Project Title

Gastrointestinal Symptom Rating Scale Constipation Scores Among Age Groups

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Abstract

The Gastrointestinal Symptom Rating Scale (GSRS) is used to measure gastrointestinal symptoms, such as constipation, in healthy populations, but it has not been validated for this purpose. This study was designed to examine whether the GSRS detects differences in constipation symptoms between age groups of healthy people. It was expected that as age increased, GSRS constipation scores would increase. Data were extracted and pooled from seven studies completed over the past seven years. The data included healthy individuals aged 18-87 years (n=1404). A linear regression yielded no correlation between GSRS constipation scores and age (adj R^2= 0.0041). Chi-square tests between counts within GSRS constipation score categories (either <2 or ≥2) and three age categories or six age/fiber intake categories yielded no significant differences in the prevalence of higher GSRS constipation scores between different age groups (P=0.186, P=0.448). However, the prevalence of GSRS constipation score of ≥2 was higher in females than in males (27.5% vs. 17.8%, P<0.001). The results were potentially affected by a large number (n=1121, 80%) of participants in the younger age group. Further research is required in a population where age groups are more evenly divided to determine whether the GSRS captures constipation symptoms in healthy populations.

Introduction

The Gastrointestinal Symptom Rating Scale (GSRS) was originally developed in 1988 to capture gastrointestinal symptoms in patients with irritable bowel syndrome and peptic ulcer diseases (1). The questionnaire consists of fifteen items under five different categories: diarrhea syndrome, constipation syndrome, abdominal pain, indigestion syndrome, and reflux syndrome. The scale ranges from one to seven, with one being no discomfort at all and seven being very severe discomfort. The constipation syndrome includes questions related to constipation, hard stools, and feeling of incomplete evacuation. The GSRS has also been tested for reliability and validity in patients with gastroesophageal reflux disease (GERD) (2). The internal consistency ranged from 0.61-0.83. Higher GSRS scores were reported by patients with more GERD related symptoms diagnosed by clinicians. Patients who were responsive to ranitidine treatment had significantly lower reflux syndrome scores than those who did not respond well to ranitidine therapy. It was concluded that the GSRS is a fair comprehensive tool to assess gastrointestinal symptoms. It was also concluded that the GSRS has good internal consistency reliability in European patients with suspected duodenal ulcer (3). The GSRS has also been tested for reliability and validity in patients with reflux and dyspepsia (4). Its internal consistency reliability ranged from 0.43 to 0.87 for this population. The questionnaire had acceptable ranges of reliability and validity even in different versions from various languages. The questionnaire also demonstrates validity because the GSRS scores have correlated with symptoms assessed by physicians. These results applied to the German, Hungarian, Italian, Polish, Spanish and Afrikaans versions (4). This six-

country study included the German version of the GSRS validated in a population of patients with reflux and dyspepsia. The internal consistency ranges from 0.53 to 0.91. Specifically, the Cronbach's alpha for GSRS constipation was 0.75. It was concluded that the German version of the GSRS has good reliability and validity, along with the other five versions (5).

Although widely used by researchers to assess gastrointestinal symptoms in healthy populations, the scale was originally designed and tested to capture gastrointestinal symptoms in diseased populations. The questionnaire has not yet been validated in a healthy population. GSRS scores were significantly lower for diarrhea and constipation, and higher for the indigestion syndrome score when 5 g of galactooligosaccharide was consumed by undergraduate students undergoing an academic stress (6). This shows that the GSRS captures changes in gastrointestinal symptoms in healthy populations undergoing an acute psychological stress.

Most research estimates that the prevalence of constipation is 12-19% in the general population and that the prevalence of constipation increases with age (7). The prevalence of constipation in people aged 30-64 years fluctuates around 20-30% and from around 30% to 50% in people aged 65-84 years, whereas it increases to over 50% in people over 85 years old.

There are known differences in gastrointestinal symptoms between males and females. The ratio of females to males who experience constipation varies across studies from 1.01

to 3.77, but the higher ratios around 3.77 (i.e. more females experience constipation than males) are often from self-reported constipation rather than a standardized criteria such as the Rome III criteria (7). Research has also shown that the prevalence of constipation in females and males who are 65 years old or older is 26% and 16%, respectively (8). At 84 years of age, the prevalence of constipation rises to 34% in females and 26% in males (9). This increase in constipation is a concern for older populations.

A systematic review was conducted to evaluate the effect of laxatives and fiber on stool frequency in elderly adults (10), since constipation is known to be more prevalent in older adults and can sometimes be helped by fiber or laxative consumption. It was shown that laxatives and fiber can increase bowel movement frequency by 1.4 bowel movements per week. Laxatives and fiber improved bowel frequency in adults with chronic constipation, but it could not be concluded whether fiber or laxatives were more effective.

Since research has shown that constipation increases with age, this study examines the potential for the GSRS to detect this increase shown by increased constipation scores in healthy people of older ages. This study also aims to examine whether the prevalence of higher GSRS constipation scores increases with age. An increase in GSRS constipation scores or an increase in the number of people with higher constipation scores in older populations would help justify the use of the GSRS to assess gastrointestinal health in healthy populations.

It is hypothesized that as age increases, so will GSRS constipation scores. This may however be dependent on fiber intake, since some older adults may not be able to consume as many fiber-containing foods due to chewing difficulty, gut disorders, or chronic diseases (11). Hence, the expected increase in GSRS constipation scores in older adults would also be expected to be smaller in people with higher fiber consumption. If the GSRS constipation scores do not increase with age and the prevalence of higher GSRS constipation scores also does not vary with age, then either the questionnaire may not be capturing changes in gastrointestinal symptoms in healthy populations or the sample in this study might not be evenly distributed among the age groups.

Materials and Methods

IRB approval from the University of Florida (IRB201701465) was obtained to use data that has been previously collected from different studies in the Food Science and Human Nutrition Department at the University of Florida. The extracted data included identification number, age, sex, daily fiber intake, daily calorie intake, and GSRS scores. Dietary fiber intake was expressed as grams/1000 kcal. The studies that were examined included the ABC (12), SAM (13), COP (14), JEN (15), AAF (16), BIF (17, 18), and GOS (6) studies **(Tables 1 and 2)**. Constipation, hard stools, and feeling of incomplete evacuation item scores, which ranged from 1=no discomfort to 7=very severe discomfort, were averaged to obtain a final GSRS constipation syndrome score. In the original version the individual scores for all the syndromes are added to get the GSRS total score

for a total minimum of 15 and a total maximum of 105. The scores for the individual symptoms are calculated by taking the average of the items within that category (1).

The data set excluded participants who were missing age or GSRS scores. The age range of the study participants was from 18 years to 87 years. The sample size consisted of 1404 participants. Of these, 869 were females and 535 were males. The mean age was 27.2 ± 15.6 years old.

The program SigmaPlot (version 13.0; Systat Software Inc, San Jose, CA) was used to analyze the data. A data set was created with age as the independent variable and baseline (i.e. not affected by any experimental intervention) GSRS constipation syndrome score for each participant as the dependent variable. A linear regression statistical test was run. A chi-square test was deemed appropriate to determine whether there was an increase in the prevalence of higher GSRS constipation scores (i.e. ≥2) by age groups. Constipation syndrome score categories were then created because those participants that reported having a constipation syndrome score of 1 meant that they had no discomfort. The cutoff was chosen based on what was deemed clinically relevant; according to the GSRS, a score of one means no symptoms and a score of two means slight discomfort. The age groups were chosen based on a highly cited epidemiological study (7). The age groups were i) 18-29 years because it mostly consisted of a college student population, ii) 30-49 years because the prevalence of constipation ranges in the lower twenty percent, and iii) at least 50 years old because the prevalence of constipation was over 25%. A chi-square

test between counts within GSRS constipation score categories (either <2 or ≥2) and three age categories (18-29 years old, 30-49 years old, and ≥50) was used.

Five of the studies had fiber data available and were included in this analysis (ABC (12), SAM (13), COP (14), JEN (15), AAF (16)). Fiber intake was included in the analysis since it could potentially have a modulating effect on constipation scores. The data were divided into six categories based on GSRS scores, age group, and fiber intake. The fiber cutoff was chosen to be 10 g based on the average fiber consumption (10.1 g/1000 kcal). Those who consumed less than 10 grams of fiber were separated from those consuming 10 or more grams of fiber per 1000 kcal. The groups were <10 g of fiber, 18-29 years old; ≥10 g of fiber, 18-29 years old; <10 g of fiber, 30-49 years old; ≥10 g of fiber, 30-49 years old; <10 g of fiber, 50+ years old; ≥10 g of fiber, 50+ years old. All of these were further separated into GSRS score categories of <2 or ≥2. To assess the effect of fiber on constipation scores between age groups, a chi-square test between GSRS constipation scores categories (either <2 or ≥2) and six fiber/age categories was run.

The prevalence of higher GSRS constipation scores (i.e. a score of at least 2) was also analyzed between sexes. The data were divided between males and females and between GSRS constipation scores of <2 or ≥2 so that there were four categories. A chi-square test was run between the categories. Data are reported as means ± SD. Significance is denoted at $P<0.05$.

Results

The adults aged 18-87 years in this study had an average constipation symptom score of 1.54 ±0.76, and 23.8% of these adults had scores of at least 2 while 76.2% had scores of less than 2. A linear regression was used to examine the relationship between GSRS constipation scores and age. There was no significant relationship between GSRS constipation syndrome scores and age (Adjusted R^2=0.00402) **(Figure 1)**.

A chi-square test with two GSRS constipation scores categories of <2 or ≥2, and three age categories (18-29 years, 30-49 years, or ≥50 years) yielded no significant difference in the prevalence of higher GSRS constipation scores among the different age groups (P=0.186) **(Table 3)**.

The average fiber per 1000 kcal was 10.1 ± 3.6 g with females consuming a slightly higher amount of fiber at 10.4 ± 3.6 g/1000 kcal versus males consuming 9.3 ± 3.6 g/1000 kcal. A chi-square rest yielded no significant difference in counts of GSRS constipation scores ≥2 between age and fiber intake groups (P=0.448) **(Table 4)**.

A chi-square test was used to examine the difference in the prevalence of GSRS constipation scores ≥2 in males and females. The test showed that GSRS constipation scores were higher in females than in males (P<0.001) **(Table 5)**.

Discussion

The purpose of this study was to examine whether the GSRS captures constipation symptoms in a healthy population. Adults of increased ages typically have a higher prevalence of constipation (7). The results indicated that there was no relationship between GSRS constipation scores and age, and the prevalence of constipation GSRS scores ≥2 (i.e. slight discomfort) did not increase with age. This was not expected. The prevalence of constipation GSRS scores ≥2 once the fiber categories were included in the chi-square analysis also did not increase with age. However, the results did show that the prevalence of higher constipation scores is higher in females than in males, and this is consistent with other studies (7-9). However, in this study, the females were more represented than males making 61.9% of the sample, whereas males represent 38.1% of the sample. The male to female ratio was consistently lower than 1 throughout all the studies.

There is a possibility that the GSRS is not capturing constipation symptoms in healthy populations, but based on a previous study, the GSRS scores were significantly lower for constipation when academically stressed participants were supplemented with galactooligosaccharide (6). This means that in a previous study the GSRS was responsive to constipation symptoms in an academically stressed college population, but perhaps the changes with age are smaller in magnitude than the changes when a supplement is added, or constipation symptoms are not as prevalent in a sample of healthy people as it is on a

sample of academically stressed college students. Further research is required to determine if the GSRS is capturing changes in constipation symptoms with age.

One of the limitations of this study was that the pooled data consisted primarily of college students. The average age was 27.2 ± SD years old even though the age ranged up to 87 years old. A greater sample size that has a similar number of people in each age group should make the results more representative of the population. Lifestyle differences between a college population and the general population can possibly affect constipation scores. College students tend to have different dietary habits, such as unhealthy snacks and low intake of fruits and vegetables (19) and more psychological stress (20). The prevalence of constipation as measured by Rome III in the general population is usually around 12-19%, but can range from 1.9-27.2% (7). In this sample, the prevalence of GSRS scores ≥2 was 23.7%. This difference could be due to the way constipation is measured or to differences in the sample included in this study.

Another possible limitation was that the inclusion/ exclusion criteria of the studies used in these analyses were designed to see larger differences in the treatment versus the control groups. For example, some of the studies limited fiber intake, the use of probiotics, and prebiotics, and medications. Although the data used were from baseline (i.e. before intervention), some participants had been excluded. Hence, this sample might not represent the general population. It is possible that the participants may be healthier or taking fewer medications that may contribute to constipation than the general population.

Various methods are used in research to assess fiber intake. The Automated Self-Administered 24-Hour (ASA-24) Dietary Assessment is a 24-hour dietary recall, and was used to assess fiber intake in ABC (12) and COP (14). The ASA-24 was found to be a somewhat effective tool for predicting fiber intakes, but may overestimate fiber intake from most dietary sources (21). The food frequency questionnaire (FFQ) is another fiber assessment tool that asks about how often a person consumes certain foods, and was used in SAM (13), JEN (15), and AAF (16). This questionnaire overestimates as well as underestimates intakes of various nutrients and food (22). An adequate intake is considered to be 14 g/1000 kcal per day (23). The average fiber intake was 10.1±3.6 g fiber/ 1000 kcal per day. Even if the participants consumed well over 1000 kcal, fiber intake was still low. It was expected that they would have experienced some constipation symptoms.

The Rome III criteria for constipation ask about symptoms occurring in ≥25% of defecations for the past 3 months: straining, lumpy or hard stools, sensation of incomplete evacuation, sensation of anorectal obstruction/ blockage, manual maneuvers to facilitate defecation. It also includes <3 defecations per week and loose stools rare without the use of laxatives (24). The GSRS constipation syndrome includes items related to hard stools, constipation (decreased passage of stools), and feeling of incomplete evacuation to measure constipation symptoms, not constipation itself. A GSRS score of 1 means no discomfort and a 2 means slight discomfort, hence it is clinically relevant. The Rome III criteria might not necessarily define a GSRS

constipation syndrome score of a 2 as constipation. However, Rome III positive patients have more severe symptoms as measured by the GSRS (25).

Conclusions

Even though epidemiological studies have shown that constipation increases with age, age did not have a significant effect on GSRS constipation scores in the sample investigated. No significant relationship was observed between age and GSRS constipation scores in a linear regression test or between age and the prevalence of constipation scores ≥2 in a chi-square test. It was hypothesized that fiber could have a mediating effect on constipation symptoms, but it did not have any significant mediating effect on constipation scores ≥2 in a different chi-square test. However, a significant difference in the prevalence of constipation scores ≥2 was observed between males and females, with females having higher GSRS constipation scores. This is consistent with other studies. Future investigation should examine why males and females have different GSRS constipation scores when they consume a similar amount of fiber.

The GSRS might not have captured changes in constipation scores among different age groups because ages were not evenly distributed in the sample or because the individual studies were not designed to capture gastrointestinal symptoms in healthy populations. It can also be attributed to how the Rome III criteria define constipation compared to how the GSRS defines constipation symptoms. Constipation symptoms and constipation are still relevant in the general population and in research. Prospective studies are required to

assess the association between GSRS scores and prevalence across the life span. In this way, it can be determined if the GSRS captures gastrointestinal symptoms in healthy populations or if a new tool should be developed for this purpose.

Supporting Tables and Graphs

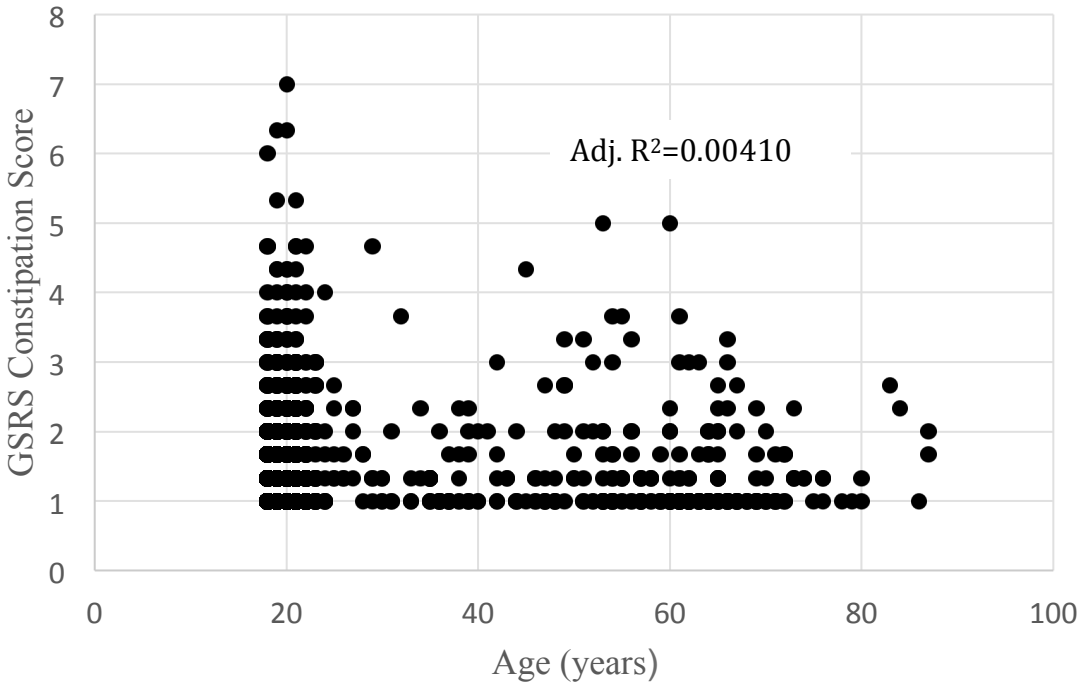

Figure 1: Linear regression of Gastrointestinal Symptom Rating Scale (GSRS) constipation syndrome scores versus age. GSRS scores represent the average of three symptoms (constipation, hard stools, and feeling of incomplete evacuation) rated 1 = no symptoms to 7 = very severe discomfort.

Table 1: Inclusion criteria for the pooled studies.

Study	Inclusion/Exclusion Criteria
ABC (12)	• Included parents (18-40 years) with at least 1 child (3-6 years) • Were not allergic to nuts • Were not taking immune enhancing supplements, medications for gastrointestinal symptoms • Were not being treated for any physician-diagnosed immune modulating or gastrointestinal disease • Had not received antibiotic therapy or colonoscopy in the last 2 months
SAM (13)	• Included healthy adults 65-80 years old • Were not taking immune enhancing supplements or probiotics • Were not smokers • Were not taking medications for gastrointestinal symptoms such as constipation, diarrhea or inflammation or being treated for immune or gastrointestinal disease • Had not received chemotherapy, immune suppressing therapy or antibiotic therapy in the last 2 months
COP (14)	• Included men and non-pregnant women 35-65 years old with waist circumference >102 cm for males and >88 cm for females • Were able to consent in English • Were willing to maintain regular dietary intake and levels of physical activity for 18 weeks • Were not taking immune enhancing supplements, prebiotics or probiotics • Had not taken statins or cholesterol-lowering medications in 6 months • Were not taking medications for constipation or diarrhoea regularly • Were not taking androgens or receiving immune suppressing interventions • Were not taking plant sterols, n-3 fatty acids, fish oil, soy protein, soluble oat fiber, psyllium seed husk or other cholesterol lowering supplements in 3 months • Were not being treated for or have physician-diagnosed diseases (except gastroesophageal reflux disease) • Did not have a central venous catheter, colostomy, or ileostomy • Were not taking medications for type 1 or type 2 diabetes • Did not receive antibiotic therapy or colonoscopy in 2 months • Did not typically consume >20 g of fiber daily • Were not physically active (daily living activities plus ≥60 minutes of daily moderate activity)

JEN (15)

- Included healthy male and female adults between the ages 18-60 years old
- Experienced some seasonal allergies with a score ≥2 global score
- Consented in English
- Maintained their physical activity and diet for eight weeks
- Were consuming probiotics or immune enhancing supplements
- Did not use allergy medications ≥5 days/ week
- Were not pregnant
- Were not taking corticosteroids or anti-inflammatory drugs
- Were not being treated for a physician diagnosed disease and were not receiving chemotherapy
- Did not have a central venous catheter
- Were not receiving chemotherapy or immune-suppressing therapy for a year

AAF (16)

- Included healthy adults ≥60 years of age
- Had at least one cold in the previous year
- Did not have chronic allergies
- Were not taking anti-inflammatory medications
- Were not smokers
- Did not receive antibiotics or have a cold in the past 2 months
- Were willing to discontinue fiber or potential immune-enhancing supplements
- Did not have a cold on the last day of the study

BIF (18)

- Included healthy, full-time undergraduate students who had one or more exams during finals week
- Had one cold in the past year, but were otherwise healthy
- Had internet access
- Were willing to discontinue probiotics or immune-enhancing supplements.
- Were not smokers
- Did not have chronic allergies
- Were not receiving immune suppressing intervention in the last year or antibiotics in the last 2 months

GOS (6)	• Included healthy University of Florida full-time students aged 18 years old or older who experienced a cold in the last year • Did not have chronic allergies, milk allergies or immunosuppressive illnesses • Had internet access • Had at least one exam during finals week • Were not smokers • Did not receive antibiotics in the last 2 months • Were willing to discontinue probiotics, fibers supplements and immune-enhancing supplements • Did not have a cold on the last day of enrollment

Table 2: Demographic characteristics and Gastrointestinal Symptom Rating Scale (GSRS) constipation symptom scores in participants from each of the studies included in the pooled analysis.[1]

Study	Age (years)	Daily fiber intake (g/1000 kcal)	Constipation syndrome score	n	n, % females	n, % males
GOS (6)	19.8±1.5[2]	N/A	1.62±0.85	424	215, 50.7%	209, 49.3%
BIF (18)	19.9±1.6	N/A	1.53±0.71	569	364, 64.0%	205, 36.0%
JEN (15)	27.1±12.2	10.1±3.4	1.53±0.81	167	115, 68.9%	52, 31.1%
ABC (12)	35.0±3.0	10.3±3.2	1.36±0.42	28	23, 82.1%	5, 17.9%
COP (14)	52.3±7.7	9.1±3.8	1.50±0.72	102	78, 76.5%	24, 23.5%
AAF (16)	66.3±6.8	10.8±3.7	1.35±0.70	81	50, 61.7%	31, 38.3%
SAM (13)	69.8±3.7	11.6±4.1	1.44±0.61	34	24, 70.6%	10, 29.4%
Overall	27.2±15.6	10.1±3.6	1.54±0.76	1404	869, 61.9%	535, 38.1%

[1]Data represent the baseline data prior to the start of any intervention. GSRS scores reflect the average of three symptoms (constipation, hard stools, and feeling of incomplete evacuation) rated 1 = no symptoms to 7 = very severe discomfort.

[2]Values are means ± SD.

Table 3: Comparison of counts within constipation score categories Gastrointestinal Symptom Rating Scale GSRS>2 or GSRS ≥2 among three different age groups (18-29, 30-49, or ≥50 years).[1]

Age Categories	GSRS <2	GSRS≥2	
18-29 y	843	278	Count
	75.2	24.8	Row %
30-49 y	65	18	Count
	78.3	21.7	Row %
≥50 y	162	38	Count
	81.0	19.0	Row %

[1]Data represent the baseline data prior to the start of any intervention. GSRS scores reflect the average of three symptoms (constipation, hard stools, and feeling of incomplete evacuation) rated 1 = no symptoms to 7 = very severe discomfort. A chi square test was used (P=0.186)

Table 4: Comparison of counts within constipation score categories Gastrointestinal Symptom Rating Scale GSRS>2 or GSRS ≥2 among six different age/fiber intake groups (18-29 years, <10 g fiber; 18-29 years, ≥10 g fiber; 30-49 years, <10 g fiber; 30-49 years, ≥10 g fiber; ≥50 years, <10 g fiber; or ≥50 years, ≥10 g fiber). [1]

Fiber intake and age categories	**GSRS <2**	**GSRS≥2**	
<10 g, 18-29 y	55	18	Count
	75.3	24.7	Row %
≥10 g, 18-29 y	39	14	Count
	73.6	26.4	Row %
<10 g, 30-49 y	38	13	Count
	74.5	25.5	Row %
≥10 g, 30-49 y	24	5	Count
	82.8	17.2	Row %
<10 g, ≥50 y	83	25	Count
	76.9	23.1	Row %
≥10 g, ≥50 y	77	13	Count
	85.6	14.4	Row %

[1]Data represent the baseline data prior to the start of any intervention. GSRS scores reflect the average of three symptoms (constipation, hard stools, and feeling of incomplete evacuation) rated 1 = no symptoms to 7 = very severe discomfort. A chi square test was used (P=0.448).

Table 5: Comparison of counts within constipation score categories Gastrointestinal Symptom Rating Scale GSRS>2 or GSRS ≥2 among males and females. [1]

	GSRS <2	**GSRS≥2**	
Females	630	239	Count
	72.5	27.5	Row %
Males	440	95	Count
	82.2	17.8	Row %

[1]Data represent the baseline data prior to the start of any intervention. GSRS scores reflect the average of three symptoms (constipation, hard stools, and feeling of incomplete evacuation) rated 1 = no symptoms to 7 = very severe discomfort. A chi test was used ($P<0.001$).

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