Epidemiology, Pathophysiology, and Classification of Fecal Incontinence: State of the Science Summary for the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) Workshop

Adil E. Bharucha, MBBS, MD[1], Gena Dunivan, MD[2], Patricia S. Goode, MSN, MD[3], Emily S. Lukacz, MD, MAS[4], Alayne D. Markland, DO, MSc[3], Catherine A. Matthews, MD[5], Louise Mott, RN[6], Rebecca G. Rogers, MD[2], Alan R. Zinsmeister, PhD[7], William E. Whitehead, PhD[5,8], Satish S.C. Rao, MD, PhD[9] and Frank A. Hamilton, MD[10]

In August 2013, the National Institutes of Health sponsored a conference to address major gaps in our understanding of the epidemiology, pathophysiology, and management of fecal incontinence (FI) and to identify topics for future clinical research. This article is the first of a two-part summary of those proceedings. FI is a common symptom, with a prevalence that ranges from 7 to 15% in community-dwelling men and women, but it is often underreported, as providers seldom screen for FI and patients do not volunteer the symptom, even though the symptoms can have a devastating impact on the quality of life. Rough estimates suggest that FI is associated with a substantial economic burden, particularly in patients who require surgical therapy. Bowel disturbances, particularly diarrhea, the symptom of rectal urgency, and burden of chronic illness are the strongest independent risk factors for FI in the community. Smoking, obesity, and inappropriate cholecystectomy are emerging, potentially modifiable risk factors. Other risk factors for FI include advanced age, female gender, disease burden (comorbidity count, diabetes), anal sphincter trauma (obstetrical injury, prior surgery), and decreased physical activity. Neurological disorders, inflammatory bowel disease, and pelvic floor anatomical disturbances (rectal prolapse) are also associated with FI. The pathophysiological mechanisms responsible for FI include diarrhea, anal and pelvic floor weakness, reduced rectal compliance, and reduced or increased rectal sensation; many patients have multifaceted anorectal dysfunctions. The type (urge, passive or combined), etiology (anorectal disturbance, bowel symptoms, or both), and severity of FI provide the basis for classifying FI; these domains can be integrated to comprehensively characterize the symptom. Several validated scales for classifying symptom severity and its impact on the quality of life are available. Symptom severity scales should incorporate the frequency, volume, consistency, and nature (urge or passive) of stool leakage. Despite the basic understanding of FI, there are still major knowledge gaps in disease epidemiology and pathogenesis, necessitating future clinical research in FI.

INTRODUCTION

Fecal incontinence (FI) is defined by the unintentional loss of solid or liquid stool, and anal incontinence (AI) includes leakage of gas and/or FI. The emotional consequences of AI often exceed the physical manifestations. Many individuals report withdrawing from their social lives and hide the problem from their families, friends, and even their doctors. This has led to difficulties for healthcare providers in identifying those affected by FI. As FI is strongly associated with age, its incidence will likely increase as the population ages. Disease prevention has been hindered by limited research and incomplete knowledge about the biological causes and interacting social and environmental factors.

[1]Division of Gastroenterology and Hepatology, Mayo Clinic, Rochester, Minnesota, USA; [2]Department of Obstetrics and Gynecology, University of New Mexico Health Sciences Center, Albuquerque, New Mexico, USA; [3]Department of Medicine, University of Alabama at Birmingham, Birmingham, Alabama, USA; [4]Department of Reproductive Medicine, UC San Diego Health Systems, La Jolla, California, USA; [5]Department of Obstetrics and Gynecology, University of North Carolina, Chapel Hill, North Carolina, USA; [6]Simon Foundation, Langley, British Columbia, Canada; [7]Division of Biomedical Statistics and Informatics, Department of Health Sciences Research, Mayo Clinic, Rochester, Minnesota, USA; [8]Division of Gastroenterology and Hepatology, University of North Carolina, Chapel Hill, North Carolina, USA; [9]Department of Gastroenterology, Georgia Regents University, Augusta, Georgia, USA; [10]National Institutes of Diabetes, Digestive and Kidney Diseases, National Institute of Health, Bethesda, Maryland, USA. **Correspondence:** Adil E. Bharucha, MBBS, MD, Division of Gastroenterology and Hepatology, Mayo Clinic, 200 First Street SW, Rochester, Minnesota 55905, USA. E-mail: bharucha.adil@mayo.edu
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Table 1. Epidemiology of fecal incontinence: community-based studies

Survey	Respondents; instrument	Response rate (number of respondents)	Prevalence
Talley *et al.* (4)	Olmsted County residents ≥65 years; mailed questionnaire	66% (328)	FI once per week over the past year: 3.1% (F) and 4.5% (M)
Drossman *et al.* (2)	US householder marketing list; mailed questionnaire	66% (5,430)	Soiling: 6.9% (F) and 7.4% (M) Gross incontinence: 0.9% (F) and 0.5% (M)
Nelson *et al.* (3)	Wisconsin residents of all ages; phone interview with 1 member in each household	73% (6,959)	Any FI over past year: 2.2% (overall) and 7.5% (aged ≥65)
Reilly *et al.* (5)	Olmsted County residents ≥50 years; mailed questionnaire	64% (1,540)	Any FI: 17.8% (F) and 12.8% (M)
Walter *et al.* (7)	County of Ostergotland (Sweden); aged 31–76 years; mailed questionnaire	81% (1,610)	Liquid FI >1/month: 10.9% (F) and 9.7% (M) Solid FI >1/month: 1.4% (F) and 0.4% (M)
Perry *et al.* (6)	Leicestershire Health Authority (UK) patient register; mailed questionnaire	70% (10,226)	Any FI: 5.7% (F) and 6.2% (M)
Bharucha *et al.* (8)	Olmsted County residents ≥20 years; mailed questionnaire	53% (2,800)	Any FI: 14% (F)
Melville *et al.* (9)	HMO population, 30–90 years, Washington State; mailed questionnaire	64% (3,536)	Loss of liquid or stolid stool once/month: 7.7% (F)
Quander *et al.* (10)	Chicago Health and Aging Project, ≥65 years; door-to-door survey of 1 household member	79% (6,158)	Any FI ("past few months"): 9.6%. No differences between men and women
Varma *et al.* (11)	Reproductive Risks for Incontinence Study at Kaiser, ≥40 years with ≥50% of deliveries at Kaiser; mailed questionnaire	2,109	Any fecal incontinence in the past 12 months: 25% (F)
Nygaard *et al.* (12) and Whitehead *et al.* (13)	National Health and Nutrition Examination Survey (2005–2006), men and women ≥20 years; door-to-door interview	64% (4,308)	Loss of liquid or stolid or mucus stool during the past 30 days: 8.9% (F) and 7.7% (M)

F, female; FI, fecal incontinence; M, male.
Prevalence rates for males and females are provided separately where available.
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To address these issues, the NIDDK (National Institute of Diabetes and Digestive and Kidney Diseases) organized a workshop in August 2013 in which a panel of experts in epidemiology, gastrointestinal physiology, gastroenterology, colorectal surgery, urogynecology, and psychology were invited to identify and discuss major issues in the diagnoses and treatment of FI/AI. We examined the barriers encountered in addressing FI/AI, and identified research priorities in both basic and clinical research to further advance treatment of the condition. This two-part document will summarize the principal findings of the workshop.

PREVALENCE

Many studies that evaluated the prevalence of FI were conducted in selected populations. For example, only 8 of 34 surveys in a review from 2004 were community based and sampled the entire population—that is, were unrestricted by age, residence, or underlying disease (1). However, 4 of these 8 studies surveyed >750 subjects, and only two studies, which were conducted in a market mailing sample and in Wisconsin households (2,3), were from the United States. **Table 1**, which summarizes the large population-based studies on the epidemiology of FI, includes studies

that were summarized in that review (2–7) and 6 others published thereafter (8–13). These studies suggest that FI is common, with a prevalence ranging from 7 to 15% in community-dwelling women. The prevalence is comparable in men (6,13).

Besides true differences, the variations in prevalence across studies may reflect differences in survey methods (e.g., by phone or in person), the screening questions, the reference time frame, and the definition of incontinence. In particular, the prevalence of AI, which includes incontinence for flatus as well as feces, is higher than FI. An internet-based survey suggests that women prefer the term "accidental bowel leakage" over fecal or bowel incontinence (14). Indeed, some surveys were anchored by the validated question "How often have you experienced accidental leakage of solid or liquid stool over the past year" (8,15)? Other surveys assessed prevalence over the preceding month (13).

The prevalence of FI is higher among care-seeking populations, home-care populations, and adults in long-term care settings (1). In some (9,11,16,17) but not all (13,18) studies, the prevalence is lower in African-American women relative to white women, but it is equal in African-American men and white men (13,18).

The incidence rate of FI in a population has only been evaluated in two studies (16,19). In a study of community-dwelling

adults aged ≥65 years, the incidence rate of FI over 4 years was 17% (13.7–20.1), with 6% (4.0–8.3) developing FI at least monthly (16). Controlling for age, comorbidity count, and body mass index, significant independent risk factors for incident FI in women were white race, depression, chronic diarrhea, and urinary incontinence (UI). UI was the only significant risk factor for incident FI in men. In a study of community-dwelling women aged ≥50 years, the incidence rate of FI was 7.0% (5.0–9.6) 10 years after the initial survey. At baseline, self-reported diarrhea (odds ratio (OR)=3.8, 95% confidence interval (CI) 1.5–9.4), incomplete evacuation (OR=3.4, 95% CI 1.2–9.8), and pelvic radiation (OR=5.1, 95% CI 1.01–25.9) predicted the development of FI. Development of urgency was the primary predictor among the set of predictors reflecting changes in bowel symptoms that were associated with the onset of FI (OR=24.9, 95% CI 10.6–58.4). However, the natural history of FI is unknown.

Finally, some, but not all, studies suggest that FI is associated with increased mortality (20–22). However, in the studies that link FI with increased mortality, it is unclear whether increased mortality is related to FI *per se* or conditions associated with FI, as the number of chronic illnesses is known to be a risk factor for FI (13).

PATIENT SUFFERING AND CAREGIVER BURDEN

FI can have a devastating impact on daily life. The inability to control an important bodily process results in a loss of confidence, self-respect, modesty, and composure (23). These consequences are compounded by the social stigma attached to FI and the secrecy attached to the condition. Hence, many people with FI do not share the condition with their closest friends and relatives, let alone care providers. Indeed, sometimes they tend to withdraw from family, friends, and even their spouses. Providers who did not screen for FI considered it less important to screen for FI compared with other health issues such as increased triglyceride levels, diabetes, excessive use of alcohol, and UI (24).

Caregiver burden is also significantly greater for FI than for UI, as measured by hours of care (25), emotional distress and health deterioration in family caregivers (26), and willingness to consider admitting the incontinent relative to a nursing home (26,27).

HEALTHCARE-SEEKING BEHAVIOR IN FI

Recognizing FI is a prerequisite to managing the symptom and providing support to patients. However, FI is underrecognized; for example, in one study less than one-third of patients with FI had disclosed this to a provider (28). This occurs because providers seldom screen for FI and patients do not volunteer the symptom. Among women presenting for benign gynecologic care, only 17% with FI were asked about the symptom by their healthcare provider (29). Only 2.7% of patients with self-reported FI also had a medical diagnosis (30). The extent to which this problem is explained by limited awareness of the prevalence, burden, and management of FI, by insufficient time during visits, or by other factors is unknown (31). There is a lack of consensus on how to screen for FI.

Factors that are associated with care seeking for FI include more frequent and severe FI symptoms (8,30,32), symptoms that are perceived as dangerous (e.g., pain) (33), loss of solid stool, having an established primary care provider, and having knowledge of FI (32). Conversely, less frequent and less severe FI (8), and lower embarrassment, as measured by the Fecal Incontinence Quality of Life (FIQOL) questionnaire (29), are associated with lower rates of consulting. Barriers to seeking care include a lack of understanding of the term FI, embarrassment, the belief that FI is a normal part of aging, unfamiliarity with whom to discuss this problem, priority of other medical conditions, concerns that there are no options to treat FI, and pessimism that physicians will be able to help (8,29,31). For example, an internet-based survey observed that only 30% of nearly 1,100 community-dwelling women with FI had heard the term "fecal incontinence"; a majority (71%) preferred the term "accidental bowel leakage" to describe their condition (14). A more patient-centered term (e.g., accidental bowel leakage) may expand opportunities for sufferers to seek care, as was seen when the term "impotence" was replaced by "erectile dysfunction."

ECONOMIC IMPACT

The burden and economic impact of FI includes direct (personal hygiene products, ambulatory care visits, diagnostic testing, and medical and surgical management) and indirect (loss of productivity and necessary alterations in living environments such as nursing home placement) costs. Because the disease is chronic, it is challenging to measure the economic impact particularly as the efficacy of treatments declines over time; data on both direct and indirect costs are extremely limited. In addition, FI rarely occurs as an isolated condition, and therefore attributing costs to the appropriate disease state can be very difficult. FI increases the likelihood that an older patient will be admitted to a nursing home rather than cared for at home (34–36). This factor, in addition to the indirect costs of lost productivity, likely represents the largest economic burden of FI.

Two studies have attempted to evaluate the full cost burden of FI. The total per-patient annual cost of FI, adjusted to 2012 dollars, was higher in the United States (i.e., $4,111) than in the Netherlands (i.e., $3,521) (37,38). Data from a health management organization suggest that in 2005, healthcare visits and the annual actual cost was $2,897 higher in people with FI than in those without FI (30). However, it is unclear whether this difference is related to FI *per se* or comorbid medical conditions.

The current surgical costs of FI are similarly difficult to estimate. Based on a review of ~3,500 surgeries performed over a 5-year interval for FI, the total hospital costs were $34.1 million (adjusted to $2,012), which is relatively low compared with the surgical management of UI. This surgical cost estimate, however, was derived before the Food and Drug Administration approved newer surgical modalities for FI management including sacral nerve stimulation (SNS) and perianal bulking agents.

The potential economic impact of these new surgical treatment modalities is sizable. For example, in Europe, the estimated 5-year

cumulative cost for SNS is seven times higher than conservative treatment (39). Expressed differently, in the United Kingdom, it was calculated that each increment in quality-adjusted life year gained with SNS for FI costs over $35,000. No such calculation has yet been reported in the United States, but it would likely be even higher, as the cost of performing the procedure, even for Medicare patients (i.e., ~$16,500 for the device and $6,800 for surgical fees), is greater in the United States than in Europe. For those with commercial insurance, the costs are even higher. In summary, although diagnostic investigations for FI are relatively inexpensive, our understanding of the direct cost of FI is incomplete, particularly since the introduction of the high-cost treatment modality of SNS. There are no prospective studies comparing the cost effectiveness of SNS and conservative therapy. Relatively little is known about the indirect costs of FI. Cost effectiveness should be considered when developing and evaluating diagnostic and treatment algorithms. As the population ages, the prevalence of FI and the associated financial burden will likely increase (9).

SYMPTOM SEVERITY AND IMPACT ON THE QUALITY OF LIFE

There are over 20 scales for rating the severity of FI. Those developed before 1992 are reviewed elsewhere (40) and are rarely used. Thereafter, 6 other scales—the Pescatori, Wexner (Cleveland Clinic), Vaizey (St Marks), Rockwood, Modified Manchester Health Questionnaires, and the Fecal Incontinence and Constipation Assessment (FICA) FI symptom severity instrument—have been developed and used in clinical studies to rate the severity of FI (8,15,40–51). The ICIQ-B (Bowel version of the International Consultation of Incontinence questionnaire) and the Revised Fecal Incontinence scale are the most recently developed and validated instruments; however, they have not been widely used in clinical studies (52–54). These eight scales, which have been at least partly validated, are summarized in **Table 2**.

All scales for rating the severity of FI incorporate the type and frequency of leakage. Some scales (i.e., Vaizey, FICA, and ICIQ-B) also incorporate rectal urgency (8,43,44,52) that is often unpredictable and causes much distress to people with FI (23). Patients with urge FI and rectal hypersensitivity have more frequent stools, use more pads, and report more lifestyle restrictions compared with patients with normal rectal sensation (55). Only one scale (i.e., the FICA FI symptom severity scale) incorporates the amount of leakage that we deem essential for characterizing the severity of FI (52) (**Table 2**). Indeed, in the absence of an assessment of the amount of leakage, the severity of FI would be rated as identical for two subjects, one of whom had minor staining and the other a large liquid incontinent bowel movement once a week.

FI can have a devastating impact on the quality of life (QOL) that can be evaluated by generic or disease-specific instruments. Some symptom severity scales also include typically one question (41,43,53) and sometimes more (52) questions related to the impact of FI on QOL. The alternative approach is to use dedicated instruments with more questions that provide a more refined assessment of the impact of FI on QOL (e.g., Rockwood Fecal Incontinence Quality of Life Scale, modified Manchester Health Questionnaire, and FICA QOL scale) (44,45,56). There is a significant correlation between symptom severity and QOL in FI (42,44). The Pelvic Organ Prolapse/Incontinence Sexual Questionnaire, IUGA Revised is validated in women with FI, allowing for measurement of sexual function with a condition-specific measure (57).

A recent study highlighted patients' perspectives of the severity of FI and its impact on the QOL. Patients reported that poor bowel control restricted social life; other issues pertained to toilet location, hygiene/odor issues, coping strategies, fear, physical activities, embarrassment, and unpredictability of bowel habits (52). Certain QOL instruments (e.g., Rockwood Fecal Incontinence Quality of Life Scale) comprehensively address issues identified by patients.

Bowel diaries are a commonly used research tool for objective measurement of condition severity, but it can be limited by poor patient adherence. These limitations to paper diaries can be miti-

Table 2. Validation of instruments for rating severity of fecal incontinence

Item	Pescatori (40)	Wexner (41)	St Mark's (43)	FISI (42)	FICA (8,15,44)	Modified Manchester Health Questionnaire	ICIQ-B (52,54)	Revised FI Scale (53)
Content[a]	Urge – Volume –	Urge – Volume –	Volume –	Urge – Volume –	A	Urge – Volume –	Volume –	Urge – Volume –
Construct	A (43)	A (43,53)	A (53)	B	A	A (45)	A	A
Criterion validity	B	A (47)	A (48)	A	A	A (45)	A	B
Internal consistency	B	A (53)	A (53)	B	B	A (45)	A	A
Reliability (test–retest)	A (43)	A (43)	A	A (45)		A (45)	A	B
Responsiveness	B	A (51)	A (48)	A (50)	A (49)	A (46)	B	A

FI, fecal incontinence; FICA, Fecal Incontinence and Constipation Assessment; FISI, Fecal Incontinence Severity Index; ICIQ-B, Bowel version of the International Consultation of Incontinence questionnaire.

"A" refers to attributes that have been partly or adequately validated. "B" refers to attributes that have not been validated. For cells with an "A" rating that do not include a citation, the citation is provided in the column heading.

[a]Items that are not incorporated in the instrument are indicated by "–" sign.

gated by internet- and telephone-based daily reporting of symptoms, although older people who are at a greatest risk of FI may not be comfortable with these technologies. Given the limitations in objective, global, and diary measures, FI assessment is likely to remain reliant on symptom severity and QOL scales.

ETIOLOGY, ASSOCIATED CONDITIONS, AND RISK FACTORS

Knowing which clinical conditions and patient characteristics are strongly associated with FI is important, because these identify patients who are at risk for FI and who should be targeted for screening and prevention strategies (**Table 3**). In general, the term "etiology" is used in clinical practice, whereas epidemiological studies identify associated conditions and risk factors. Only epidemiological studies that assess the temporal relationship between FI and associated conditions can identify risk factors that precede the onset of FI.

Few epidemiological studies have comprehensively evaluated the risk factors for FI in the community. In community surveys, bowel disturbances, particularly diarrhea, the symptom of rectal urgency, and burden of chronic illness rather than obstetric history (e.g., forceps use, complicated episiotomy) are by far the most important independent risk factors for fecal incontinence (13,19,58–61). Specifically, in a community-based cohort of 176 randomly selected women with and 176 women without FI, independent risk factors for FI were diarrhea (mean OR=53, 95% CI 6.1–471), cholecystectomy (4.2, 95% CI 1.2–15), current smokers (4.7, 95% CI 1.4–15), rectocele (4.9, 95% CI 1.3–19), stress UI (3.1, 95% CI 1.4–6.5), and body mass index (per unit, 1.1, 95% CI 1.004–1.1). A history of smoking and obesity are emerging and potentially modifiable risk factors (9,11,17,60,61); smoking is also a risk factor for external sphincter atrophy by magnetic resonance imaging (61). The mechanisms by which obesity predisposes to FI are incompletely understood (62). Other conditions associated with FI include advanced age, disease burden (comorbidity count, diabetes), anal sphincter trauma (obstetrical injury, prior surgery), and decreased physical activity (3,9,13,17,63).

Several diseases that can cause anorectal sensorimotor dysfunctions and/or altered bowel habits are associated with FI in clinical practice (**Table 3**). Some of these conditions do not emerge as risk factors in community studies, possibly because their prevalence is relatively low. Consistent with the findings of community-based studies, the vast majority of women with FI who consult a physician do not have a neurological or inflammatory disorder but rather bowel disturbances, typically diarrhea, perhaps associated with a history of obstetric risk factors.

OBSTETRIC TRAUMA

The relationship between obstetric anal sphincter injury and FI may be summarized as follows. The incidence of FI following vaginal delivery appears to be declining from rates of 13% of primiparous women two decades ago (64) to 8% in the most recent series (65). This may reflect improvements in obstetrical practices including decreased use of instrumented vaginal delivery (forceps and vacuum extraction) and more selective use of episiotomy. Obstetric anal sphincter injury is a significant risk factor for postpartum FI (66). However, and similar to UI, the available studies indicate that obstetric anal sphincter injury is not, after adjusting for bowel disturbances (60), a major risk factor for FI occurring many decades after vaginal delivery in women. Among women in the community, the median age of onset of FI is the seventh decade—that is, many decades after vaginal delivery (60,61). Moreover, the prevalence of FI is similar in men and women. Postpartum AI results from vaginal delivery rather than pregnancy or labor. Epidemiologic studies show similar rates of AI and FI between nulligravid and nulliparous women, and prospective observational studies demonstrate that rates of AI do not significantly change throughout pregnancy (67–70). Similarly, comparisons of rates of AI in labored and unlabored cesarean sections show no significant differences in either epidemiologic surveys or prospective observational trials (68,71,72). Third-degree (i.e., involving the external anal sphincter) and fourth-degree lacerations (i.e., extending through the external and internal anal sphincters) are strong risk factors for AI FI. A prospective trial conducted by the NIH/NICHD Pelvic Floor Dis-

Table 3. Pathogenesis and etiology of fecal incontinence
Anal sphincter weakness
Injury: obstetric trauma, related to surgical procedures, e.g., hemorrhoidectomy internal sphincterotomy, fistulotomy
Nontraumatic: scleroderma, internal sphincter thinning of unknown etiology
Neuropathy: stretch injury, obstetric trauma, diabetes mellitus
Anatomical disturbances of pelvic floor: fistula, rectal prolapse, descending perineum syndrome
Anorectal inflammation: Crohn's disease, ulcerative colitis, radiation proctitis, anorectal infection
Central nervous system disease: dementia, stroke, brain tumors, spinal cord lesions, multiple system atrophy (Shy Drager's syndrome), multiple sclerosis
Bowel disturbances: diarrhea (e.g., irritable bowel syndrome, post-cholecystectomy diarrhea) and constipation with or without fecal impaction/overflow diarrhea
More than one mechanism may be contributory in some patients. Reproduced with permission from (102).

orders Network matched women with sphincter injury to a vaginal delivery without recognized sphincter injury control group and identified a nearly twofold increase in the odds of FI (73). Among deliveries requiring instrumentation, the risk is highest for instrumented (forceps and vacuum) deliveries, with increased odds of 1.5 for AI and higher risk with forceps than vacuum (74). Cesarean delivery obviously minimizes the risk of anatomic anal sphincter injury, but it does not universally protect against the development of FI/AI. The 2006 NIH consensus conference on cesarean delivery on maternal request concluded that there was insufficient evidence to support a practice of elective cesarean delivery for the prevention of pelvic floor disorders, including FI. Thus, there are likely inherent predispositions (i.e., genetic) that predispose to development of FI in women who are exposed to an event such as childbirth or other factors (i.e., obesity and age). Our understanding of the relationship between obstetric injury and FI/AI is based on cross-sectional and case–control studies because randomized trials are not feasible.

FI IN THE ELDERLY

The prevalence of FI is 15% in community-dwelling older people (13), 18–33% in hospitals, 38% in home health, and 50–70% in nursing homes (75–77). Among the community-dwelling elderly, the incidence of FI (i.e., new-onset FI) ranges from 7% over 10 years to 17% over 4 years (16,19). Within 10 months of admission to nursing homes, 20% of those continent at admission develop FI (20), suggesting that nursing home practices may contribute to FI but may also be related to the high comorbidity burden and low functional status of individuals admitted to nursing homes. Older adults frequently do not report FI. Providers screen for FI among patients in nursing homes but not in the community (78).

Dementia (20,28,79), mobility impairment (80,81), and comorbid chronic diseases (18,20) are more significant risk factors for FI in older adults. Constipation with fecal impaction is a significant risk in nursing homes (20,81). Cross-sectional studies suggest that age is associated with alterations in anorectal functions (i.e., lower anal resting and squeeze pressures, anal sphincter denervation, increased rectal compliance, and decreased rectal sensation) (82–85). These changes may predispose to FI.

Several studies have evaluated the effects of various interventions in nursing home residents. Prompted toileting and regular fitness training reduced the frequency of FI from 8 to 0% of incontinence checks, and increased the proportion of continent bowel movements from 0 to 75% (86). In a separate study, a program of prompted toileting, fitness training, and increased fluid intake was accompanied by more bowel movements and continent stools, but there was no change in the number of incontinent bowel movements (87). However, 89% of these patients had an underlying evacuation disorder. In a trial comparing lactulose alone with lactulose plus glycerin suppositories, residents who had complete rectal emptying, as determined by a rectal examination, also had fewer FI episodes and soiled less frequently (88). Finally, a perineal washcloth with dimethicone reduced incontinence-associated dermatitis from 22 to 8%, whereas water and pH-neutral soap had no effect (89).

MECHANISMS OF NORMAL FECAL CONTINENCE AND PATHOPHYSIOLOGY OF FI

Fecal continence is maintained by anatomical factors, rectoanal sensation, and rectal compliance (90) (**Figure 1**). The internal anal sphincter, which is made of circular smooth muscle, maintains ~70% of anal resting tone. The external anal sphincter, comprising the striated muscle, accounts for the remaining component of resting tone. The puborectalis is a U-shaped component of the levator ani complex that also helps maintain the rectoanal angle at rest. The external sphincter, puborectalis, and levator ani can be voluntarily contracted further to preserve continence. Rectal distension by stool induces rectal contraction, the sensation of urgency, and reflex relaxation of the internal anal sphincter. Thereafter, if socially convenient, the pelvic floor muscles relax followed by defecation. If not, rectal contractions and the sensation of urgency generally subside as the rectum accommodates to continued distention. This, together with voluntary contraction of the external anal sphincter and puborectalis muscles, permits defecation to be postponed when necessary.

Bowel disturbances, typically diarrhea, and/or anorectal dysfunctions (i.e., anal sphincter weakness, reduced rectal compliance, and increased or reduced rectal sensation) can cause FI (91,92). Many patients have more than one disturbance (93). A majority of older women with FI have reduced anal resting and/or squeeze pressures, reflecting weakness of the internal and/or external anal sphincters, respectively (94). Anal sphincter damage, which is most frequently caused by obstetric or iatrogenic trauma, or neurogenic injury can cause anal weakness. The association between sphincter injury documented by imaging and weakness is incompletely understood. Neurogenic lesions can occur at any level of the axis extending from the central nervous system to the external anal sphincter (85). The most common causes of neurogenic injury include a peripheral neuropathy (e.g., due to diabetes mellitus), pudendal nerve stretch injury, or obstetric injury. Moreover, recent
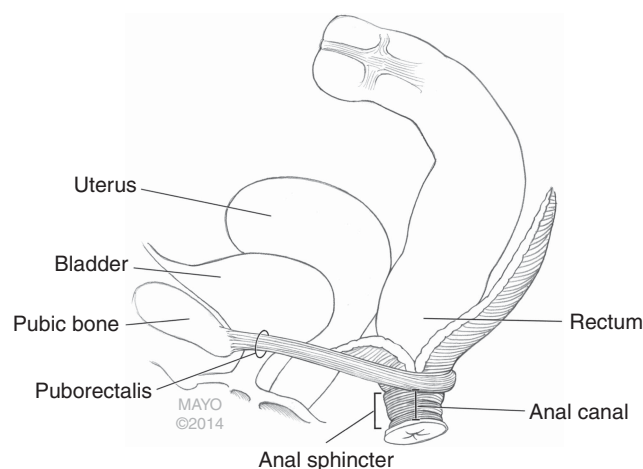

Figure 1. Mechanisms of normal and disordered fecal continence. In addition to formed stools, anatomical factors, rectoanal sensation, and rectal compliance contribute to fecal continence. Conditions that affect stool consistency, impair rectal capacity or sensation, weaken the anal sphincters and pelvic floor weakness, and limit mobility or mental faculties result in fecal incontinence (FI).

studies suggest that even asymptomatic older nulliparous women have anal sphincter neurogenic injury, which partly explained weak squeeze pressures (85). As needle electromyography is the only available technique for documenting neurogenic injury, newer, and preferably less invasive, approaches are necessary (95).

In addition to anal sphincter injury, FI is also associated with atrophy, denervation, and impaired function of the puborectalis muscle (94). Excessive straining may cause increased perineal descent that can stretch and thereby damage the pudendal nerve and also make the anorectal angle more obtuse.

Patients with FI may have normal, reduced, or increased rectal sensation (94,96). When rectal sensation is reduced, the external anal sphincter may not contract promptly when the rectum is distended by stool, predisposing to FI. Conversely, rectal hypersensitivity in FI may be partly secondary to an exaggerated contractile response to distention, and/or reduced rectal capacity, and may explain the symptom of rectal urgency (93,94,97–99). The pathogenesis of a smaller rectal reservoir, which may predispose to FI particularly when associated with anal weakness, is unknown. Finally, some patients with fecal seepage have high anal pressures and impaired rectal evacuation (100). Such patients may benefit from biofeedback retraining to not only improve rectal sensation and rectal coordination but also abdomino-pelvic coordination during defecation.

In summary, multiple physiological mechanisms preserve continence. Deficits in any of these mechanisms may contribute to FI and, as a consequence, no single physiological measure is consistently associated with FI. Treatments that target only one mechanism (such as sphincter weakness) are unlikely to benefit all patients with FI. It is unknown whether the phenotype based on symptoms and pathophysiological mechanisms is useful for guiding therapy for FI.

CLASSIFICATION OF FI

An ideal system for classifying FI would preferably be user friendly and preferably require less testing, provide discrete categories with minimal overlap among categories, be related to underlying mechanisms and guide therapy, and also predict the response to therapy. In contrast to UI, there is no widely accepted approach for classifying FI. Currently, FI is classified by separate systems based on etiology (**Table 3**), pathophysiology (i.e., bowel disturbances, anorectal dysfunctions), type of leakage (urge, passive, or combined), or symptom severity scales. At this meeting, it was proposed that these domains can be incorporated into a new system to comprehensively characterize FI. Consideration should be given to further developing this classification.

Area	Topics
Table 4. Suggestions for future research in fecal incontinence	
Epidemiology	• Evaluate the natural history of FI[a]
	• Assess the impact of modifying risk factors on incidence and natural history of FI[a]
	• Assess the patient's perspective in the measurement of FI
	• Further validate psychometric properties of instruments for evaluating symptom severity and QOL in FI
	• Develop novel methods of administering questionnaires using IRT and CAT that may improve the measurement of FI with less burden for patients
Low rates of consulting and low rates of screening by providers	• Facilitate screening for FI by providers (e.g., effective tools, educate providers) and health-seeking behavior in those with FI (e.g., reduce the stigma associated with FI, and identify a well-known personality to advocate for FI)[a]
	• Assess whether specific materials and methods are more successful in promoting health-seeking behavior in individuals with FI in minority racial and ethnic groups
Burden and economic impact	• Assess the associated costs of FI and incorporate cost effectiveness in diagnostic and treatment algorithms
Pathophysiology	• Refine approaches for classifying FI
	• Assess whether the "phenotype" facilitates targeted therapy for FI
	• A better understanding of the interaction between stool consistency and anorectal functions that contribute to FI
	• Identify the mechanisms of sphincter weakness in women without injury by imaging
	• Refine the ability of available imaging techniques to define the type (e.g., tear or scar) of anal sphincter injury and its functional consequences
	• Develop newer techniques to identify neurogenic anal sphincter injury.
	• Clarify the mechanisms of increased rectal stiffness and develop pharmacological approaches to restore rectal reservoir function in FI
	• Elucidate the mechanisms by which obesity predisposes to FI
	• Understand the contributions of age, menopause, and chronic straining to anorectal dysfunctions and FI

CAT, computerized adaptive testing; FI, fecal incontinence; IRT, item response theory; QOL, quality of life.
[a]These issues can also be evaluated specifically in the elderly.

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SUGGESTIONS FOR FUTURE RESEARCH

Table 4 summarizes the topics for future research in the epidemiology and pathophysiology of FI. These topics are an extension of the gaps in our current knowledge identified in this document.

In conclusion, FI is a common, but often underrecognized, symptom that can affect both men and women. Patient-centered terms such as accidental bowel leakage may be preferable to medical terms (e.g., FI) in communication with the public. Particularly, when severe, the symptom can substantially impair the QOL and, based on limited data, can have a substantial economic impact. Symptom severity and QOL can be quantified by questionnaires. Community studies suggest that bowel disturbances, particularly diarrhea, are the strongest risk factors for FI. Deficits in any of the multiple physiological mechanisms that preserve continence may also contribute to FI. There is considerable scope for enhancing our understanding of these issues, thereby facilitating identification of FI and improving the lives of people who have the symptom.

Study Highlights

WHAT IS CURRENT KNOWLEDGE

✓ Fecal incontinence (FI) is a common symptom and can have a devastating impact on the quality of life but is often underreported.

✓ The strongest independent risk factors for FI in the community are bowel disturbances, especially diarrhea, the symptom of rectal urgency, and burden of chronic illness.

✓ Diarrhea, anal and pelvic floor weakness, reduced rectal compliance, and reduced or increased rectal sensation contribute to FI; many patients have multifaceted anorectal dysfunctions.

✓ Symptom severity in FI and its impact on the quality of life can be classified by validated scales. Symptom severity scales should incorporate the frequency, volume, consistency, and nature (urge or passive) of stool leakage.

WHAT IS NEW HERE

✓ Despite the basic understanding of FI, there are still major knowledge gaps in epidemiology and pathogenesis, necessitating future clinical trials.

✓ Several topics for future research were identified in this conference and summarized in this article.

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