (15). The increasing incidence with age is also supportive of the birth cohort effect for peptic ulcer, in which age-specific mortality has been found to decline with successive decades of birth in this century (1).

As regards risk factors other than age, low socioeconomic status is an acknowledged risk factor for peptic ulcer (1), and it is also associated with infection with *Helicobacter pylori*, an important pathogen for peptic ulcers (16). The relatively equal risk of incident ulcers for men and women reflects a long-term trend in the changing demographic patterns of peptic ulcer (1, 5, 9, 15). Peptic ulcer incidence among diabetics was higher than that among nondiabetics. This elevated risk was not statistically significant and may have been subject to ascertainment bias, as the information on diabetes diagnosis was obtained by self-report. Nevertheless, these results do not indicate that diabetics are at low risk of ulcers, as has been suggested (17).

They are also in keeping with the results of other national surveys (18). Overweight, as estimated by body mass index, had no relation to ulcer incidence and did not confound the association of diabetes and peptic ulcer. Musculoskeletal pain and headaches were strongly associated with ulcer. Musculoskeletal pain and headache, which are known to be strong risk factors for peptic ulcers (19–21), were used as a proxy for the use of NSAIDs. However, the temporal relation between the pain and ulcer occurrence could not be established nor can such pain be considered an exact proxy for drug use. For example, it is possible that participants with ulcers developed more severe musculoskeletal pain because of a need to stop consuming ulcerogenic analgesics. Of interest, the strength of the association of age with incident ulcers changed little when controlling for pain. Thus, the increase in ulcer disease with aging may not be entirely due to increased use of NSAIDs.

We were also interested in determining if risk factors were the same for incident ulcers as for chronic active ulcers. Peptic ulcers tend to recur over many years (22), and factors responsible for ulcer incidence

TABLE 2. Risk factors for incident peptic ulcer, confined to persons with prevalent ulcer (incident and chronic active ulcer) in the United States, 1989 National Health Interview Survey

| Risk factor* | Odds ratio | 95% confidence interval | p value |
|--|------------|-------------------------|---------|
| Age (per 10 years) | 1.01 | 0.90–1.13 | 0.87 |
| Less than high school (greater than college education) | 1.05 | 0.48–2.27 | 0.90 |
| Men (women) | 1.34 | 0.86–2.08 | 0.20 |
| Non-Hispanic black (non-Hispanic white) | 0.63 | 0.35–1.14 | 0.13 |
| Hispanic (non-Hispanic white) | 1.95 | 0.91–4.17 | 0.09 |
| Income less than \$20,000 (at least \$20,000) | 1.40 | 0.92–2.12 | 0.11 |
| Veteran (nonveteran) | 0.64 | 0.34–1.20 | 0.17 |
| Not married (married) | 0.94 | 0.64–1.39 | 0.77 |
| Body mass index (per 5 kg/m ²) | 0.94 | 0.80–1.10 | 0.42 |
| Diabetic (nondiabetic) | 1.02 | 0.51–2.03 | 0.57 |
| Pain (no pain) | 0.93 | 0.64–1.35 | 0.71 |
| Smoked greater than 1 pack/day (nonsmoker) | 0.32 | 0.14–0.72 | 0.006 |

* Referent group in parentheses.

may differ from those that prevent healing or that precipitate relapse in a person with ulcer diathesis. We found that most risk factors were the same for ulcer incidence and for chronic active ulcers, particularly age, lower family income and educational attainment, and musculoskeletal pain and headache. However, cigarette smoking stood out in the comparison of incident and chronic ulcers. Neither the presence of smoking nor the amount smoked was associated with ulcer incidence. In contrast, smoking showed a strong stepwise association with chronic active ulcers. Numerous studies have found a relation of smoking and ulcer recurrence and delayed healing (23–29). Although some studies have also suggested that smoking might also be a risk factor for incident ulcers (30, 31), our analysis suggests that smoking may be more important in the perpetuation of ulcers than in their initial occurrence. Hispanic participants appeared to have a disproportionate number of incident ulcers. It is possible that, in the past, peptic ulcer may not have been common among Hispanics, but recently the incidence has been rising for Hispanics relative to non-Hispanic whites. It is also possible that the differences in ethnicity regarding incident and chronic active ulcers could have resulted from different cultural interpretations of the questions.

All ulcers required doctor diagnosis with appropriate diagnostic procedures, which are usually not performed unless the patient has symptoms. However, neither incident nor chronic active ulcers are necessar-

ily symptomatic, which might have led to the underreporting of ulcers. On the other hand, symptomatic persons with previously documented ulcers may not undergo repeated diagnostic reevaluation; instead, they may be treated based on the recurrence of ulcer symptoms, which could have led to overreporting chronic active ulcers. In any event, it is unlikely that misreporting chronic active ulcers would have strongly biased our evaluation of risk factors for ulcers.

In conclusion, this national population-based study measured the incidence of peptic ulcers in the United States. Additionally, we found evidence for the following: duodenal ulcer incidence is declining faster than gastric ulcer incidence; incident ulcers are associated with increasing age, low socioeconomic status, and painful conditions associated with the use of NSAIDs; and cigarette smoking is associated with chronic active ulcers but not incident ulcers.

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