Gastrointestinal Tract Symptoms Among Persons With Diabetes Mellitus in the Community

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Background: Gastrointestinal (GI) tract symptoms are common among patients with diabetes mellitus (DM) seen in tertiary care centers. The degree to which this reflects referral bias is unclear.

Objectives: To determine whether GI tract symptoms are more prevalent in unselected patients with DM from the general community compared with their age- and sex-matched counterparts without DM and to assess the association of GI tract symptoms in persons with DM with psychosomatic symptoms, medication use, and symptoms of autonomic neuropathy.

Methods: In this population-based, cross-sectional study, Olmsted County, Minnesota, residents with type 1 DM, a random sample of residents with type 2 DM, and 2 age- and sex-stratified random samples of nondiabetic residents (total of 1262 person for the 4 groups) were mailed a previously validated symptom questionnaire.

Results: Heartburn was less common in residents with type 1 DM vs controls (12% vs 23%; P<.05). No significant difference in prevalence was detected (residents with type 1 DM vs controls; residents with type 2 DM vs controls) for nausea or vomiting (12% vs 11%; 6% vs 6%), dyspepsia (19% vs 21%; 13% vs 17%), or constipation (17% vs 14%; 10% vs 12%). However, constipation and/or laxative use was slightly more common in residents with type 1 DM (27% vs 19%; P<.15), particularly in men, and was associated with the intake of calcium channel blockers.

Conclusions: In the community, the prevalence of most GI tract symptoms is similar in persons with or without DM, except for a lower prevalence of heartburn and an increased prevalence of constipation or laxative use in residents with type 1 DM, especially in men. This difference is associated with calcium channel blocker use rather than symptoms of autonomic neuropathy. In community-based practices, physicians should not immediately assume that GI tract symptoms in patients with DM represent a complication of DM.

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The affiliations of the authors appear in the acknowledgment section at the end of the article.
SUBJECTS AND METHODS

STUDY SETTING

Population-based research is feasible in Olmsted County, Minnesota, because medical care is virtually self-contained within the community and provided by the Mayo and Olmsted County medical centers. Most endocrinologic care, is provided by the Mayo Clinic, Rochester, which has maintained a common medical record with its 2 large affiliated hospitals (Saint Mary’s and Rochester Methodist) for over 90 years. Recorded diagnoses and surgical procedures are indexed, including the diagnoses made for outpatients seen in office or clinic consultations, emergency department visits, or intravenous home, as well as the diagnoses recorded for hospital inpatients, at autopsy examination, or on death certificates. Medical records of the other physicians who serve the local population of approximately 100,000 people, most notably the Olmsted Medical Center, are also indexed and retrievable. Thus, details of the medical care provided to the residents of Olmsted County are available for study through this unique medical records linkage system, the Rochester Epidemiology Project (REP).

STUDY SUBJECTS

Following approval by the Mayo Foundation and Olmsted Medical Center Institutional Review Boards, the present study used these REP resources to identify potential subjects: type 1 DM and type 2 DM cases and controls, aged 18 to 75 years, and residing in Olmsted County in 1995. The method of identification of cases of DM is described in detail elsewhere. The REP diagnostic index is used to generate a list of Olmsted County residents assigned a clinical diagnosis of DM or DM-like condition during the study period. The complete inpatient and outpatient community-based medical records of these individuals are then reviewed to confirm case status. Diagnostic criteria for DM closely follow National Diabetes Data Group Investigators’ recommendations and consist of 2 consecutive fasting glucose levels of 7.8 mmol/L or higher (≥140 mg/dL) or 1- and 2-hour levels of 11.1 mmol/L or higher (≥200 mg/dL) obtained during a standard oral glucose tolerance test. The levels are based on the autoanalyzer ferrocyanide reductase technique for plasma, the method used at the Mayo Clinic since May 1972. Glucose values and case definitions are standardized over time to account for secular changes in diagnostic criteria and laboratory methods. Persons who fail to meet these criteria but for whom oral agents or insulin are used for at least 2 weeks also qualify as cases. Persons are classified as having type 1 DM or type 2 DM using an algorithm described in previous studies. Persons are classified as having type 1 DM if age at diagnosis of DM (ie, fulfillment of National Diabetes Data Group Investigators’ criteria) is younger than 20 years, or if they meet the following 3 criteria: (1) body mass index at diagnosis for men less than 27.8 kg/m² and for women less than 27.3 kg/m²; (2) insulin therapy within 2 weeks of diagnosis and continued for at least 1 year or until death; and (3) evidence of ketones in serum or urine samples. Conversely, persons who are older than 20 years at diagnosis and do not meet all criteria for type 1 DM are classified as having type 2 DM.

To assist in identifying Olmsted County residents with DM in 1995, the present study took advantage of the previous identification of all individuals who met the National Diabetes Data Group Investigators’ criteria and were residing in Rochester (Rochester is the Olmsted county seat) as of January 1, 1990. The 1990 study excluded county residents who lived outside of Rochester or persons who moved into the county or were diagnosed with DM after January 1, 1990. In the present study, the list of 1990 prevalence cases was supplemented with the list of persons assigned a diagnosis of DM or DM-like condition in the REP diagnostic index from 1945 through 1995. Persons known to be deceased or who were younger than 18 years or older than 75 years as of January 1, 1995, were excluded.

The protocol aimed to obtain at least 150 persons in each group (ie, residents with type 1 DM, residents with type 2 DM, controls with type 1 DM, and controls with type 2 DM), which would provide a maximum SE of 4% for each specific proportion. To obtain the required sample of cases with type 1 DM, all individuals in the combined list with a known clinical type 1 DM from the 1990 study were identified. The complete medical records of these cases plus those for a random sample of the remaining individuals in the combined list were reviewed. Persons not residing in Olmsted County in 1995, those who underwent major abdominal surgery (other than appendectomy or cholecystectomy), those with a history of GI cancer or inflammatory bowel disease, or those with recent peptic ulcer disease were excluded as eligible study subjects. Non–English-speaking individuals (<2% of Olmsted County residents) and those with major psychiatric diagnoses that were considered likely to influence the ability to answer questions (ie, psychosis or dementia) were also excluded. For those individuals for whom case status and clinical type (type 1 DM vs type 2 DM) were not obtained in the 1990 study, this information was also obtained; those who did not meet the National Diabetes Data Group Investigators’ criteria for DM were excluded.

Rochester Epidemiology Project resources were also used to identify controls. The REP provides what is essentially an enumeration of the population from which samples can be drawn. Each year, over 80% of the local population is attended by the Mayo Clinic or the Olmsted Medical Center; in any 3-year period, over 95% of Olmsted County residents are seen at least once at the Mayo Clinic or the Olmsted Medical Center. Using this database, 2 separate samples of Olmsted County residents were drawn at random. The samples were age- and sex-stratified to approximate the age and sex distributions of the residents with type 1 DM and type 2 DM, respectively. The complete medical record of each potential control was reviewed to confirm that they did not meet criteria for DM prior to 1995, they resided in Olmsted County in 1995, and they met none of the other exclusionary criteria listed earlier.

A questionnaire (described in the following section) was mailed to all eligible persons with type 1 DM (n = 261). For the samples of persons with type 2 DM and the nondiabetic controls, questionnaires were mailed to people in the order in which they were randomly selected until at least 150 persons responded. Thus, surveys were mailed to 378 eligible persons with type 2 DM, 380 eligible controls with type 1 DM, and 355 eligible controls with type 2 DM, for a total of 1374 potentially eligible subjects for the entire study. Repeated mailings were sent to the remaining nonresponders at 2, 4, and 6 weeks after the first mailing. A total of 112 surveys (8%) were returned with no forwarding address. The response...
In the community, GI tract symptoms are common regardless of whether a person has DM, and autonomic neuropathy is rare. The only controlled population-based study to date involved subjects with DM aged 45 to 64 years; this only included 89 subjects with type 1 DM. Consequently, we were concerned that GI tract symptoms in community-dwelling persons with DM were being inappropriately attributed to DM (“diabetic neuropathy is rare.”)

Thus, the previous literature suggests that GI tract symptoms and autonomic dysfunction are both common in the DM clinics of tertiary referral centers; however, symptoms and neuropathy are not always related. In the community, GI tract symptoms are common regardless of whether a person has DM, and autonomic neuropathy is rare. The only controlled population-based study to date involved subjects with DM aged 45 to 64 years; this only included 89 subjects with type 1 DM. Consequently, we were concerned that GI tract symptoms in community-dwelling persons with DM were being inappropriately attributed to DM (“diabetic neuropathy is rare.”)
Our aims were to determine whether GI tract symptoms are more prevalent in unselected patients with DM from the general community compared with their age- and sex-matched counterparts without DM and, furthermore, to assess the association of GI tract symptoms in persons with DM with psychosomatic symptoms, medication use, and symptoms of autonomic neuropathy.

RESULTS

CHARACTERISTICS OF STUDY POPULATIONS

Table 1 lists the demographics of the study population. As expected, residents with type 1 DM had a younger median age and longer median duration of their disease than residents with type 2 DM. Residents with type 1 DM were also slightly younger (median age, 40 years vs 44 years for controls; \( P,.05 \)), less likely to drink alcoholic beverages (\( P,.05 \)), and slightly less likely to be married (\( P=.07 \)) than their matched controls. In comparison with their corresponding controls, residents with type 2 DM were less likely to drink alcoholic beverages (\( P,.05 \)) and fewer were college graduates (\( P,.05 \)). No significant sex differences were noted between subgroups.

PSYCHOSOMATIC SYMPTOMS CHECKLIST SCORES

Women had higher Psychosomatic Symptom Checklist scores than men (\( P<.001 \)). Women with type 2 DM had the highest scores, although the differences in scores by sex between residents with DM and their respective controls were not statistically significant. Among women, the mean (\( \pm SE \)) Psychosomatic Symptom Checklist scores were 0.6 (\( \pm 0.06 \)) for residents with type 1 DM, 0.6 (\( \pm 0.05 \)) for controls with type 1 DM, 0.7 (\( \pm 0.06 \)) for residents with type 2 DM, and 0.6 (\( \pm 0.04 \)) for controls with type 2 DM. Among men, the values were 0.5 (\( \pm 0.06 \)) for residents with type 1 DM, 0.5 (\( \pm 0.05 \)) for controls with type 1 DM, 0.6 (\( \pm 0.04 \)) for residents with type 2 DM, and 0.5 (\( \pm 0.05 \)) for controls with type 2 DM.

As in previous studies, the Psychosomatic Symptom Checklist score was significantly associated with the reporting of individual GI tract symptoms (\( P<.01 \)). However, no sex prevalence by Psychosomatic Symptom Checklist score interaction was detected, ie, the overall association between reporting GI tract symptoms and Psychosomatic Symptom Checklist scores was similar in men and women. The associations between Psychosomatic Symptom Checklist score and symptoms are given for constipation and heartburn in Table 2.

MEDICATION USE

Table 3 lists the distribution of selected medication use in the study population. Overall, patients with DM tended to use laxatives more than their corresponding controls. This was most evident in men with type 1 DM (\( P<.05 \)), even though women used laxatives much more overall (21.7% in women vs 6.9% in men). For both type 1 and type 2 DM, less acid-reducing medication was used by the residents with DM (\( P<.05 \)). Calcium channel blockers were more commonly used among residents with either type of DM than among corresponding controls (\( P<.05 \)). Antacid use was less frequent among residents with DM (both type 1 and type 2 DM) than their respective controls (\( P<.05 \)). Residents with type 1 DM were less likely to use nonsteroidal anti-inflammatory drugs than their respective controls (\( P<.05 \)), whereas there was no difference in nonsteroidal anti-inflammatory drug (NSAID) use between residents with type 2 DM and their respective controls. Among residents with type 2 DM, 55% used insulin for optimal management of DM, but they did not fulfill diagnostic criteria for type 1 DM.
Table 2. Prevalence of Selected Gastrointestinal Tract Symptoms and Medication Use by Psychosomatic Symptom Checklist (PSC) Score

<table>
<thead>
<tr>
<th>PSC Score</th>
<th>Constipation and/or Laxative Use</th>
<th>Heartburn + Medication Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Females</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 1 diabetes mellitus (DM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low* (n = 38)</td>
<td>13</td>
<td>29</td>
</tr>
<tr>
<td>High* (n = 39)</td>
<td>21</td>
<td>31</td>
</tr>
<tr>
<td>Type 2 DM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (n = 36)</td>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>High (n = 61)</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>All controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (n = 81)</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>High (n = 120)</td>
<td>22</td>
<td>37</td>
</tr>
<tr>
<td><strong>Males</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 1 DM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (n = 33)</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>High (n = 23)</td>
<td>17</td>
<td>26</td>
</tr>
<tr>
<td>Type 2 DM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (n = 54)</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>High (n = 61)</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>All controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low (n = 99)</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>High (n = 77)</td>
<td>9</td>
<td>16</td>
</tr>
</tbody>
</table>

*PSC score indicates less than or equal to the median value PSC score for all subjects; high PSC score, greater than or equal to the median value PSC score for all subjects.

Table 3. Prevalence of Medication Use Among Residents of Olmsted County, Minnesota, With Diabetes Mellitus (DM) Compared With Their Respective Community Controls*

<table>
<thead>
<tr>
<th>Medication</th>
<th>Type 1 DM (Patients = 138)</th>
<th>Controls (n = 170)</th>
<th>Type 2 DM (Patients = 217)</th>
<th>Controls (n = 218)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laxative use</td>
<td>15.9</td>
<td>10.0</td>
<td>17.0</td>
<td>14.7</td>
</tr>
<tr>
<td>Antacids (aluminum and others)</td>
<td>10.9†</td>
<td>20.0</td>
<td>12.0†</td>
<td>23.9</td>
</tr>
<tr>
<td>Histamine₂-blockers</td>
<td>5.1</td>
<td>6.5†</td>
<td>9.2</td>
<td>12.4</td>
</tr>
<tr>
<td>Proton pump inhibitors</td>
<td>0.5</td>
<td>0.6</td>
<td>0</td>
<td>1.4</td>
</tr>
<tr>
<td>Prokinetics</td>
<td>1.5</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>Calcium channel blockers</td>
<td>5.8†</td>
<td>1.2</td>
<td>18.9†</td>
<td>8.7</td>
</tr>
<tr>
<td>α₂-Adrenergic blockers</td>
<td>2.9</td>
<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Insulin</td>
<td>96.4</td>
<td>...</td>
<td>54.8</td>
<td>...</td>
</tr>
<tr>
<td>NSAIDs</td>
<td>35.5</td>
<td>53.5</td>
<td>54.4</td>
<td>61.5</td>
</tr>
</tbody>
</table>

*All values are expressed as percentages. Ellipses indicate not applicable. †P < .05 (univariate association for diagnosis pairs).
‡One control subject with type 2 DM reported insulin use.
§NSAIDs indicates nonsteroidal anti-inflammatory drugs.

**PREVALENCE OF GI TRACT AND NEUROLOGIC SYMPTOMS**

Table 4 gives the prevalence of GI tract symptoms in persons with DM and matched controls residing in Olmsted County. The prevalence of GI tract symptoms among residents with type 2 DM and type 1 DM was similar to that among community controls of similar age and sex in each instance, except for decreased heartburn in residents with type 1 DM (P < .05). The prevalence of dyspepsia, nausea, vomiting, IBS, dyschezia, or fecal incontinence was not significantly different in residents with either type 1 or type 2 DM relative to their respective controls. No subjects met the definition of diarrhea.

As also given in Table 4 type 2 DM was associated with symptoms of peripheral neuropathy, specifically numbness in any part of the body (P < .01) and weakness of the muscles of the extremities (P < .05). No difference was noted in the prevalence of autonomic symptoms overall among the groups studied, although residents with type 1 DM were more likely to report insufficient sweating.

**CONSTIPATION**

The combination of constipation and/or laxative use was somewhat more common among residents with type 1 DM than their respective controls (26.8% vs 19.4%), but was similar between residents with type 2 DM and their respective controls (22.6% vs 21.6%). Subjects taking calcium channel blockers had greater odds (relative to those not taking calcium channel blockers) for reporting constipation or laxative use...
(P<.05). Also, residents with higher Psychosomatic Symptom Checklist scores and women overall reported constipation and/or laxative use more often (P<.005 and P<.001, respectively). Though overall both subgroups of residents with DM reported constipation and/or laxative use more often than their respective controls (26.8% and 22.6% vs 20.6%), the odds for constipation and/or laxative use in residents with type 1 DM (relative to their respective controls) depended on sex and Psychosomatic Symptom Checklist score (P<.05 for both interaction terms).

**Table 5** lists the effects of DM, sex, Psychosomatic Symptom Checklist score, and constipating drug use on the reporting of constipation and/or laxative use. Males with type 1 DM reported greater constipation and/or laxative use relative to male controls, both in the absence (OR = 3.53, 95% CI, 1.52-8.19) and the presence (OR = 2.92, 95% CI, 1.28-6.64) of constipating drugs. In contrast, the ORs for constipation and/or laxative use in females with type 1 DM was similar to controls (OR = 0.96 [whether or not they used constipating drugs]). Although a greater proportion of females with type 2 DM taking constipating drugs reported constipation and/or laxative use (44.1%) than their corresponding controls (37.1%), the OR (0.80) was not statistically significant after adjusting for Psychosomatic Symptom Checklist scores.

Although univariately, insufficient sweating (P<.001) and numbness (P = .06) were associated with reported constipation and/or laxative use, insufficient sweating was only borderline significant (P = .07) in the final multiple logistic regression model for constipation and/or laxative use.

**HEARTBURN**

The proportions reporting either heartburn or use of acid-reducing medications were 18.8% for residents with type 1 DM vs 36.5% for their respective controls, and 24.0% for residents with type 2 DM vs 36.2% for their respective controls. As summarized in **Table 6**, residents taking NSAIDs had greater ORs for reporting heartburn and/or acid-reducing medication use relative to those not taking NSAIDs (P<.001) and this was similar for residents with type 1 DM, residents with type 2 DM, and their respective controls. Again univariately, insufficient sweating, numbness, and muscle weakness were associated with heartburn and/or acid-reducing medication use, though only insufficient sweating and numbness remained significant in the final multiple logistic regression model. After adjusting for age, sex, Psychosomatic Symptom Checklist scores, smoking, NSAID use, and autonomic and peripheral neuropathy symptoms, controls had greater ORs for either heartburn or use of acid-reducing medications compared with residents with DM (OR = 2.35 [1.52,3.64] relative to type 2 DM, P<.001; OR = 2.41 [1.37,4.26] relative to type 1 DM, P<.005]).

**COMMENT**

This population-based study of the prevalence of GI tract symptoms in persons with DM addressed the asso-
cation between GI tract symptoms, psychosomatic symptoms, medication intake, and autonomic and peripheral neuropathy symptoms in a representative sample of persons with DM in Olmsted County, Minnesota. We were particularly interested in assessing the intake of medications that commonly cause GI tract symptoms because the contribution of medications to the prevalence of GI tract symptoms has not been assessed in the reported literature. This study has 3 key findings. First, the prevalence of most GI tract symptoms (ie, nausea, vomiting, dyspepsia, diarrhea, or fecal incontinence) was no greater among residents with DM than controls of similar age and sex. Second, the prevalence of heartburn was lower in residents with type 1 DM. Third, the higher prevalence of constipation and/or laxative use seen in residents with type 1 DM was associated with medications, but not autonomic neuropathy symptoms.

This confirms and extends, in a US population, the previous findings of Janatuinen et al in Finland who sent a postal questionnaire to 624 patients with DM and 648 controls (both groups were aged from 45 to 64 years) randomly selected from a hospital catchment population of 250,000 persons. In their study, mild symptoms were very common, but no differences were detected in the prevalence of dysphagia, nausea, vomiting, abdominal pain, diarrhea, or constipation among patients with type 1 DM, patients with type 2 DM, and controls. The only differences were that patients with type 2 DM and men with type 1 DM reported significantly more laxative use, patients with type 1 DM had less heartburn, and women with type 2 DM had undergone more cholecystectomies than controls. Since this Finnish study was limited to middle-aged people with DM, the number of patients with type 1 DM was smaller (n=89), and only 1 control group was assembled.

Many studies, including our own, have indicated that GI tract symptoms are common in the general population. For the most part, people with GI tract symptoms in the community are thought to have functional GI disorders rather than undiagnosed organic conditions. The similarity in symptom prevalence between the population-based diabetic and nondiabetic persons suggests that most of the GI tract symptoms that occur among unselected patients with DM are, in fact, functional in origin and do not represent a distinct diabetic enteropathy. Indeed, to postulate that a significant number of population-based diabetic persons have their GI tract symptoms secondary to DM implies that DM somehow “protects” people from GI tract disorders that the general population experiences. In a way, DM does protect people from functional GI tract disorders because the label “functional” is not applied to people with known organic illnesses. However, we believe that GI tract symptoms not explained by anatomical or biochemical abnormalities should be considered functional, regardless of whether the patient has DM. Why might subjects with type 1 DM have less heartburn? It is not because of increased use of acid-reducing medications; in fact, our data showed that fewer residents with type 1 DM used antacids, H2-receptor antagonists, and proton pump inhibitors. More residents with type 1 DM used prokinetics, but this proportion was small (1.5%) and could not explain the difference. Persons with DM were less likely to use alcohol and NSAIDs, but the inverse association between type 1 DM and heartburn was significant after adjusting for these covariates. Heartburn is associated with obesity, and subjects with type 1 DM may have been leaner than their respective controls. We did not directly measure height or weight in this study and, therefore, cannot address that possibility. Another alternative explanation is that persons with DM have an increased prevalence of atrophy of gastric mucosa and impaired gastric secretion. “Autovagotomy” among persons with DM has been shown by assessment of gastric acid secretion in response to maximal histamine stimulation and by histological assessment. However, our study did not identify other symptoms associated with such an autovagotomy.

The overall prevalence of constipation was similar in persons with DM and nondiabetic controls. The overall age- and sex-adjusted (to the 1980 US white population) prevalence of constipation symptoms for the total sample in this study was 19.4%, which is similar to the 19.2% (95% CI, 16.1-22.3) previously reported in the same community. However, patients with type 1 DM, particularly men, reported more laxative use compared with control subjects. The prevalence of combined constipation and laxative use was greater among those with type 1 DM. Our results differ from those of Janatuinen et al who found that it was the patients with type 2 DM rather than type 1 DM who used laxatives more than controls.

The prevalence of constipation and/or use of laxatives in the community controls was clearly related to sex. Thus, 26.5% of female controls and 6.6% of male controls reported constipation; these prevalence rates were, as expected, even higher among those using medications that are associated with the side effect of constipation (37.1% among females and 19.1% among males). The most commonly reported drug class associated with constipation in persons with DM was calcium channel blockers. Despite this high background prevalence of constipating drug use in the community, males with type 1 DM still experienced a significant increase in the prevalence of constipation. The tendency to report psychosomatic symptoms was not a significant confounder among males since they had the lowest median scores in the Psychosomatic Symptom Checklist (0.3 for those not using constipating drugs and 0.5 for those using such drugs).

Autonomic nervous system dysfunction occurs more commonly in persons with DM who have had the disease longer and persons with type 1 DM have a longer duration of documented disease compared with persons with type 2 DM. However, in our study, autonomic symptoms were not associated with increased constipation, laxative use, or decreased incidents of heartburn, except for a borderline association (P=.07) between the symptom of insufficient sweating and constipation and/or laxative use. Similarly, in a study of 114 persons with DM, with nearly equal numbers of...
type 1 and type 2 DM, Clouse and Lustman reported that autonomic neuropathy was not independently associated with the reporting of any GI tract symptoms. In that study, psychiatric illness rather than neuropathy had an independent effect on the reporting of the upper abdominal symptoms. As noted earlier, the Psychosomatic Symptom Checklist score was associated with reporting abdominal symptoms in our study.

Although persons with DM do not seem to have higher rates of GI tract symptoms, they are at risk for complications. The Rochester Diabetic Neuropathy Study found that 66% of the persons with type 1 DM and 59% with type 2 DM had some form of neuropathy, with 7% and 5%, respectively, having visceral autonomic neuropathy. However, only 1% had gastroparesis by symptoms. No population-based study of gastric emptying has been done to identify the prevalence of asymptomatic gastroparesis. This study also found that 79% of the patients with type 1 DM and 55% of the patients with type 2 DM had retinopathy and 16% and 32%, respectively, had elevated serum creatinine values suggestive of nephropathy. In a separate study, the cumulative incidence of peripheral vascular disease among residents of Rochester with DM was 15% at 10 years and 45% after 20 years.

The prevalence of most GI tract symptoms in persons with DM in the community is similar to that of age- and sex-matched controls, except for a lower prevalence of heartburn and increased use of laxatives or constipation in residents with type 1 DM, particularly among men. This difference is associated with the use of medications that cause constipation, particularly calcium channel blockers. The presence of GI tract symptoms is not associated with autonomic symptoms. Our study suggests, first, that referral bias contributes to the conflicting reports in the literature between the prevalence of GI tract symptoms among persons with DM managed in the tertiary care setting compared with the general population. Second, medications can contribute to the reporting of certain GI tract symptoms such as constipation, and constitute a significant confounder that must be assessed and corrected for in any community-based studies of GI tract symptoms. Two practical implications of our study are that persons with GI tract symptoms and DM should not be assumed to have gastropathy, enteropathy, or any other diabetic complication, and that a careful medication history is essential before resorting to more expensive anatomical or physiological studies to determine the basis for symptoms such as constipation.

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From the Gastroenterology Research Unit (Drs Maleki, Locke, and Camilleri) and the Department of Health Sciences Research, Mayo Clinic (Drs Locke, Zinsmeister, Leibson, and Melton), and Olmsted Medical Center (Dr Yawn), Rochester, Minn. Dr Maleki is now with the Department of Gastroenterology, Allegheny University Hospitals, Philadelphia, Pa. Dr Locke is a recipient of grants to perform patient-based research from GlaxoWellcome Inc, Research Triangle Park, NC; SmithKline Beecham Pharmaceuticals, Collegeville, Pa; and AstraZeneca Pharmaceuticals, Wayne, Pa. Dr Locke has served as a consultant for GlaxoWellcome Inc and Novartis Pharmaceuticals, Hanover, NJ. Dr Camilleri is a recipient of grants to perform patient-based research or participated in the development of the clinical research programs of the following pharmaceutical companies: Janssen Pharmaceutica, Titusville, NJ; GlaxoWellcome Inc, Research Triangle Park, NC; SmithKline Beecham Pharmaceuticals, Philadelphia, Pa; Sandoz Pharmaceuticals Corp (formerly Novartis), Hanover, NJ; Merck, Nashville, Tenn; TAP Pharmaceuticals, Deerfield, Ill; Abbott Laboratories, North Chicago, Ill; Regeneron, Tarrytown, NY; Sanofi Inc, New York, NY. He also received also received honoraria or consultancy fees for lecturing to the gastrointestinal or neuroscience groups of some of these companies. Dr Camilleri has given visiting lectureships at several hospitals and university medical centers.

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