

# Digital disease management programme reduces chronic gastrointestinal symptoms among racially and socially vulnerable populations

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## ABSTRACT

**Objective** Considerable disparities exist in access to gastrointestinal (GI) care and digestive outcomes across gender, racial, and socioeconomic groups. We evaluated (1) whether adults with chronic GI symptoms from diverse demographic groups would use a digital digestive care programme and (2) the effects of participation on GI symptom severity and other patient-reported outcomes.

**Methods** Access to a digital digestive chronic care programme was provided to participants regardless of prior digestive diagnoses or symptoms for 90 days. The intervention included GI symptom tracking, personalised medical nutrition therapy, GI-specific health coaching, and targeted education on common GI symptoms. We assigned a Social Vulnerability Index (SVI) score to each participant according to their home address and compared baseline and end-intervention symptoms and other patient-reported outcomes by gender, race/ethnicity, and SVI.

**Results** Of the 1936 participants, mean age was 43.1 years; 67% identified as white/Caucasian, 11% Asian/Pacific Islander, 6% Hispanic/Latinx, 7% black/African American, and 7% of multiple races. Participants of all demographic groups used the app symptom logging, reviewed educational materials, and interacted with their care team and reported similar statistically significant improvements in GI symptoms (by the end of the intervention, 85% improved,  $p < 0.05$ ). Participants reported feeling greater control of their health (83%), better able to manage their digestive symptoms (83%), increased happiness (76%), and greater productivity at work (54%), with black/African Americans and Native Americans most likely to report these changes.

**Conclusion** We conclude that a digital GI disease management programme may be of value in reducing disparities in access to GI care.

## INTRODUCTION

In the USA, chronic gastrointestinal (GI) diseases account for substantial morbidity, mortality, and cost, including 105 million ambulatory care visits, 14 million hospital admissions, 236 000 deaths, and \$142 billion in total costs annually.<sup>1–4</sup> Considerable disparities exist in the prevalence of GI conditions

### WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Considerable disparities exist in the prevalence of gastrointestinal (GI) conditions and access to care for them across racial and socioeconomic groups. Digital digestive care solutions have been shown to be effective in improving health outcomes.

### WHAT THIS STUDY ADDS

⇒ We demonstrated that a digital digestive healthcare solution is appealing across racial and socioeconomic groups and a potentially promising approach for reducing health disparities.

### HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Implementations of digital digestive health programmes that include virtual GI-focused dietitians and GI specialty health coaches could provide access to traditionally underserved populations—thus, they warrant comprehensive evaluations.

and access to care for them across racial and socioeconomic groups, including constipation, *Helicobacter pylori* infection and associated gastritis, hepatitis B and C, non-alcoholic fatty liver disease and non-alcoholic steatohepatitis, gallbladder disease, pancreatitis, GI cancers, and obesity.<sup>5,6</sup> Notably, black/African Americans have the highest incidence of colorectal cancer (CRC) of any racial group in the USA and twice the hepatitis C and liver cancer as white/Caucasians.<sup>5</sup> Healthcare-related inequities such as lower access to screening and care, education and health literacy, and food and nutrition resulting in poorer outcomes have been noted for people with irritable bowel syndrome (IBS), inflammatory bowel disease, and GI cancers.<sup>7–11</sup> For example, disparities in CRC screening rates are responsible for 42% of the disparity in CRC incidence and 19% of the disparity in mortality rates for black and white patients.<sup>5</sup>



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Chronic GI symptoms peak in mid-life, affect working adults,<sup>4</sup> and employees who report GI symptoms are more likely to miss work, be less productive, and quit their jobs than those who do not have chronic GI symptoms.<sup>12 13</sup> Thus, employers bear a significant burden of the costs associated with GI conditions. Moreover, numerous employers have prioritised efforts to reduce healthcare disparities by gender, race, LGBTQ+ status, and socioeconomic status.<sup>14</sup> Unfortunately, studies have not been published on employer-sponsored interventions that specifically address disparities for diverse populations with GI conditions.

We compared engagement and clinical outcomes associated with the use of a digital digestive chronic care programme across demographically diverse populations. The intervention included longitudinal GI symptom tracking, personalised medical nutrition therapy, GI-specific health coaching, and targeted education on nine common GI symptoms. We sought to characterise, first, whether adults with chronic GI symptoms from various gender, racial, and socioeconomic groups would use an app for symptom monitoring and, second, the effects of participation in a digitally delivered chronic care programme on GI symptom severity by group.

## METHODS

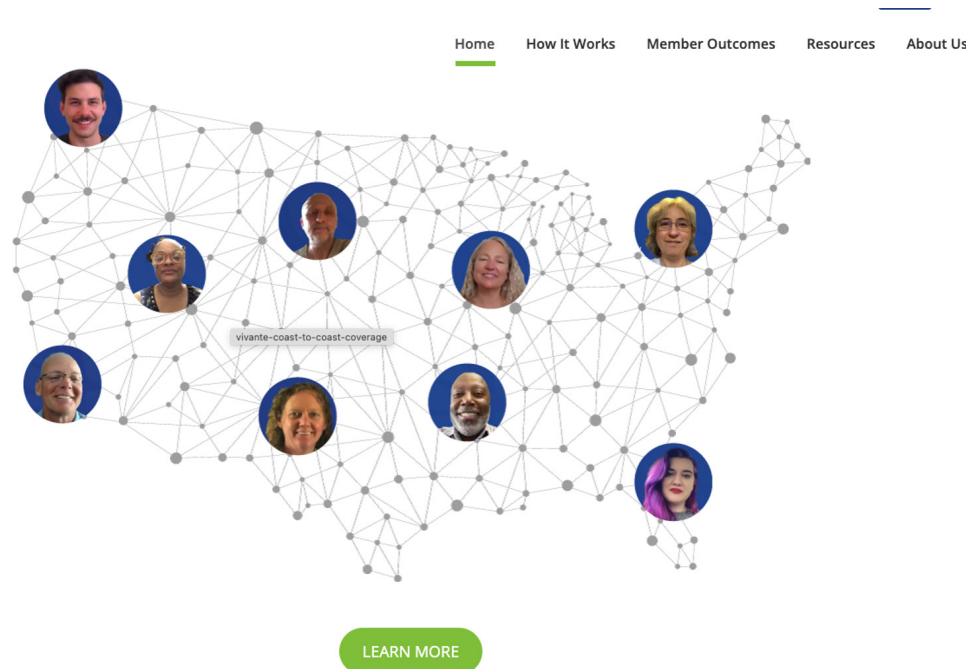
### Recruitment

Access to a digital digestive chronic care program called Cylinder was provided to US employees of participating companies via their employee benefits regardless of prior digestive diagnoses or symptoms.<sup>15</sup> Participants were recruited via employer-approved marketing materials via mailings, emails, and other outreach. Recruitment materials and all content were specifically designed to be

attractive to patients from diverse geographies, genders, and racial/ethnic groups and highlighted the importance of digestive wellness to overall health, and targeted individuals suffering from common GI symptoms such as heartburn, gas, bloating, and indigestion (Figure 1). Materials aim to be developed at the 6th–8th grade reading level. Those who enrolled in the programme between 1 January 2022 and 28 November 2023, and tracked symptoms on more than one occasion on the app between days 30 and 90 after registration were eligible to participate in this evaluation. Participants were given free access to the digital digestive chronic care programme but were not otherwise compensated for their participation.

### Data collection

At baseline, participants completed an intake survey with questions regarding their demographics, GI history, including previously diagnosed GI conditions, and digestive symptoms over the last week. Surveys and symptom tracking were administered within the app. We assigned a Social Vulnerability Index (SVI) score to each participant according to their home census tract according to the Centers for Disease Control and Prevention.<sup>16</sup> The SVI is presented as a percentile from 0 (least vulnerable) to 1 (most vulnerable) that allows geographies to be directly compared based on 16 measures across four categories per geography: socioeconomic status (rate of population below 150% of the federal poverty line, unemployed, high housing cost burden, no high school diploma, no health insurance); household characteristics (per cent of aged 65 or older, aged 17 or younger, civilians with a disability, single-parent households, English language proficiency); racial and ethnic minority status; housing type and transportation (rate of multiunit structures,



**Figure 1** Example recruiting materials/website.



**Table 1** Baseline participant characteristics

Characteristic	Total	Caucasian/white	Asian/Pacific Islander	African American/black	Latinx/Hispanic	Native American	Multiple races	Other	P value (among racial groups)
n (%)	1936 (100)	1292 (66.7)	215 (11.1)	139 (7.2)	116 (6.0)	6 (0.3)	141 (7.3)	27 (1.4)	n/a
Age, years (SD)	43.0 (11.5)	42.9 (11.6)	42.4 (11.2)	44.4 (11.9)	43.0 (11.2)	51.3 (8.2)	43.0 (12.0)	42.4 (10.0)	0.5
Gender, n (%)									
Female	1450 (74.9)	993 (76.9)	133 (61.9)	117 (84.2)	85 (73.3)	4 (66.7)	101 (71.6)	17 (63.0)	<0.001
Male	474 (24.5)	290 (22.4)	82 (38.1)	22 (15.8)	31 (27.7)	2 (33.3)	39 (27.7)	8 (29.6)	
Prefer not to disclose	12 (0.6)	9 (0.7)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.7)	2 (7.4)	
SVI	0.42 (0.20)	0.41 (0.19)	0.35 (0.18)	0.53 (0.20)	0.50 (0.24)	0.49 (0.13)	0.42 (0.21)	0.38 (0.15)	<0.001
BMI (kg/m <sup>2</sup> )									
18.5 or less	31 (1.6%)	15 (1.2%)	7 (3.3%)	0 (0%)	2 (1.7%)	0 (0%)	6 (4.3%)	1 (3.7%)	<0.001
18.5–25	650 (33.6%)	425 (32.9%)	112 (52.1%)	12 (8.6%)	24 (20.7%)	3 (50%)	64 (45.4%)	10 (37.0%)	
25–30	599 (30.9%)	403 (31.2%)	67 (31.2%)	45 (32.4%)	44 (37.9%)	1 (16.7%)	33 (23.4%)	6 (22.2%)	
30 or greater	656 (33.9%)	449 (34.8%)	29 (13.5%)	82 (59.0%)	46 (39.7%)	2 (33.3%)	38 (27%)	10 (37.0%)	

BMI, body mass index; SVI, Social Vulnerability Index.

mobile homes, crowding, no vehicle, group quarters).<sup>17</sup> Since we collected racial group from patients directly, we report the total SVI and the three other SVI categories.

### GI symptoms

Participants logged their digestive symptoms during the course of their care to track clinical progress and guide subsequent interventions. They rated nine common GI symptoms (abdominal pain, bloating, diarrhoea, constipation, reflux, gas, nausea, vomiting, and loss of bowel control) on a 5-point scale: 0 (no symptoms), 1 (mild symptoms), 2 (moderate symptoms), 3 (severe symptoms), and 4 (very severe symptoms). We computed individual scores for each of the nine symptoms and an overall digestive symptom score (0–36, computed as the sum of each of the scores) at baseline and at the last recorded symptom tracking between 30 and 90 days. If participants recorded symptoms more than once per day, we used the last data they provided.

### Patient-reported outcomes

On day 28 of the programme, participants were sent a five-item survey about their experience with the programme. Four questions had three response options (yes, no, or not applicable): (1) ‘Since joining the program, I feel more in control of my health’; (2) ‘I’m happier since using the program’; (3) ‘Since joining the program, I feel more productive at work’; and (4) ‘The program has helped me better manage my digestive symptoms’. The fifth question asked, ‘Where would you have gone for digestive health care if you had not signed up for the program?’

### Intervention

The digital digestive chronic management programme has been described elsewhere.<sup>18</sup> Briefly, it includes four key components: symptom tracking, personalised medical nutrition therapy, GI-specific health coaching, and targeted education.

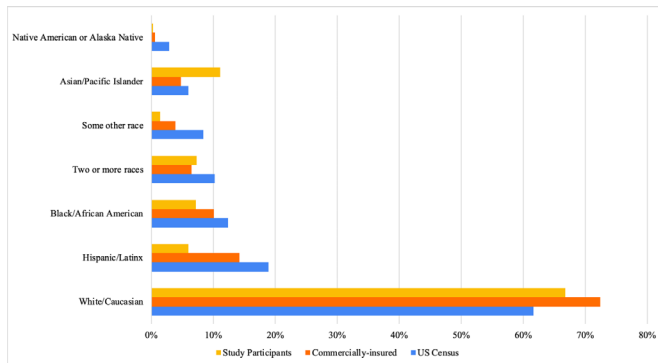
### Symptom tracking

The app facilitates symptom tracking so users can see how their symptoms have changed over time. The care team evaluates how dietary and lifestyle changes affect symptoms. For participants reporting highly acute symptoms, nursing staff are available on call at all times to provide support, education, and triage to the appropriate level of care.

### Personalised nutrition therapy

Registered dietitians provide individualised, evidence-based,<sup>7 17 19</sup> and culturally sensitive medical nutrition therapy. Topics of discussion include nutritional monitoring and management of common GI conditions (eg, Crohn’s disease, ulcerative colitis, IBS), chronic symptoms (eg, constipation, diarrhoea), specialised diets (eg, ostomy nutrition, elimination diets, FODMAP (fermentable oligosaccharides, disaccharides, monosaccharides and polyols diets)), among other topics (eg,





**Figure 2** Comparison of race/ethnicity of the study population, the US commercially insured population, and the overall US population.

food allergies, small intestinal bacterial overgrowth, access to food, malnutrition, and barriers to meeting nutrition needs). Dietitians use the platform's educational resources, health coaches, on-demand nursing referrals, and external referrals as needed to optimise patient care.

### GI health coaching

GI coaches used digestive health protocols to provide culturally sensitive individualised support with goal setting, lifestyle management (eg, stress reduction, mindfulness, healthy sleep, physical activity), medication adherence, self-advocacy, self-monitoring, cognitive-behavioural therapy, and assistance with the app.

### Targeted education

Each participant has a personalised care plan that includes targeted education on their conditions, symptoms, and supportive lifestyle interventions. Each time users interact with the app, they are reminded of the key interventions to drive clinical outcomes based on their clinical status and can access additional resources (eg, courses, articles, recipes, and weekly webinars).

### Statistical analysis

We compared means at baseline for each of the outcomes of interest by gender, race/ethnicity, and SVI using  $\chi^2$  testing. We evaluated patterns of engagement, symptom clustering, and change in symptoms by analysis of variance and considered p values <0.05 to be statistically significant. Analyses were performed using SPSS V.29.

## RESULTS

### Participant characteristics

Overall, 1936 participants completed the registration process and were enrolled in the study. Of these, 67% identified as white/Caucasian, 11% as Asian/Pacific Islander, 6% as Hispanic/Latinx, 7% as black, and 7% as being of multiple races (table 1). Compared with the US commercially insured population,<sup>20</sup> participants were more likely to be Asian/Pacific Islander and identify as multiple races but less likely to be white/Caucasian or Hispanic/Latinx (figure 2).<sup>21</sup> The average age of

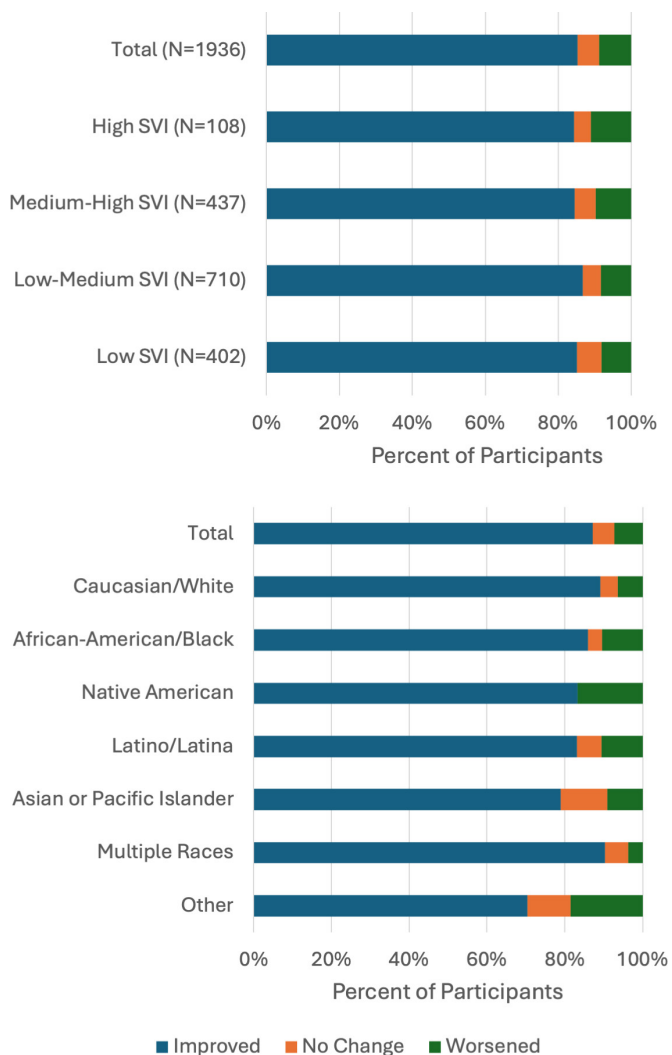
participants was 43.1 years (SD 11.5 years) and 75% identified as female (table 1). On average, participants' SVI was 0.42 (SD 0.20), with black/African Americans most likely to be living in geographies with the greatest social vulnerability ( $p<0.001$ ) (table 1). Their SVI subscores for socioeconomic status (mean 0.4 (SD 0.21)) and household characteristics (mean 0.41 (SD 0.19)) were lower than for housing (mean 0.47 (SD 0.22)) and transportation (mean 0.49 (SD 0.19)).

At baseline, 37% of participants reported having been diagnosed with a GI condition. White/Caucasian participants were more likely to report having a diagnosed condition than participants of other racial groups (42% vs 27% for black/African Americans, 23% for Asian/Pacific Islanders, 30% for Hispanic/Latinx, or 17% for Native Americans ( $p<0.001$ )). Among those with a GI diagnosis, their most common conditions were IBS (16.9%) and gastro-oesophageal reflux disease (GORD) or acid reflux (16.7%). White/Caucasian participants were more likely to report being diagnosed with gastritis ( $p=0.01$ ), haemorrhoids ( $p<0.001$ ), and IBS ( $p<0.001$ ) than participants of other racial groups. 60% of participants who reported any diagnosis had two or more diagnosed GI conditions.

At baseline, participants were overweight (body mass index (BMI) 28.5 kg/m<sup>2</sup> (SD 7.4 kg/m<sup>2</sup>); table 1). Participants identified as Asian/Pacific Islander were less likely to be obese and those identified as black/African American were more likely to be obese ( $p<0.001$ ; table 1). Participants identifying as female and those who preferred not to provide a gender were more likely to be obese than those identifying as male ( $p<0.001$ ). Participants living in more vulnerable areas (high SVI) were more likely to be underweight (BMI<18.5 kg/m<sup>2</sup>) and obese (BMI>30 kg/m<sup>2</sup>) than participants living in less vulnerable areas ( $p<0.001$ ).

### Utilisation of digestive care management

Participants used the app for symptom logging, reviewing educational materials, and interacting with their care team. Participants of all genders, races, and SVI groups engaged with the app similarly. 82% used the app to schedule a synchronous visit with their care team and there was no difference by racial group. Participants with more GI conditions ( $p=0.003$ ) were more likely to remain engaged longer ( $p=0.003$ ). Not surprisingly, as symptoms improved, participants were less likely to log their GI symptoms. By 30 days after registration, the total symptom score improved significantly (-4.42;  $p<0.001$ ;  $n=566$ ). This increased to -4.99 at day 75 ( $p<0.001$ ;  $n=475$ ) and -5.38 at day 90 ( $p<0.001$ ;  $n=111$ ). There was no difference by gender or SVI in the duration of app usage. Native American participants used the app for fewer days than participants of other racial groups ( $p=0.01$ ); notably, their symptoms improved more than participants of other ethnic groups and they were a small group (only six participants).



**Figure 3** Change in symptom severity by race and Social Vulnerability Index. The Social Vulnerability Index is a score from 0 (least vulnerable) to 1 (most vulnerable) that allows geographies to be directly compared based on 16 measures across four categories (eg, socioeconomic status, household characteristics, housing type).

### GI symptoms

At baseline, the most commonly reported symptoms were gas (93%), bloating (84%), constipation (55%), abdominal pain (54%), reflux (48%), diarrhoea (48%), and nausea (36%). Loss of bowel control was reported by 31%, and only 5% of participants reported vomiting. GI symptoms were reported variably across genders and racial groups. For example, women were more likely to endorse all of the nine symptoms except for diarrhoea, reflux, and bowel control than other genders ( $p < 0.05$  for all), and Caucasian/white participants were more likely to report abdominal pain and diarrhoea while black/African Americans and Asian/Pacific Islanders were more likely to report gas and bloating. Highly socially vulnerable populations reported more symptoms overall and specifically reported more nausea ( $p = 0.02$ ) than less socially vulnerable populations.

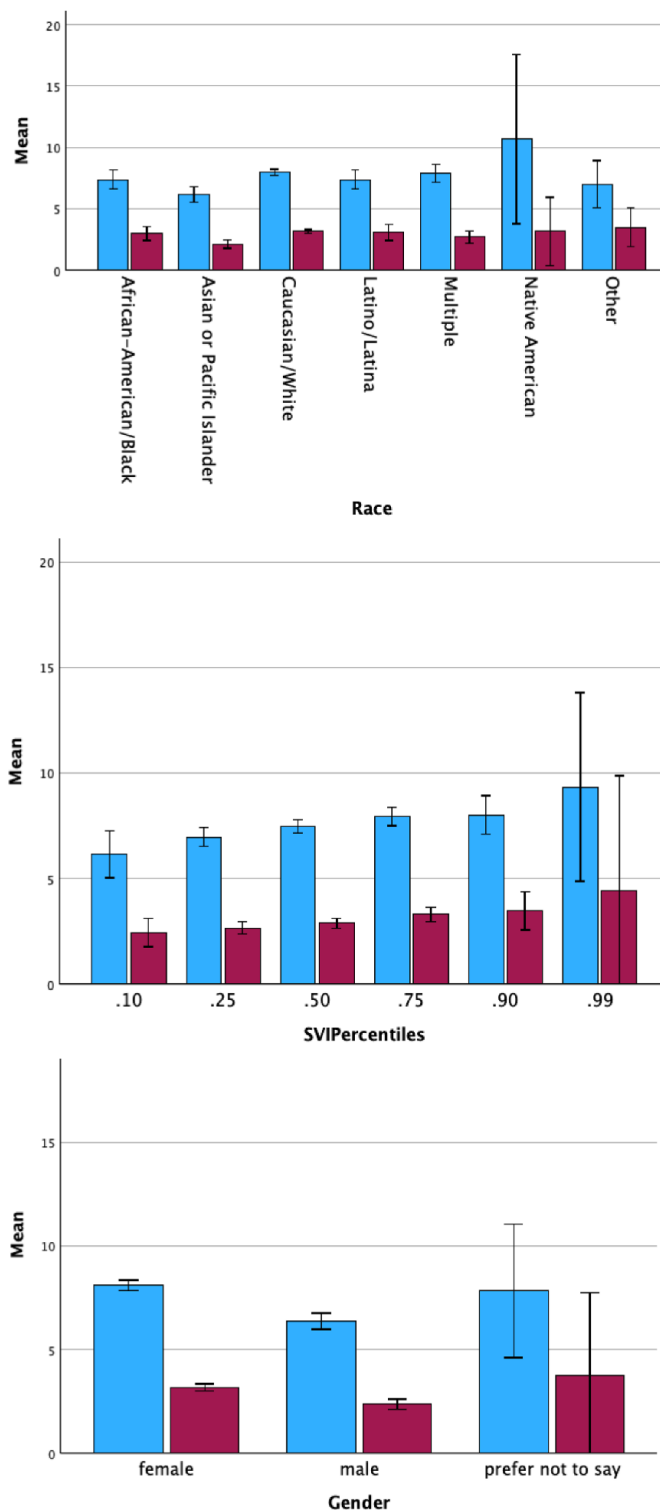
At baseline, 80% of participants reported at least moderate GI symptom severity for at least one symptom. Baseline symptom severity was highest for Hispanic/Latinx participants (85% reporting at least moderate symptoms) and lowest for Asian/Pacific Islanders (63% reporting at least moderate symptoms; [figure 3](#),  $p < 0.001$ ). At baseline, the mean total symptom score was 7.7 (SD 4.7), which improved at the end of the intervention to 3.0 (SD 3.2,  $p < 0.001$ , [figure 4](#)). The mean change in symptom scores declined for all nine symptoms with the greatest improvements for gas (-1.09 (SD 1.2)), bloating (-0.86 (SD 1.2)), constipation (-0.63 (SD 1.0)), diarrhoea (-0.56 (SD 1.0)), and reflux (-0.52 (SD 1.0)). Participants reported more modest improvements for nausea (-0.34 (SD 0.9)), abdominal pain (-0.31 (SD 1.1)), loss of bowel control (-0.31 (SD 0.9)), and vomiting (-0.06 (SD 0.5)).

The mean change in total symptom score was -4.7 (SD 4.7); this represents a 61% decrease in symptom severity across the population. The greatest improvements were for participants with a history of CRC (-13.1 (SD 8.7)) and GI bleeding (-12.1 (SD 8.5)) ([table 2](#)). Overall, 85.3% of participants reported GI symptom improvement, 5.8% reported no change in symptoms, and 8.8% reported worsening symptoms. There were no significant differences by gender, race, or SVI in the change in total symptoms ([figures 3 and 4](#)).

### Patient-reported outcomes

Overall, 532 participants (27% of those eligible to respond to the survey) completed the patient-reported outcomes survey. Of these, 83% endorsed, 'Since joining the program, I feel more in control of my health.' Black/African Americans (92%), Native Americans (100%), and women (86%) endorsed feeling more in control of their health than participants of other races/ethnicities and genders ( $p = 0.01$  for race,  $p = 0.046$  for gender). Among all participants, 76% endorsed, 'I'm happier since using the program,' with black/African Americans (89%), Native Americans (100%), and women (57%) most likely to report this ( $p = 0.048$  for race,  $p = 0.02$  for gender). 54% of all participants endorsed, 'Since joining the program, I feel more productive at work,' with black/African Americans (76%) and Native Americans (100%) most likely to report this ( $p = 0.006$ ). Overall, 83% endorsed, 'The program has helped me better manage my digestive symptoms,' with black/African Americans (94%), Native Americans (100%) and women (88%) most likely to report this ( $p = 0.002$  for race,  $p < 0.001$  for gender). There were no differences across SVI for these measures.

In response to the question, 'Where would you have gone for digestive health care if you had not signed up for the program?', 186 stated that they would not have received care, 183 would have gone to a primary care physician, 76 would have gone to a gastroenterologist, 3 would have gone to the emergency room, 2 would have gone to urgent care, and 38 would have sought other



**Figure 4** Improvement in total symptom scores by race, gender, and Social Vulnerability Index. Error bars represent the 95% CI.

care. There were no statistically significant differences in these responses based on race/ethnicity or gender.

## DISCUSSION

This study of a novel digital digestive chronic disease management programme for a sociodemographically

diverse population demonstrated three key findings. First, adults of various genders, races, and social vulnerabilities engaged with a digitally enabled disease management for digestive symptoms. This is an important finding since non-white populations have higher rates of some GI symptoms (eg, constipation, hepatitis) but historically had lower rates of screening for key GI conditions (eg, CRC, GORD) and poorer outcomes.<sup>6 9 22</sup> Moreover, patients of lower socioeconomic status often have poorer access to care, lower health literacy, and worse outcomes. This suggests that the GI care management programme recruiting materials were appealing and relevant to users with GI symptoms from a wide range of racial groups and could contribute to ongoing efforts to deploy health benefits with a lens on diversity, equity, and inclusivity.

The study population included a high proportion of participants who identified as female (75%). Women participants were more symptomatic at baseline (which may have accounted for their higher rate of symptom tracking) and had more improvement in symptoms than men, especially in constipation, gas, nausea and bloating. This may be expected given the higher prevalence of some common GI conditions among women, such as IBS.<sup>23</sup> Future studies will test participant recruiting materials that may be more appealing to men.

Second, participation in the disease management programme was associated with a significant reduction in GI symptoms. At baseline, 80% of participants reported at least moderate GI symptom severity for at least one symptom, and by the end of the intervention, 85% had improved. Participants from all genders, races, and SVI groups experienced significant improvement in GI symptoms, and improvement was comparable across all groups. These data suggest that a digitally enabled GI care management programme can be an effective approach to mitigating common, debilitating GI symptoms. Given health disparities in GI treatment and outcomes,<sup>6 9 22</sup> a detailed evaluation of outcomes beyond symptom improvement is warranted. In particular, given that the intervention has multiple components (eg, symptom tracking, personalised nutrition therapy), it would be valuable to understand if particular components were more valuable than others to participants and if those preferences varied by race or SVI.

Third, in addition to symptom reduction, participants reported feeling greater control of their health (83%), better able to manage their digestive symptoms (83%), increased happiness (76%), and greater productivity at work (54%), with black/African Americans and Native Americans most likely to report these changes but no differences across SVI groups. The magnitude of these self-reported effects is large compared with other workplace interventions.<sup>24</sup> Notably, only 27% of participants reported these outcomes. Thus, these findings warrant further evaluation with a larger sample size and with validated tools for the assessment of health-related quality of life,<sup>25</sup> depression screens,<sup>26</sup> and workplace absenteeism and presenteeism.<sup>27</sup> Overall, they are promising

**Table 2** Change in total symptom score by condition

Condition	Change in total symptom score		Participants with this condition, n	P value
	Mean	SD		
Barrett's oesophagus	-10.33	8.6	18	<0.001
Celiac disease	-7.66	8.3	32	<0.001
Colorectal cancer	-13.09	8.7	11	<0.001
Crohn's disease	-10.50	9.9	20	<0.001
Diverticular disease	-6.51	7.0	71	<0.001
Gallstones	-6.73	6.4	73	0.002
Gastritis	-6.95	5.7	104	<0.001
Gastroparesis	-11.26	8.4	23	<0.001
GORD (acid reflux)	-5.87	5.7	323	<0.001
GI bleeding	-12.07	8.5	15	<0.001
Haemorrhoids	-6.60	5.8	151	<0.001
Hiatal hernia	-6.57	7.0	75	<0.001
Irritable bowel syndrome	-6.44	5.7	328	<0.001
Lactose intolerance	-7.19	6.2	118	<0.001
Pancreatitis	-10.87	9.5	15	<0.001
Small intestinal bacterial overgrowth (SIBO)	-8.84	7.0	51	<0.001
Stomach or intestinal ulcers	-6.96	6.4	52	<0.001
Ulcerative colitis	-7.73	7.9	37	<0.001

GI, gastrointestinal; GORD, gastro-oesophageal reflux disease.

early results for employers interested in reducing health disparities among their plan beneficiaries.

This study had three key limitations. First, the analysis control group and some racial groups (eg, Native Americans) included small numbers. A controlled trial that compares participation in this GI disease management programme to other related interventions would be a valuable contribution to the literature. Second, the study population included only commercially insured adults, as the programme was provided to them via their health benefits. Thus, this limits the generalisability of these results to other populations. Finally, this evaluation was for 3 months of use of the intervention. Given that the users enrolled all had GI conditions or symptoms, and many had severe symptoms, it is important to understand the programme's effectiveness over a longer duration.

Given prevalent disparities in access to GI specialty care, a digital digestive chronic care programme provides a promising tool for increasing access for populations with chronic GI symptoms, especially populations that have historically had poorer access to GI care. Further research is urgently required to comprehensively assess the ability of virtual care programmes to provide effective digestive care at scale for populations with a variety of common GI concerns.

**Contributors** DB, the guarantor, was responsible for data analysis and manuscript preparation, and approved the final manuscript. HL, ACB, and MMC were responsible for data acquisition, reviewed the analyses, and provided critical

review and approval of the manuscript. EC and MP contributed to and approved the manuscript.

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**Competing interests** HL, MMC, ACB and EC were employees of Cylinder. DB was a consultant to Cylinder. MP was a member of the Cylinder Health Clinical Advisory Board.

**Patient consent for publication** Not applicable.

**Ethics approval** Given that all data were routinely collected as part of the condition management programme, this protocol was considered exempt by the WCG IRB (VORD.00A, April 2023).

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request. Data are available upon reasonable request from the corresponding author.

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