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Probiotic use is common in constipation, but only a minority of general and specialist doctors recommend them and consider there to be an evidence-base

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Highlights

- More people with constipation use probiotics compared to those without constipation
- A strong predictor for probiotic use in the general population is having constipation
- The most common sources of information regarding probiotics are TV adverts
- Most GPs and gastroenterology specialists however do not recommend them for constipation.
- Most GPs and gastroenterology do not believe probiotics have been tested for constipation.

ABSTRACT

Objective: To assess the use and perceived effectiveness of probiotics by the general population (with or without self-reported constipation), and their recommendation and perceived effectiveness by general practitioners (GPs) and gastroenterology specialists.

Research Methods & Procedures: A cross-sectional, primarily online, survey was undertaken. Responses were compared between groups using chi squared tests, and logistic regression was employed to identify predictors of probiotic use.

Results: 2,557 members of the general population (1,623 self-reported constipation, 934 without), 411 GPs and 365 GI specialists completed the survey. 37% of the general population with self-reported constipation had tried probiotics, compared to 11% of those without ($p<0.001$), with the strongest predictors of use being the belief that probiotics have been tested in appropriate studies (OR 1.9; $p<0.001$), receiving a formal constipation diagnosis by a doctor (OR 1.6, $p<0.001$) and a self-diagnosis of constipation (OR 1.6; $p<0.001$). Only 26% of GPs and 34% of gastroenterology specialists recommended probiotics for constipation ($p=0.012$). Almost two thirds of the general population (65%) believed that probiotics had been tested in studies for constipation, whereas only 35% GPs and 43% gastroenterology specialists believed this ($p<0.001$).

Conclusion: There is high usage and perceived evidence for probiotics among people with constipation. However, most GPs and gastroenterology specialists do not recommend them for constipation suggesting a need for further research, and education of health care professionals on existing evidence.

INTRODUCTION

Chronic constipation is a common bothersome disorder affecting approximately 14% of the general population ⁽¹⁾. Although there are several management options for constipation, typically a range of laxative compounds, approximately half of patient are dissatisfied with current treatment strategies ⁽²⁾. Indeed, the vast majority of people with constipation self-manage using over-the-counter products ⁽³⁾ and constipation has been shown to be the third

most cited symptom in patients attending an outpatient GI clinic for which complementary and alternative therapies (CAMs) are used ⁽⁴⁾.

Over the past decade, there has been an increase in research investigating the effect of probiotics in chronic constipation. Probiotics are live micro-organisms that, when administered in adequate amounts, confer health benefits to the host ⁽⁵⁾. Particularly, various probiotic strains have been shown to have beneficial effects on several constipation-related symptoms (e.g. stool frequency and consistency), such as *Bifidobacteria lactis* ^(6; 7; 8). Probiotics may help normalise gut motility and improve constipation symptoms via their effect on the gut microbiota and their metabolites, the central and enteric nervous system, as well as the immune system ⁽⁹⁾.

Probiotics are widely available as either probiotic-containing food products (e.g. yoghurts, fermented milks) or probiotic supplements (e.g. sachets, capsules) and can be purchased in supermarkets, health shops, pharmacies and online. Overall, 45% of patients with GI conditions who use CAMs for their GI symptoms commonly use probiotics, while adults with GI conditions are more likely to use probiotic supplements than adults without a GI condition ⁽¹⁰⁾. However, there is lack of evidence as to whether people with constipation use probiotics specifically to manage constipation-related symptoms, and how effective they believe they are.

Probiotics are commonly recommended by general practitioners for the management of GI disorders, such as chronic diarrhoea and IBS ⁽¹¹⁾. For example, a UK survey that included over 1500 primary care health professionals (e.g. GPs, dietitians, nurses) showed that 78% of GPs advise probiotic use for their patients, with constipation being the 5th most common condition

for recommendation ⁽¹²⁾. Nevertheless, specific use in constipation is little researched. Furthermore, there is no evidence as to whether GI specialists recommend probiotics for constipation and their perceived effectiveness.

The aim of this study was to assess the use and perceived effectiveness of probiotics by the general population (with or without self-reported constipation), as well as their recommendation and perceived effectiveness by general practitioners (GPs) and gastroenterology specialists. The hypothesis was that people with self-reported constipation more commonly use probiotics than those without self-reported constipation.

MATERIAL AND METHODS

This was a cross-sectional questionnaire survey using a self-administered questionnaire. Ethical approval was granted by the Newcastle and North Tyneside 2 NHS Research Ethics Committee (reference ID: 15/NE/0060) on 13 February 2015.

Participants

Members of the general population (with and without self-reported constipation), as well as GPs and GI specialists were recruited. Inclusion criteria for members of the general population were as follows: men and women aged 18 years or above; individuals who lived in the UK; and individuals who were able to consent, whereas exclusion criteria were: individuals with severe gastrointestinal diseases (e.g. inflammatory bowel disease); pregnancy or lactation; and individuals who were health professionals. Inclusion criteria for GPs and GI specialists were the

following: being in clinical contact with patients; and living in the UK. Both registrars and consultants in gastroenterology or colorectal surgery were eligible for the GI specialists group.

An opportunistic sampling technique was adopted. The general population were recruited via circular emails and advertising in eight UK universities, on advertising websites, in magazines, in newspapers and via healthy volunteer databases across the UK. In order to ensure representation of self-reported constipated individuals within the sample, circular emails were also sent to people with constipation-related symptoms who have participated in previous trials run by the study team members.

GPs were recruited via an advert placed in the monthly newsletter of the Royal College of General Practitioners, and individual personalised emails were sent to all members of the Primary Care Society for Gastroenterology (n=475). Furthermore, 90 GP practices in South and East London were contacted by telephone and/or attended in person and 34 GP meetings in Greater London were attended where questionnaires were distributed for completion.

GI specialists were recruited through personalised emails, sent to all members of the British Society of Gastroenterology (n=2,202) and all members of the Association of Coloproctology of Great Britain and Ireland (n=668). Two GI conferences were attended in person where questionnaires were distributed for completion.

In order to limit sampling bias, various approaches were adopted to increase response rate, including: non-monetary incentive offered to participants (prize draw), personalised emails were sent to recruit doctors and the advertisements stated the number of participants recruited to date ⁽¹³⁾.

The sample size calculation was based on the margin of random sampling error^(14; 15). On the basis of generating a margin of error of <5% at a 95% confidence level, it was calculated that a sample size of at least 900 members of the general population, 400 GPs and 325 GI specialists was needed.

Questionnaire

In the absence of a previously validated questionnaire, a questionnaire was developed to investigate perceptions of probiotic use and effectiveness. The self-administered questionnaire included closed-ended questions as well as free-text boxes where appropriate. The questionnaire included the following sections: (1) bowel habits and constipation status (2) probiotic use and effectiveness, and (3) demographics. The questionnaire was piloted in five people for the terminology used, the clarity of the questions, the response sets and the length of the questionnaire.

Initially, members of the general population were asked whether they considered themselves to have constipation (yes/no), which was used to define participants as having self-reported constipation or not. All members of the general population were also asked whether they had ever received a formal diagnosis of constipation by a doctor (yes/no). They were then asked about their use of probiotics, and their reason for using them (symptoms of constipation, digestive comfort, general health, for reasons not related to health). If participants reported using probiotics for symptoms of constipation, digestive comfort or general health, they were then asked about the products used overall, the source of information that led them to use probiotics, their perceived effectiveness (using a 4 point Likert scale from 1 to 4; 1=not effective

at all, 2=a little effective, 3=moderately effective, 4=very effective), and their perceptions of the scientific evidence for their effectiveness in constipation.

GPs and GI specialists were asked regarding their recommendations for using probiotics in constipation, the products they recommended, their perceived effectiveness, and their perceptions of the scientific evidence for their effectiveness in constipation.

The questionnaire was available online for the general population, whereas online and paper copies were available for GPs and GI specialists to facilitate recruitment. Prior to completing the questionnaire, participants were required to read a comprehensive participant information sheet; this was provided on the initial page on both the electronic and hard-copy of the questionnaire. The participant information sheet clearly stated that participant were providing informed consent by completing the questionnaire.

Statistical analysis

Descriptive statistics were used to summarise and describe data. For continuous data, mean (SD) were reported. Associations between categorical variables and counts (e.g. differences in use of probiotics between constipated and non-constipated) were analysed using a Chi-squared test. A step-wise logistic regression model was used to determine the effect of factors on the use/recommendation of probiotics for the management of constipation. P values of < 0.05 were considered statistically significant.

RESULTS

Participant characteristics

Overall, 2,557 members of the general population (1,623 without self-reported constipation, 934 with self-reported constipation), 411 GPs and 365 GI specialists were eligible. The GI specialist group comprised 224 (61%) gastroenterologists and 141 (39%) colorectal surgeons; of these 269 (74%) were consultants and 96 (26%) were registrars. The participant's characteristics are shown in Table 1. Those with constipation were slightly older, more likely to be female and fewer had higher qualifications, compared with those without constipation. The ethnic profile of the general population broadly reflected that of the UK general population ⁽¹⁶⁾.

Participants with self-reported constipation had significantly lower stool frequency and harder stools compared to those without self-reported constipation (Table 1). Those with constipation who were currently using probiotics had a similar stool frequency to those not currently using probiotics (3.7 ± 1.0 bowel movements/week vs 3.6 ± 1.0 bowel movements/week, respectively; $p=0.2$), and they also had a similar stool consistency (2.5 ± 1.4 stool type vs 2.6 ± 1.5 stool type, respectively; $p=0.590$).

| | General population | | | | P value |
|--|-----------------------------------|---------------------------------------|-----------------------|---------------------------|---------------------|
| | Without constipation (n=1,623) | Self-reported constipation (n=934) | GPs (n=411) | GI specialists (n=365) | |
| Age , years, mean (SD) | 37.8 (14.5) | 40.7 (13.5) | - | - | <0.001 [†] |
| Females , n (%) | 1,128 (70) ^a | 822 (88) ^b | 211 (51) ^c | 102 (28) ^d | <0.001 [‡] |
| Ethnicity , n (%) | | | | | |
| White | 1,419 (87) ^a | 814 (87) ^a | 197 (48) ^b | 244 (67) ^c | |
| Asian / Asian British | 110 (7) ^a | 54 (6) ^a | 159 (39) ^b | 87 (24) ^c | |
| Black/African/Caribbean/British | 32 (2) ^{a,b} | 29 (3) ^b | 31 (8) ^c | 2 (1) ^a | <0.001 [‡] |
| Mixed | 46 (3) ^a | 28 (3) ^a | 12 (3) ^a | 12 (3) ^a | |
| Other | 16 (1) ^a | 9 (1) ^a | 12 (3) ^{a,b} | 20 (6) ^b | |
| Education , n (%) | | | | | |
| No formal qualifications | 46 (3) ^a | 37 (4) ^a | - | - | |
| Vocational qualifications | 120 (7) ^a | 141 (15) ^b | - | - | |
| School level qualifications | 572 (35) ^a | 383 (41) ^b | - | - | <0.001 [‡] |
| Undergraduate degree | 553 (34) ^a | 267 (29) ^b | - | - | |
| Postgraduate degree | 332 (21) ^a | 106 (11) ^b | - | - | |
| Stool frequency / wk , mean (SD) | 8.0 (4.3) | 4.5 (4.4) | - | - | <0.001 [†] |
| Stool consistency , Bristol stool form scale, mean (SD) | 3.6 (1.0) | 2.8 (1.5) | - | - | <0.001 [†] |

[†]Independent t-test p value. [‡]Chi-squared p value.

Data within each row that do not share the same subscript letter are significantly different.

Table 1: Participants characteristics by study group.

Use and recommendation of probiotics

As shown in Table 2, the majority of the general population with constipation had previously used or were currently using probiotics (563/934, 60%), which was significantly greater than the proportion of those without constipation (832/1623, 51%) ($p < 0.001$). Of those who previously or currently used probiotics, 346 (62%) with constipation had done so for their gut health (including constipation symptoms, digestive discomfort), while only 181 (22%) of those without self-reported constipation had done so for gut health (e.g. digestive discomfort) ($p < 0.001$). In those with constipation, 123/934 (13%) were currently using probiotics for their gut health (e.g.

constipation symptoms, digestive discomfort) compared to only 42/1623 (3%) of those without constipation ($p<0.001$). The odds ratio for previous or current probiotic use for gut health in constipation was 4.7 (95% CI 3.8 to 5.7, $p<0.001$), while the odds ratio for current use only was 5.7 (95% CI 4.0 to 8.2, $p<0.001$).

The probiotic most commonly used for gut health by those without constipation was the probiotic-containing food product Actimel (followed by Activia and Yakult) and for those with constipation was Activia (followed by Actimel and Yakult) (Table 2). The probiotic most commonly recommended for constipation by GPs was the probiotic supplement VSL#3, and by GI specialists was Yakult (Table 2). Only 10 (10%) of GPs and 3 (2%) of GI specialists recommend probiotics as a first-line treatment.

| | General population | | | | Chi-squared P value |
|--|--|---|-----------------------------|----------------------------|------------------------|
| | Without self-reported constipation (n=1,623) | With self-reported constipation (n=934) | GPs (n=411) | GI specialists (n=365) | |
| Probiotic use (for any reason) | | | | | |
| Never used before | 791 (49%) ^a | 371 (40%) ^b | - | - | |
| Previously used | 649 (40%) ^a | 404 (43%) ^a | - | - | <0.001 |
| Currently using | 183 (11%) ^a | 159 (17%) ^b | - | - | |
| Probiotic use specifically for gut health | | | | | |
| Previously or currently using | 181 (11%), | 346 (37%) | - | - | <0.001 |
| Currently using only | 42 (3%), | 123 (13%) | - | - | <0.001 |
| Recommend probiotics for constipation | - | - | 105 (26%) | 124 (34%) | 0.012 [†] |
| Prescribe probiotics for constipation | - | - | 22 (5%) | 41 (11%) | 0.004 [†] |
| Using/recommending probiotics for gut health as a: | | | | | |
| First-line treatment | - | 79/346 (23%) ^a | 10/105 (10%) ^b | 3/124 (2%) | |
| In addition to other treatments | - | 215/346 (62%) ^a | 77/105 (73%) ^{a,b} | 107/124 (86%) ^b | <0.001 |
| After other treatments failed | - | 52/346 (15%) ^a | 18/105 (17%) ^a | 20/124 (16%) ^a | |
| Probiotics used/recommended for gut health, n (% of users): | | | | | |
| Probiotic-containing food products | | | | | |
| Actimel | 137 (76%) ^a | 260 (75%) ^a | 43 (41%) ^b | 65 (50%) ^b | <0.001 |
| Activia | 132 (73%) ^a | 276 (80%) ^a | 40 (38%) ^b | 59 (46%) ^b | <0.001 |
| Yakult | 123 (68%) ^a | 226 (65%) ^a | 41 (39%) ^b | 75 (58%) ^a | 0.001 |
| Probiotic supplements | | | | | |
| VSL#3 | 4 (2%) ^a | 5 (1%) ^a | 69 (53%) ^b | 22 (21%) ^c | <0.001 |
| Acidophilus | 50 (28%) ^a | 97 (28%) ^a | 19 (18%) ^{a,b} | 19 (15%) ^b | 0.006 |
| Probio 7 | 14 (8%) ^a | 32 (9%) ^a | 3 (3%) ^a | 15 (12%) ^a | 0.099 |
| Multibionta | 22 (12%) ^{a,b} | 56 (16%) ^b | 8 (6%) ^a | 6 (6%) ^a | 0.003 |
| Other | 20 (11%) ^a | 85 (25%) ^b | 49 (47%) ^c | 30 (23%) ^b | <0.001 |

Values are n (%), unless otherwise stated. [†] Fisher's exact test.

Data within each row that do not share the same subscript letter are significantly different.

Table 2: The use of probiotic-containing food products and probiotic supplements by the general population (with or without self-reported constipation), and their recommendation by General Practitioners (GPs) and GI specialists.

The sources of information for probiotic use for gut health in the general population are shown in Figure 1. The most common sources of information regarding probiotics were TV adverts, seeing a product in a shop and family. GPs were a source of information regarding the use of probiotics for only 14 (8%) of individuals without constipation and 24 (7%) with constipation. Specialist doctors were a source of information regarding probiotics for only 2% of the general population, irrespective of constipation status (Figure 1).

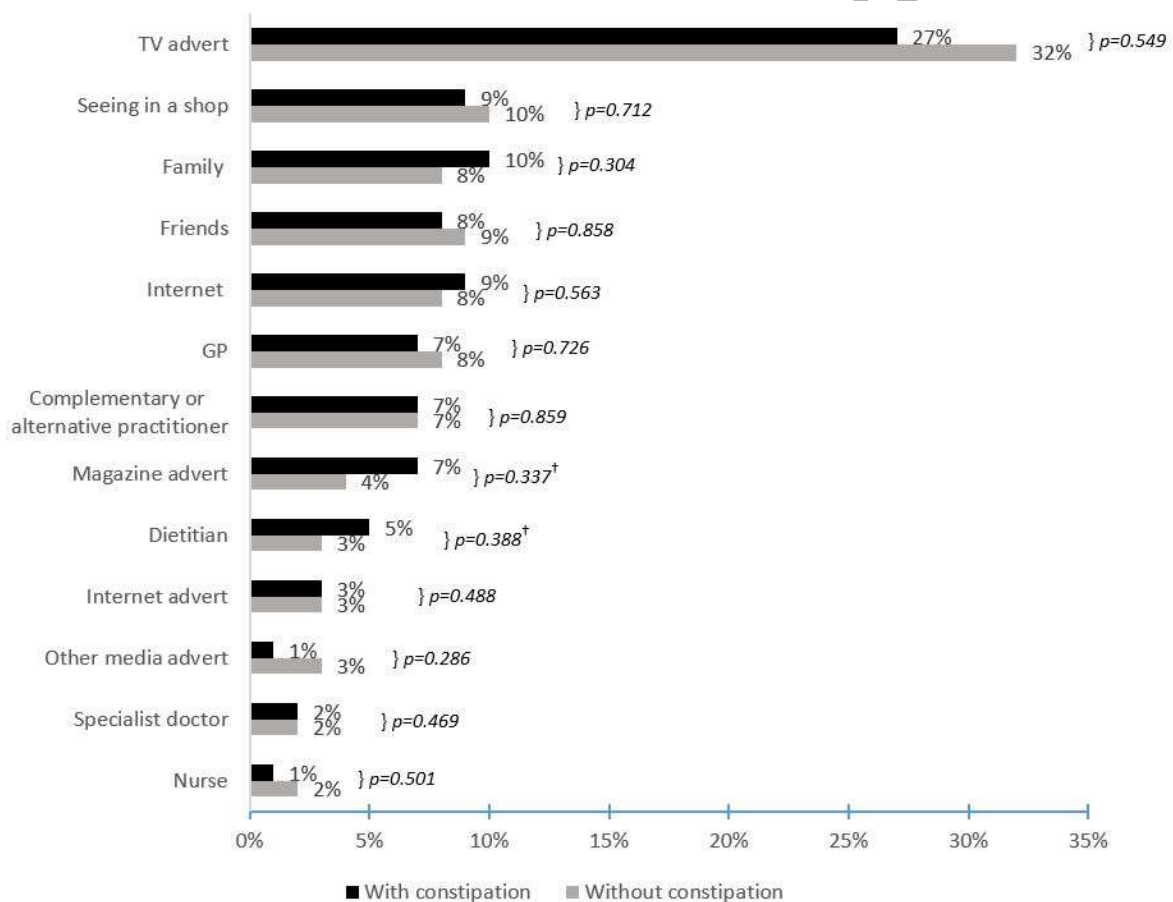


Figure 1: Sources of information for probiotic use for gut health in the general population, including those with (n=346) and without (n=181) constipation. Comparisons between groups are via a Chi-squared test. †Fisher's Exact Test.

Factors associated with probiotic use

In the general population as a whole, factors associated with *previous* or *current* probiotic use for health were having received a formal diagnosis of constipation by a medical practitioner (OR 1.6; 95% CI 1.3-1.9), self-reporting constipation (OR 1.6; 95% CI 1.3-1.9) and believing that probiotics have been tested in research studies (OR 1.9; 95% CI 1.6-2.2) (Table 3). Having a university degree was also a factor associated with probiotic use for health (OR 0.62; 95% 0.51-0.75).

For those with self-reported constipation, factors associated with probiotic use were having visited a complementary and alternative therapist for their constipation symptoms (OR 2.5; 95% CI 1.3-4.9) and believing that probiotics have been tested in research studies (OR 2.1; 95% CI 1.6-2.8) (Table 3).

For people without self-reported constipation, factors associated with probiotic use was actually having received a formal diagnosis of constipation by a medical practitioner (OR 1.9; 95% CI 1.4-2.7), as well as meeting the Rome IV criteria for chronic constipation (even though they do not consider themselves to have constipation) (OR 1.3; 95% CI 1.0-1.6) (Table 3).

For GPs, the factor associated with recommending probiotics for constipation was believing that probiotics have been tested in research studies (OR 1.9; 95% CI 1.2-3.03). No factors were associated with recommending probiotics for constipation among GI specialists (Table 3).

| | General Population | | | | | | | | | |
|---|--------------------|--------|------------------------------------|--------|---------------------------------|--------|------------------|-------|----------------|---|
| | All | | Without self-reported constipation | | With self-reported constipation | | GPs | | GI specialists | |
| | OR (95% CI) | P | OR (95% CI) | P | OR (95% CI) | P | OR (95% CI) | P | OR (95% CI) | P |
| Age (per year) | 1.02 (1.01-1.02) | <0.001 | 1.02 (1.01-1.02) | <0.001 | 1.02 (1.01-1.03) | <0.001 | - | - | - | - |
| Gender (compared to females) | 0.62 (0.51-0.75) | <0.001 | 0.65 (0.52-0.82) | <0.001 | 0.54 (0.35-0.81) | 0.003 | - | - | - | - |
| University degree | 1.50 (1.27-1.77) | <0.001 | 1.21 (1.09-1.34) | <0.001 | 1.76 (1.32-2.35) | <0.001 | - | - | - | - |
| Diagnosis of constipation via: | | | | | | | | | | |
| Self-reported constipation | 1.55 (1.30-1.86) | <0.001 | - | - | - | - | - | - | - | - |
| Rome IV diagnosis | - | - | 1.28 (1.02-1.60) | 0.032 | - | - | - | - | - | - |
| Formal diagnosis by a doctor | 1.56 (1.25-1.93) | <0.001 | 1.93 (1.37-2.72) | <0.001 | - | - | - | - | - | - |
| Believe probiotics have been tested | 1.85 (1.56-2.19) | <0.001 | 1.70 (1.36-2.12) | <0.001 | 2.06 (1.56-2.72) | <0.001 | 1.91 (1.20-3.03) | 0.006 | - | - |
| Professional visited for constipation: | | | | | | | | | | |
| Specialist doctor | - | - | - | - | 1.67 (1.10-2.53) | 0.015 | - | - | - | - |
| Complementary and alternative practitioner | - | - | - | - | 2.46 (1.25-4.85) | 0.010 | - | - | - | - |

Table 3: Significant predictors of probiotic use for general and gut health by the general population, and significant predictors for probiotic recommendation for constipation by doctors.

Perceptions of the evidence and effectiveness of probiotics

The majority of the general population (1,662, 65%) believed that probiotics have been tested in research studies for the treatment of constipation, contrary to the perceptions of GPs (144, 35%) and GI specialists (156, 43%) in whom only a minority believe probiotics had been tested in constipation ($p < 0.001$) (

Table 2). There was no significant difference among people with constipation (2.1 ± 0.8 using a 4 point Likert scale), GPs (2.3 ± 0.8) and GI specialists (2.1 ± 0.5) on the perceived degree of effectiveness of probiotics for the relief of constipation ($p = 0.209$)

In order to further investigate the effect of the perceived *evidence* for probiotics and constipation on the perceived *effectiveness* of probiotics, each group was dichotomised on the basis of whether they thought probiotics had been tested for constipation or not. GI specialists who thought probiotics have been tested for constipation believed that they were significantly more effective for the management of constipation, compared to those who believed probiotics have not been tested for constipation (2.5 ± 0.8 vs 2.0 ± 0.6 , $p = 0.001$). This difference was not demonstrated in GPs ($p = 0.480$).

People with constipation that were *currently* using probiotics believed probiotics were significantly more effective compared to those that were *previously* using probiotics (2.4 ± 0.9 vs 1.9 ± 0.8 , $p < 0.001$). Similarly, significantly more people with constipation who were *currently* using probiotics for gut health believed they have been tested in research studies for constipation, compared to those that had *previously* used probiotics (83% vs 45%, $p = 0.003$). This effect was not shown by those without self-reported constipation ($p = 0.842$).

DISCUSSION

Significantly more people with self-reported constipation use probiotics for their health, compared to those without self-reported constipation. Indeed, four times as many people with constipation as those without constipation were currently using probiotics, confirming that probiotics are used by people with constipation as a management strategy. Another survey has likewise shown that constipation was the third most commonly cited reason for the use of complementary and alternative medicines among patients attending a gastroenterology clinic, with the most common product used being probiotics⁽⁴⁾. Probiotics may be perceived as a “natural” alternative to medications and are considered by the public to be safer and pose fewer health risks⁽¹⁷⁾.

Despite the fact that some people with constipation use probiotics for their symptoms, the majority of GPs and GI specialists do not recommend probiotics for constipation management. Although a US survey of gastroenterologists has shown that over-the-counter products dominate primary therapy for constipation, that study did not measure probiotic use⁽¹⁸⁾. Specifically, fibre supplements and laxatives were the most commonly recommended treatments recommended by gastroenterologists⁽¹⁸⁾. According to the current findings, a possible reason for not recommending probiotics for constipation might be the perceived lack of research evidence in this area. Indeed, this study showed that believing probiotics have been tested for their effectiveness in constipation was a significant predictor of probiotic recommendation by GPs, but not for GI specialists.

The majority of the general population believe that probiotics have been tested in research studies for the treatment of constipation, whereas the majority of GI specialists and GPs do not believe this to be the case. These findings might explain the higher rate of probiotic use in the general population, compared with the lower rates of probiotic recommendation by GPs and GI specialists. However, although there was a significant difference between the general population and medical practitioners in the perceived evidence on probiotics and constipation, there was no difference in the perceived *effectiveness* of probiotics for constipation. As expected, it was shown that the GI specialists who believed that probiotics had been tested for their treatment of constipation thought that probiotics were significantly more effective for the management of constipation, compared to those who believed probiotics have not been tested. This highlights the fact that research is crucial for shaping GI specialists' perceptions regarding the effectiveness of probiotics in constipation, and emphasizes the need for communicating the findings of relevant research studies to medical professionals. Although several RCTs investigating the effect of probiotics in patients with constipation have already been published ⁽⁸⁾, the fact that the vast majority of GPs and GI specialists do not believe that probiotics have been tested for the management of constipation. This confirms the findings of a survey of GPs in the UK where only 6.3% reported that they had a good understanding of probiotics in general ⁽¹⁹⁾. This highlights a need to (i) improve the dissemination of the findings of published trials of specific probiotic strains in constipation, (ii) educate healthcare professionals on current evidence regarding the effectiveness of specific probiotic strains in constipation, and (iii) conduct further high quality RCTs in this area to identify novel probiotic strains that have the potential to improve constipation.

The probiotics most commonly used by the general public, and recommended by GPs and GI specialists were not the same species/strains and were often not those with the greatest levels of evidence. The probiotics most commonly used by people with constipation were the probiotic-containing food products Activia (*B. lactis* DN-173010), Actimel (*L. casei* DN 114 001) and Yakult (*L. casei* Shirota). This is in agreement with the probiotic brands that patients with IBD also choose to use ⁽²⁰⁾. Yakult was the probiotic most commonly recommended by GI specialists, while the probiotic supplement VSL#3 (a mixture of *Streptococcus*, *Bifidobacterium* and *Lactobacillus* strains) was the most commonly recommended by GPs. Indeed, various probiotic strains have been shown to have beneficial effects on several constipation-related symptoms, such as *Bifidobacteria lactis* ^(6; 7; 8). However, a systematic-review and meta-analysis showed, based on studies published to date, that *L. casei* Shirota (Yakult) did not improve symptoms in people with chronic constipation ⁽⁸⁾, while no study has been previously published on the effect of *L. casei* DN 114 001 (Actimel) on constipation. Therefore, it appears that the choice of the probiotic brands used by the general population and doctors is not necessarily driven by the current scientific evidence available, but could instead be driven by other factors, such as product availability or advertisement.

This is also the first study to investigate the predictors of probiotic use in constipation. Interestingly, one of the strongest predictors for probiotic use for health in the general population was having constipation (self-reported or a formal medical diagnosis). Another interesting striking finding was that a strong predictor for probiotic use in those without self-reported constipation was also the fulfilment of the Rome IV criteria for chronic constipation. Therefore, even though certain people did not believe they had constipation, those that met

the formal diagnostic criteria for chronic constipation were more likely to use probiotics for health than those who did not meet these criteria. A possible reason for this could be that these people do experience constipation-related symptoms included in the formal criteria, but that these symptoms are not burdensome to the individual or severe enough to lead to a perception that they have constipation. Nevertheless, these symptoms appear important enough to lead people to consume probiotics for their own digestive comfort. This is of major importance as it shows that the presence of certain symptoms, even though they are not perceived to be important or severe enough to result in self-reporting of constipation, may still lead people to seek relief from probiotics. A possible reason why probiotics are the therapy they choose is because they believe there is evidence they effectively manage constipation; indeed, our analysis showed that believing probiotics have been tested in research for their effectiveness in constipation was a significant predictor for probiotic use for the management of gut health among the general population. Furthermore, the strongest predictor for probiotic use by people without current self-reported constipation was having received a formal diagnosis of constipation in the past by a medical practitioner. It is hence feasible that such patients are now successfully managing their symptoms and do not consider themselves constipated any longer.

As expected, older age and female gender were significant predictors of probiotic use for gut health by people with or without self-reported constipation. It is possible that older people have been experiencing constipation or gut symptoms for longer and thus have investigated and tried a wide range of different products, including probiotics, to manage their symptoms. Females were also shown to be more likely to use probiotics than males. These findings could

be explained by the fact that constipated women report significantly worse QoL compared to constipated men⁽²¹⁾. Therefore, women may be more likely to seek some sort of treatment for their symptoms than men. Indeed, a previous study has confirmed that constipated subjects seeking medical care are most likely to be women⁽²²⁾. Furthermore, having a university degree significantly predicted the use of probiotics in the general population, emphasising the impact of education on health choices.

Strengths of this study include the use of a control group drawn from the same population (i.e. general population without constipation). The sample size of this study was large and the recruitment was not region-specific, as most of the advertisements and newsletters were nationwide, in an effort to obtain a more representative sample of the UK population. Indeed, the findings show that the ethnicity of the study population is representative of that of the UK population⁽¹⁶⁾. Furthermore, several evidence-based techniques were used in this study, such as using a non-monetary incentive, to maximise response rates⁽¹³⁾. A limitation of the study is the fact that this questionnaire was only available to the general population via the internet, as well as that it was advertised in universities, websites, online magazines, online newspapers, and online volunteer databases, all of which could introduce selection bias. In the absence of a previously validated questionnaire on this topic, the questionnaire was developed *de novo*, and although it was piloted for comprehensibility it did not undergo psychometric testing for validity and reliability. Furthermore, the members of the general population were able to self-report constipation that could have been either primary or secondary to medication or diseases, and no distinction between primary vs secondary constipation was made for the data analysis. Moreover, the use of a quantitative cross-sectional design did not allow capture of the

complete perceptions of the study participants, and could not provide data on the reasons behind participants' behaviour and attitudes towards probiotic use.

To conclude, this is the first study to demonstrate that significantly more people with constipation use probiotics compared to those without constipation suggesting they do believe probiotics to be effective in the management of their constipation-related symptoms. A strong predictor for probiotic use for constipation in the general population is having constipation (self-reported or formally diagnosed by a medical practitioner). The influence of TV adverts in choosing a treatment for constipation was also emphasised as this was shown to be the most common source of information for probiotics in the general population. Finally, education of health care professionals is needed on the prevalence of use of probiotics by the general population and by those with constipation, together with the current evidence for the effectiveness of specific strains of probiotics in constipation.

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