Gastrointestinal Function in the Elderly

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It is commonly believed that intestinal function declines significantly with increasing age. Elderly people express gastrointestinal complaints more frequently than younger people and some disorders (e.g., diverticulosis, ischemic bowel disease) occur primarily in the elderly. In addition, most elderly people take medications, and many of these agents have significant effects on gastrointestinal function as well as on food intake.

Data collected during the first phase of the Georgia Centenarian Study illustrate the prevalence of gastrointestinal complaints with increasing age and their potential significance for nutritional status (Table 1) (1).

This chapter summarizes recent human studies of aging and the digestive system, emphasizing physiologic alterations associated with "normal" aging, particularly those that might affect nutritional requirements. Several comprehensive reviews are available (2–5).

ORAL CAVITY

Sensory changes in taste and smell and their effects on appetite and food intake are discussed elsewhere (see Murphy). Although stimulated salivary flow rates were not affected by age in the Baltimore Longitudinal Study of Aging (6), some medications may alter salivary flow. Decreased saliva production could increase the risk of dental caries and erosion. Whereas loss of teeth is common in current elderly cohorts (Table 1), secular trends in oral health suggest that tooth loss may not be universal in future cohorts.

ESOPHAGUS

Some minor abnormalities of esophageal motility (so-called presbyesophagus) have been described in elderly subjects. In the absence of neurologic disease (stroke,
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TABLE 1. Preliminary data on nutritional risk measures from the first phase of the Georgia Centenarian Study*

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>60–69 (n = 46)</th>
<th>80–89 (n = 44)</th>
<th>100+ (n = 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% answering “yes”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you now have an illness or condition that interferes with your eating?</td>
<td>13</td>
<td>14</td>
<td>26</td>
</tr>
<tr>
<td>Do you now have an illness that has cut down on your appetite?</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Do you have trouble biting or chewing any kind of food?</td>
<td>17</td>
<td>16</td>
<td>37</td>
</tr>
<tr>
<td>Are there any kinds of foods that you don’t eat because they disagree with you?</td>
<td>48</td>
<td>48</td>
<td>5</td>
</tr>
<tr>
<td>Do you wear dentures?</td>
<td>39</td>
<td>70</td>
<td>95</td>
</tr>
<tr>
<td>Have you had any spells of pain or discomfort for 3 days or more in your abdomen in the past month?</td>
<td>4</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Did you have any trouble swallowing at least 3 days in the last month?</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Did you have any vomiting at least 3 days in the past month?</td>
<td>2</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Do you have any troubles with your bowels that make you constipated or give you any diarrhea?</td>
<td>17</td>
<td>25</td>
<td>37</td>
</tr>
<tr>
<td>Have you gained or lost any weight in the last 30 days?</td>
<td>11</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Have you ever had an operation on your abdomen?</td>
<td>30</td>
<td>52</td>
<td>42</td>
</tr>
<tr>
<td>Have you ever been told by a doctor that you were “anemic” (had iron-poor blood)?</td>
<td>24</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>Do you smoke cigarettes regularly now?</td>
<td>16</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>In the past month, have you taken any medicines prescribed by a doctor?</td>
<td>76</td>
<td>74</td>
<td>74</td>
</tr>
<tr>
<td>In the past month, have you taken any medicines that were not prescribed by a doctor?</td>
<td>22</td>
<td>36</td>
<td>47</td>
</tr>
<tr>
<td>Are you on any kind of a special diet?</td>
<td>9</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>


Participants are cognitively intact and community dwelling. For methods, see ref. 1.

diabetes mellitus), however, their clinical significance is uncertain and normal esophageal function appears to be maintained until at least 80 years of age (2,3,5). The effect of aging on gastroesophageal reflux does deserve study.

STOMACH

The most prominent effect of aging on gastrointestinal function involves the stomach. The prevalence of gastric atrophy and atrophic gastritis increases significantly
with age. In a survey of free-living Bostonians, the prevalence of atrophic gastritis increased from 21% of those age 60 to 69 years, to 31% of 70- to 79-year-olds, and to 37% of those older than 80 years (7). The physiologic consequences include reduced gastric acid secretion (hypochlorhydria, achlorhydria), decreased intrinsic factor secretion, and increased risk of bacterial overgrowth of the small intestine (reviewed in ref. 8).

Hypochlorhydria has several potential effects on nutrient metabolism, including reduced solubility and bioavailability of dietary calcium and iron, and reduced bioavailability of folate, vitamin B₆, and vitamin B₁₂. Interestingly, studies by Russell and coworkers indicate that a compensatory mechanism, increased bacterial vitamin synthesis, and intraluminal release of folate (9) and vitamin B₆, may prevent deficiency of these vitamins (reviewed in ref. 8). These effects are summarized in Table 2.

Work from the Goteborg Longitudinal Study has shown convincingly that low serum vitamin B₁₂ concentrations are not a normal concomitant of aging but rather a consequence of gastrointestinal disease, particularly gastric atrophy (10). Healthy elderly subjects with normal gastric function and elderly subjects with atrophic gastritis absorb crystalline vitamin B₁₂ normally; however, absorption of protein-bound vitamin B₁₂, which is reduced in atrophic gastritis, is normalized with antibiotic therapy (11). Nevertheless, covert small bowel bacterial overgrowth may be an underlying cause of malnutrition in the elderly. Treatment of 16 elderly patients with bacterial overgrowth resulted in significant weight gain and improvement in anthropometric measurements (12).

**MOTILITY**

Data on gastric emptying rates of the elderly are conflicting. In one recent study, gastric emptying of a mixed solid–liquid meal was significantly prolonged in elderly subjects: \( t_{1/2} = 136 \) versus 81 min \( (p < 0.001) \); however, there was no difference in mouth-to-cecum or whole gut transit time (13). In another study, using a liquid meal, the half-times for gastric emptying and small and large intestinal transit were not
significantly different for young and elderly subjects (14). However, gastric emptying in the early phase (first 5 min) was significantly more rapid in the elderly (14).

In hypochlorhydria, gastric emptying should, in principle, be increased. A study of interdigestive motor activity demonstrated abnormal motility in all elderly subjects examined, independent of hypochlorhydria (15). Additional research is needed to establish whether and how hypochlorhydria and bacterial overgrowth affect gastric emptying and intestinal motility. Most studies indicate that age per se does not increase mouth-to-cecum transit time (16).

**PANCREAS AND LIVER**

With aging, morphological changes have been documented in both pancreas and liver. However, the functional significance of such changes is uncertain. Although stimulated pancreatic secretion of bicarbonate, lipase, and amylase was significantly decreased (by 40%) in older versus younger adults (17), digestive function appears to be maintained on usual dietary intakes, probably because of the excess physiologic reserve capacity. Similarly, whereas variable effects on hepatic drug uptake, metabolism, and clearance have been attributed to aging, liver function tests remain in the normal range, although the lithogenicity of bile is increased (18).

**SMALL INTESTINE**

Given the significant age-related decreases in average cardiac output (about 30%) and splanchnic blood flow (about 50%) (19), decreased intestinal absorption of nutrients might be expected in the elderly. In fact, absorption of fat, protein, and carbohydrate appears to be essentially unaffected by age in healthy elderly subjects, although high fat, high protein, and high carbohydrate meals are often less well tolerated.

For example, daily fecal fat excretion on a 100-g fat diet averaged 2.8 g, 2.5 g, and 2.9 g in subjects age 19 to 44, 45 to 69, and 70 to 91 years, respectively (20). However, at higher intakes (115–120 g), fecal fat excretion was significantly increased in elderly but not younger Swedish subjects (21). Interestingly, Southgate and Durnin reported a small difference in the apparent digestibility of fat, 96.4% versus 94.7% for young versus elderly women, on a fat intake of 80 to 95 g/day (22). Most earlier studies of carbohydrate absorption relied on urinary recovery of non-metabolized sugars. When the results of such studies are adjusted for decreased renal function (creatinine clearance), there is little evidence of carbohydrate malabsorption (reviewed in ref. 5). However, meals high in complex carbohydrate (up to 200 g) do evoke significantly higher breath hydrogen excretion in elderly subjects (23).

Milk and dairy products are often avoided by elderly people, who may associate them with gastrointestinal symptoms. Jejunal lactase activity does decrease with age, in contrast to sucrase and maltase, for which activities remain fairly constant
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throughout the life span (24). However, in a double-blind study, lactose malabsorption was not a predictor of symptomatic lactose intolerance in healthy elderly subjects (25).

In contrast, calcium absorption and adaptation to low calcium diets are significantly decreased in the elderly (26–28). Potential physiologic mechanisms include decreased gastric acid secretion, decreased skin synthesis of previtamin D, decreased renal activation of 25-hydroxyvitamin D, and perhaps end-organ resistance to 1,25-dihydroxyvitamin D (reviewed in ref. 29). In a recent study, a meal high in dietary fiber reduced calcium absorption in both healthy elderly subjects and elderly subjects with atrophic gastritis (30).

For some of the remaining micronutrients, including iron (31) and copper (32), there is little evidence of malabsorption in healthy elderly people. However, zinc absorption was significantly reduced in healthy elderly men (33). As discussed by Heseker (elsewhere in this volume), although cross-sectional surveys often report low blood vitamin concentrations in the elderly, vitamin supplementation usually normalizes blood levels, suggesting that dietary intake, rather than intestinal absorption, is inadequate.

Because intestinal lipoproteins are cleared more slowly in the elderly, older subjects actually have higher postprandial vitamin A concentrations after a test dose than younger subjects (34). Because of their high vitamin A stores, elderly Americans may have a lower margin of safety for this vitamin (35).

LARGE INTESTINE

Alterations in gastrointestinal motility may lead to constipation or diarrhea; both disorders occur in the elderly. Although clinical and patient definitions of constipation are often significantly different, it is clear that the prevalence of constipation increases substantially after 65 years of age and contributes significantly to morbidity (36,37). Because chronic constipation can be extremely refractory to treatment and may have a significant impact on the individual’s sense of well-being, it is important to prevent this disorder by maintaining mobility and adequate fluid and fiber intakes.

CONCLUSION

There are age-related alterations in gastrointestinal function but they are usually not pronounced. However, even subtle alterations might increase the vulnerability of the elderly to illness and malnutrition, as discussed by Berry (elsewhere in this volume). Use of multiple medications, so common in this age group, and the presence of chronic disease significantly increase the potential for adverse effects on gastrointestinal function.

Gastric atrophy may have a significant effect on nutritional requirements for calcium and vitamin B₁₂, but efficient digestion and absorption of macronutrients (fat, protein, and carbohydrate) and most micronutrients seem to be maintained in healthy
elderly people. Normative data, particularly for motility and intestinal transit, need to be established better for this age group.

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REFERENCES


DISCUSSION

Dr. Guesry: You mentioned that wheat bran reduces calcium absorption. It also reduces zinc absorption and I believe that the effect is not primarily due to the fiber but to the phytic acid that is very often linked with fiber in bran.

Dr. Kritchevsky: I was going to make that point too. It should also be pointed out that a high-fiber diet is not a low-fiber diet with added fiber. It is a diet where you have the fiber you get in the grocery, not in the pharmacy. Most studies have shown that on high-fiber diets or with high-fiber foods you don't generally see major effects on nutrient absorption unless the fiber is being consumed in enormous amounts. Study groups in the United States and Canada have concluded that fiber recommendations should be made in terms of grams per 1000 kcal, otherwise elderly people or children, who anyway eat smaller quantities of food, may erroneously be given excessive amounts on the basis that high-fiber diets are good, so more is better.

Dr. Bowman: However, it is virtually impossible to meet the US dietary recommendations for fiber intake without the use of foods that have been supplemented with fiber such as
wheat bran. I agree that it is important to see whether there are physiological effects of adding fiber; it is also important to know whether these have biological or nutritional significance.

Dr. Kritchevsky: I'm not 100% convinced that the amounts of fiber that have been suggested are based on more than just a guess of what may be right.

Dr. Edwardson: Are there any examples of nutrients that are better absorbed with advancing age?

Dr. Bowman: Most studies have shown that there is a plateau of absorptive capacity that is maintained into old age. The possible exception to this is calcium. However, there is some suggestion that changes in intestinal membrane composition and fluidity may increase the absorption of fat-soluble nutrients, particularly vitamin A, in old age.

Dr. Heseker: Lipoproteins are increased in the blood of elderly people. Since retinyl esters are transported in the lipoprotein fraction, any differences in apparent vitamin A absorption in the elderly may be due to this difference in blood lipids.

Dr. Bowman: Studies on triglyceride clearance using stable isotope-labeled triglycerides support what you say and indicate slower intestinal lipoprotein clearance in the elderly (1).

Dr. Vellas: When we talk about gastrointestinal function in the elderly we must differentiate between elderly people in good health and elderly people suffering from anorexia and undernutrition. There is much greater modification of gastrointestinal function in the latter.

Dr. Munro: Is there any evidence that the rate of movement of cells on the intestinal mucosa slows down with age?

Dr. Bowman: In experimental animals, decreased rates of cell migration from the crypt to the villus occur in some species but not in others. In humans I am not aware of any studies. There is a suggestion that the villi may be somewhat shorter in the elderly but I have not seen any data on kinetics of intestinal cell maturation or turnover in humans.

Dr. Heseker: What is the prevalence of malnutrition caused by malabsorption in the elderly?

Dr. Vellas: It seems that malabsorption is not usually the cause of malnutrition in the elderly. Maybe the decrease in intake is a cause of malabsorption, but the aging gut per se is not a cause of malabsorption and malnutrition in healthy old people. When an old person has a poor food intake, then one of the consequences of the reduced intake is a decrease in gut function and possibly malabsorption. When we studied the physiological function of the gut in elderly people after starvation we found many alterations. Maybe this is the reason for the poor response to tube feeding that is usually found in old people.

REFERENCES