





In search of stool donors: a multicenter study of prior knowledge, perceptions, motivators, and deterrents among potential donors for fecal microbiota transplantation

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ABSTRACT

Fecal microbiota transplantation (FMT) is a highly effective therapy for recurrent *Clostridioides difficile* infection. Stool donors are essential, but difficult to recruit and retain. We aimed to identify factors influencing willingness to donate stool. This multi-center study with a 32-item questionnaire targeted young adults and health care workers via social media and university email lists in Edmonton and Kingston, Canada; London and Nottingham, England; and Indianapolis and Boston, USA. Items included baseline demographics and FMT knowledge and perception. Investigated motivators and deterrents included economic compensation, screening process, time commitment, and stool donation logistics. Logistic regression and linear regression models estimated associations of study variables with self-assessed willingness to donate stool. 802 respondents completed our questionnaire: 387 (48.3%) age 21–30 years, 573 (71.4%) female, 323 (40%) health care workers. Country of residence, age and occupation were not associated with willingness to donate stool. Factors increasing willingness to donate were: already a blood donor (OR 1.64), male, altruism, economic benefit, knowledge of how FMT can help patients (OR 1.32), and positive attitudes towards FMT (OR 1.39). Factors decreasing willingness to donate were: stool collection unpleasant (OR 0.92), screening process invasive (OR 0.92), higher stool donation frequency, negative social perception of stool, and logistics of collection/transporting feces. We conclude that 1) blood donors and males are more willing to consider stool donation; 2) altruism, economic compensation, and positive feedback are motivators; and 3) screening process, high donation frequency, logistics of collection/transporting feces, lack of public awareness, and negative social perception are deterrents. Considering these variables could maximize donor recruitment and retention.

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Introduction

Clostridioides difficile infection is the most common global cause of nosocomial diarrhea,^{1–5} creating an enormous health-care burden.^{2–7} Antimicrobials directed against *C. difficile* are the mainstay of treatment, but many patients experience recurrences.^{2,8} Fecal microbiota transplantation (FMT) is a highly effective therapy for patients with recurrent *C. difficile* infection, with a greater than 90% success rate.^{9–12} Emerging evidence suggests that FMT may

also have therapeutic benefits in other conditions associated with perturbed gut microbiota, including ulcerative colitis,^{13–16} Crohn's disease,¹⁷ irritable bowel syndrome,¹⁸ metabolic syndrome,^{19,20} multiple sclerosis,^{21,22} depression,²³ and autism.^{24,25} Intense interest in FMT is evident, with over 250 clinical trials registered on of January 11, 2019.

A reliable pool of healthy stool donors is essential for any FMT program, but recruiting and retaining stool donors are not easy. The rigorous screening

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process and significant time commitment narrow the donor pool substantially. Studies conducted by public stool banks have found that 40% of the potential donors decline screening because of the frequency and duration of donating.²⁶ Furthermore, donor eligibility screening eliminates over 55% of the potential donors with history of asthma, allergies, gastrointestinal illnesses, autoimmune diseases, antibiotic use in the past 3 months, recent travel to a tropical country, or high body mass index.²⁷⁻²⁹ Additionally, many potentially eligible candidates are excluded following blood and stool testing for pathogens.²⁷⁻²⁹ Only 2–12% of potential candidates successfully pass all the necessary screening steps.^{26,28,30,31} An observational study in Denmark found that this increased to 20% when donors were recruited from a pool of blood donors.³²

Although few studies have explored attitudes toward stool donation, previous studies on blood, gamete, and biospecimen donation have examined motivators and deterrents for potential donors. One small survey of nine participants investigated attitudes toward stool donation; four of the participants indicated that the main reason for becoming a donor was altruism.³³ Although altruism has repeatedly been shown to be the main reason for donating, regardless of type of donation, economic compensation does further motivate gamete donors.^{11,34-40} However, blood and biospecimen donors viewed monetary compensation negatively in some studies.^{34,41} Factors which deterred people from donating blood and gametes include anxiety, concerns over adverse events and pain from phlebotomy or procedures, lack of information and accessibility, time constraints, negative perception from others, religious or cultural beliefs, and impact on future relationships.^{35,36,39,42-46}

Unique challenges for stool donation may include the embarrassment of donation, logistics of stool donation, and the lack of public awareness of FMT. Given the paucity of data on potential motivators and deterrents for stool donation, the aims of this study were to (1) assess knowledge of and attitudes toward FMT and stool donation and (2) identify factors that may motivate or discourage stool donation.

Results

A total of 802 participants responded to the online survey. We excluded 17 responses from countries

other than Canada, the United States, and the United Kingdom. Also seven participants were excluded who did not indicate their gender on the questionnaire. This resulted in a total of 782 participants in the analytic sample. Willingness to donate stool had a median score of 8, with 25th percentile of 6 and 75th percentile of 10. Dichotomizing scores as 1–7 and 8–10 yielded 448 (57.6%) participants who were highly willing to donate stool and 330 (42.4%) participants less than highly willing to donate stool.

Table 1 shows participant characteristics by willingness to donate stool. High willingness to donate did not vary notably by country of origin or having considered being an organ donor. Relative to participants who did not indicate high willingness to donate, among those with high willingness to donate, the proportion female was slightly lower, the proportion in the youngest age group was somewhat smaller, the proportion in the highest age group was somewhat larger, and the proportion that had donated blood was substantially greater (59.2% vs. 47.9%, $P = 0.002$).

Table 2 summarizes other questionnaire responses by willingness to donate stool. Relative to participants who did not express high willingness to donate, those with high willingness to donate scored higher on average on positive attitude toward FMT, and opposition to donating stool frequently. A larger proportion of those with high willingness to donate indicated altruism as the primary reason for stool donation and willingness to receive FMT if medically indicated.

Logistic regression model

The logistic regression model identified several variables associated with high willingness to donate stool (Table 3). First, having self-identified as female gender was associated with lower odds of being highly willing to donate stool (odds ratios [OR] = 0.56, 95% confidence interval [CI]: 0.37–0.85, $P = 0.007$). Second, the odds of being highly willing to donate stool were 64% higher for blood donors than for participants who had not been a blood donor (OR = 1.64, 95% CI: 1.13–2.37, $P = 0.009$). Eight other survey variables were identified as associated with being highly willing to donate stool. Three of those

Table 1. Willingness to become a stool donor, on a scale from 1 (strongly disagree that they are willing) to 10 (strongly agree that they are willing) by participant characteristics.

	Number of participants (total $n = 778$)	High willingness to be a stool donor		<i>P</i> value
		No ($n = 330$)	Yes ($n = 448$)	
Country				0.41
Canada	311 (40.0%)	123 (37.3%)	188 (42.0%)	
United Kingdom	164 (21.1%)	72 (21.8%)	92 (20.5%)	
USA	303 (38.9%)	135 (40.9%)	168 (37.5%)	
Female gender	565 (72.6%)	249 (75.5%)	316 (70.5%)	0.13
Age (years)				0.14
<21	33 (4.2%)	21 (6.4%)	12 (2.7%)	
21–30	377 (48.5%)	160 (48.5%)	217 (48.4%)	
31–40	149 (19.2%)	62 (18.8%)	87 (19.4%)	
41–50	85 (10.9%)	35 (10.6%)	50 (11.2%)	
>50	134 (17.2%)	52 (15.8%)	82 (18.3%)	
Occupation				0.83
Health-care professional	320 (41.1%)	138 (41.8%)	182 (40.6%)	
Student	240 (30.8%)	96 (29.1%)	144 (32.1%)	
University faculty or staff	76 (9.8%)	34 (10.3%)	42 (9.4%)	
Other	142 (18.3%)	62 (18.8%)	80 (17.9%)	
Blood donors	423 (54.4%)	158 (47.9%)	265 (59.2%)	0.002
Number of blood donations				0.017
0 donations	355 (45.6%)	172 (52.1%)	183 (40.8%)	
<10 donations	288 (37.0%)	110 (33.3%)	178 (39.7%)	
11–20 donations	87 (11.2%)	32 (9.7%)	55 (12.3%)	
>20 donations	48 (6.2%)	16 (4.8%)	32 (7.1%)	
Considered being an organ donor	703 (90.4%)	292 (88.5%)	411 (91.7%)	0.13

variables could be considered barriers to stool donation and five were motivators for stool donation.

Barriers to stool donation

If participants found collecting their own stool unpleasant, they were less likely to be highly willing to donate stool (OR = 0.92, 95% confidence interval [CI]: 0.86–0.995, $P = 0.037$). If participants felt that having to see a doctor to review medical history and undergo a physical examination was invasive, they were less likely to be highly willing to donate stool (OR = 0.92, 95% CI: 0.84–1.00, $P = 0.05$). Those who believed that donating stool every month was a large commitment were also less likely to be highly willing to become a donor (OR = 0.82, 95% CI: 0.76–0.89, $P < 0.001$).

Motivators for stool donation

Participants who had positive attitudes toward FMT were more likely to be highly willing to become stool donors (OR = 1.39, 95% CI: 1.24–1.56, $P < 0.001$). Those who were more willing to consider stool donation without economic compensation were more likely to be highly willing to become a stool donor (OR = 1.29, 95% CI: 1.17–1.42, $P < 0.001$). Economic compensation also increased the likelihood of

becoming a stool donor. Participants who were more willing to consider stool donation with \$5–10 compensation per donation were more likely to be highly willing to become a stool donor (OR = 1.19, 95% CI: 1.11–1.29, $P < 0.001$). In other words, people were highly willing to be a donor even without compensation (altruism) but if compensation was offered, it was still a motivator (supplementary figures A and B). If participants felt that helping others was more important than the inconvenience of donating, they were more likely to be highly willing to become a donor (OR = 1.32, 95% CI: 1.19–1.46, $P < 0.001$). Also, having a purely or mostly economic reason for stool donation was associated with a greater likelihood of being highly willing to be a stool donor (OR = 2.55, 95% CI: 1.14–5.7, $P = 0.022$).

Sensitivity analysis by linear regression model

Table 4 shows results from the linear regression model, consistent with results from the logistic regression model. Having self-identified as female gender was again associated with a lower willingness to consider stool donation. Willingness to donate stool averaged 0.39 points lower for females than males on the 10-point Likert scale (95% CI: 0.15–0.64, $P = 0.001$). For participants whose primary reason for stool

Table 2. Summary of survey responses by willingness to become a stool donor.

	Median survey response and interquartile range (Likert scale of 1–10)	Highly willing to be a stool donor		P value
		No (n = 330)	Yes (n = 448)	
Attitude toward FMT				
Previous knowledge about FMT and how it could help patients	8.0 (4.0–9.0)	7.0 (2.0–9.0)	8.0 (5.0–10.0)	<0.001
Positive attitude toward FMT	9.0 (8.0–10.0)	8.0 (6.0–9.0)	10.0 (8.0–10.0)	<0.001
Collection of my own stool is unpleasant	5.0 (3.0–8.0)	7.0 (5.0–8.0)	4.0 (2.0–7.0)	<0.001
Time commitment				
Having to see a doctor to review my medical history and undergo a physical examination is invasive	2.0 (1.0–4.0)	3.0 (2.0–5.0)	2.0 (1.0–4.0)	<0.001
Having to do blood/stool tests every 4 months is a reasonable commitment	7.0 (5.0–8.0)	6.0 (5.0–8.0)	8.0 (6.0–9.0)	<0.001
Becoming a stool donor would be a large commitment for me to make if I have to				
Donate twice a week	8.0 (6.0–10.0)	9.0 (7.0–10.0)	8.0 (6.0–9.0)	<0.001
Donate once a week	7.0 (5.0–9.0)	7.0 (6.0–9.0)	6.0 (4.0–8.0)	<0.001
Donate every 2 weeks	5.0 (3.0–7.0)	6.0 (4.0–8.0)	4.0 (2.0–6.0)	<0.001
Donate every month	3.0 (1.0–5.0)	4.0 (3.0–6.0)	2.0 (1.0–4.0)	<0.001
Economic compensation				
Economic compensation is fair to blood donors	5.0 (2.0–7.0)	5.0 (3.0–7.0)	5.0 (2.0–7.0)	0.038
Economic compensation is fair to stool donors	5.0 (3.0–7.0)	5.0 (3.0–7.0)	5.0 (2.0–7.0)	0.013
More likely to become a stool donor if economic compensation is offered	7.0 (3.0–9.0)	7.0 (4.0–8.0)	7.0 (3.0–9.0)	0.92
Would consider being a stool donor if there is no economic compensation	6.0 (5.0–8.0)	5.0 (4.0–6.0)	7.0 (6.0–9.0)	<0.001
For \$5–10 per donation	5.0 (3.0–7.0)	5.0 (2.0–6.0)	6.0 (4.0–8.0)	<0.001
For \$10.01–20 per donation	6.0 (4.0–8.0)	5.0 (3.0–7.0)	7.0 (5.0–9.0)	<0.001
For \$20.01–30 per donation	7.0 (5.0–9.0)	7.0 (4.0–8.0)	8.0 (5.0–10.0)	<0.001
For \$40 per donation	8.5 (5.0–10.0)	8.0 (5.0–10.0)	9.0 (6.0–10.0)	<0.001
Opinion in terms of a fair amount for each stool donation		Number of participants (total n = 778)		<0.001
\$0	178 (28.1%)	60 (21.8%)	118 (33.0%)	
\$1–10	91 (14.4%)	27 (9.8%)	64 (17.9%)	
\$11–20	136 (21.5%)	52 (18.9%)	84 (23.5%)	
\$21–30	85 (13.4%)	45 (16.4%)	40 (11.2%)	
\$31–40	84 (13.3%)	53 (19.3%)	31 (8.7%)	
\$40+	59 (9.3%)	38 (13.8%)	21 (5.9%)	
Motivations for donating				
Primary reason for stool donation if choosing to become a donor		Number of participants (total n = 778)		<0.001
Purely altruistic	323 (41.6%)	103 (31.3%)	220 (49.1%)	
Mostly altruistic, but also economic	272 (35.0%)	120 (36.5%)	152 (33.9%)	

(Continued)

Table 2. (Continued).

	Median survey response and interquartile range (Likert scale of 1–10)	Highly willing to be a stool donor		P value
		No (n = 330)	Yes (n = 448)	
Equally altruistic and economic	133 (17.1%)	77 (23.4%)	56 (12.5%)	
Mostly economic, but also altruistic	40 (5.1%)	23 (7.0%)	17 (3.8%)	
Purely economic	9 (1.2%)	6 (1.8%)	3 (0.7%)	
	Median survey response and interquartile range (Likert scale of 1–10)			
Helping others is more important to me than any inconvenience being a stool donor may impose	7.0 (5.0–9.0)	6.0 (5.0–7.0)	8.0 (6.0–9.0)	<0.001
Would like to know how my donations are helping patients requiring FMT	8.0 (7.0–10.0)	8.0 (6.0–9.0)	9.0 (7.0–10.0)	<0.001
Donor status				
Would be willing to receive FMT if becoming sick	9.0 (7.0–10.0)	7.0 (5.0–9.0)	10.0 (8.0–10.0)	<0.001

Table 3. Estimated effects of selected factors on the odds of being highly willing to donate stool.

	OR (95% CI)	P value
Self-identifying as female vs. male gender	0.56 (0.37–0.85)	0.007
Blood donor vs. not a blood donor	1.64 (1.13–2.37)	0.009
Collection of my own stool is unpleasant	0.92 (0.86–0.995)	0.037
Having to see a doctor to review my medical history and undergo a physical examination is invasive	0.92 (0.84–1.00)	0.05
Becoming a stool donor would be a large commitment for me to make if I have to donate every month	0.82 (0.76–0.89)	<0.001
Positive attitude toward FMT	1.39 (1.24–1.56)	<0.001
Would consider being a stool donor without economic compensation	1.29 (1.17–1.42)	<0.001
Would consider being a stool donor for \$5–10 per donation	1.19 (1.11–1.29)	<0.001
Helping others is more important to me than any inconvenience being a stool donor may impose	1.32 (1.19–1.46)	<0.001
Primary reason for stool donation is mostly or purely economic vs. mostly or purely altruistic or equally economic and altruistic	2.55 (1.14–5.7)	0.022

donation was mostly or purely economic, the willingness to donate stool averaged 0.63 points higher (95% CI 0.15–1.10; $P = 0.011$). Similar to the result in the logistic regression model, potential barriers to donation were finding stool collection unpleasant, finding the need to see a physician to qualify as a stool donor invasive, and finding monthly stool donation frequency to be as large commitment. Potential motivators were having positive attitudes toward FMT, knowing that FMT helps others, and economic compensation. An additional motivator identified by the linear regression model was knowledge of how their

Table 4. Results of linear regression model with willingness to become a stool donor as dependent variable.

	Estimate (95% CI)	P value
Self-identifying as female vs. male gender	−0.39 (−0.64, −0.15)	0.002
Considered organ donation vs. not considered organ donation	0.49 (0.12, 0.87)	0.011
Collection of my own stool is unpleasant	−0.08 (−0.13, −0.04)	<0.001
Having to see a doctor to review my medical history and undergo a physical examination is invasive	−0.06 (−0.12, −0.01)	0.017
Becoming a stool donor would be a large commitment for me to make if I have to donate every month	−0.13 (−0.17, −0.08)	<0.001
Positive attitude toward FMT	0.27 (0.20, 0.33)	<0.001
Economic compensation is fair to blood donors	0.05 (0.01, 0.10)	0.021
Would consider being a stool donor without economic compensation	0.25 (0.20, 0.31)	<0.001
Would consider being a stool donor for \$20.01–30 per donation	0.12 (0.08, 0.17)	<0.001
Helping others is more important to me than any inconvenience being a stool donor may impose	0.21 (0.15, 0.27)	<0.001
Would like to know how my donations are helping patients requiring FMT	0.07 (0.02, 0.12)	0.005
Primary reason for stool donation is mostly or purely economic vs. mostly or purely altruistic or equally economic and altruistic	0.63 (0.15, 1.10)	0.011

stool donation helps others. In addition, participants who considered being an organ donor were more willing to become a stool donor, with their willingness to be a stool donor averaging 0.49 points higher (95% CI: 0.12–0.87, $P = 0.011$). Blood donors were still more highly willing to be a stool donor (point estimate = 0.19), but the difference in willingness to

donate stool did not reach statistical significance (95% CI: -0.03 – 0.41 , $P = 0.088$).

Qualitative analysis

There were 307 responses to the optional open text question at the end of the survey: “Are there any other motivators and/or apprehensions that you can think of for becoming a stool donor?”

Barriers to stool donation

We identified four themes related to barriers to stool donation: logistics, social norms, disgust, and risks. Over 100 participants expressed concerns about the potential logistical barriers associated with time and transportation of stool donation, as the following quote illustrates:

Really the time commitment and location of drop off for donation would be the biggest factors affecting whether I would donate. Wouldn't want to have to drive across the city twice a week, for example.

Concerns of societal stigma, embarrassment, and awkwardness of stool donation were expressed by 13 participants:

There is a stigma around feces; most people find it abhorrent and we are not exposed to others' bowel movements very often.

The “ick” factor being a deterrent for donating was commented on by 30 participants:

Would need to get past squeamishness ... it's not a pleasant subject!

The risks of harmful effects of FMT to the donor or recipient were a concern for nine participants:

As for blood transfusion, the concern that the donation in and of itself could actually do harm to the recipient.

Motivators of stool donation

Three key themes were identified in connection to motivators to stool donation: altruism, compensation, and helping family and friends.

Helping those who were ill and contributing to progress in scientific research were suggested by 38 participants as important reasons to donate stool:

Understanding what it is like for people who require transplants is enough of a motivator for me to be a donor.

Just over 20 participants discussed interest in compensation, either economically or in the form of information about their gut microbiome health. The following two examples illustrate these different approaches to compensation:

the concept of “being paid to take a dump” is quite attractive.

I am also interested in how healthy my gut is. I'd like to know the results of any analysis done on my stool.

Many expected that out-of-pocket expenses would be covered, as this quote demonstrates:

If it's something that would have to be done often, I would think money to cover transportation is not unreasonable.

Donating to family and friends was preferred for over 20 participants and would be more of a motivator than donating to strangers:

I am fully aware of the benefits it can bring but it still feels rather weird. If it was for family, I would be much more likely to donate.

Personal narratives

A small number of participants provided responses, one quite lengthy, that outlined a narrative of their personal experience of family members receiving FMT. The following two excerpts highlight how people who have first-hand experience of the impact of FMT on family and friends can be both knowledgeable and positive about the benefits of FMT.

I have a family member who passed away from *C. diff* colitis and had been a recipient of the FMT, so I'm very passionate about this subject matter.... For patients with other co-morbidities (i.e., elderly patients with weakened immune systems), the FMT should be performed during the FIRST infection.

My sister got *C. diff* after chemo and was hospitalized over a month. She received a fecal transplant after antibiotics were unsuccessful. I think if she received it earlier, her hospitalization would have been much shorter.

Discussion

FMT is currently being used primarily as a therapy for recurrent *C. difficile* infection. As clinical interest grows in the use of FMT for treating an

expanding number of medical conditions, so will the need for healthy donors. Finding donors who both pass the stringent screening process and are committed to donating stool on a regular basis is a significant challenge in setting up a successful FMT program or stool bank. Unlike other tissue donation, stool donation is not well known to the general public and may be embarrassing for potential donors. To operate a cost-efficient program, better understanding of why people may consider stool donation is needed for developing best strategies to recruit and retain donors.

This is the largest survey of potential FMT donors to date. Responses collected from six academic institutions in three countries offer important insights into the factors that determine the likelihood of success in recruiting FMT donors. As with blood, gamete, and biospecimen donations, we found that altruism is the main reason individuals consider stool donation.³⁴⁻⁴¹ Positive attitudes toward FMT, knowledge of how one's donation is helping others, and economic compensation may contribute to the decision to donate. In addition, we found that individuals who are blood donors and those who considered organ donation are more likely to consider becoming stool donors. These same factors may facilitate donor retention over time. Barriers to stool donation included lack of knowledge about FMT and actual logistics of stool donation, both of which are barriers to blood donation.^{35,36,42} Higher frequency of stool donation decreases willingness to donate.

One interesting finding was that survey participants self-identifying as female gender are less willing to become stool donors. Female gender was found to be associated with lower odds of having strong willingness to donate stool, when answers to the survey were included in the regression model. However, when we examined the model variables in more detail, we could not find a compelling reason or explanation as to why this was the case. Three factors (related to time commitment, monetary compensation, and altruism) seemed to be a confounder for gender only when taken together, and none of these variables taken individually were statistically significant for gender. Although there are no data on the influence of gender and willingness to donate stool, the field of biological donation is very complex. A recent sociological study of the gendered aspects of biological donations highlights a variety of cultural

and social complexities that may influence willingness to participate in the donation of biological material.⁴⁷ The literature on blood donation also shows conflicting gender data. In the United Kingdom, in 2017, a study found that more women than men donated blood (56.6% vs. 43.4%).⁴⁸ In contrast, women only accounted for 30% of blood donors in Italy and Greece in another study.⁴⁹ Factors explaining gender difference in Italy included a greater expectation of trauma, adverse reactions, or fear of some aspects of the blood collection process (e.g., vasovagal reactions, dizziness, bruising at blood draw site, etc. as well as anxiety over the procedure), as compared to men.⁴⁹ This could conceivably apply to stool donation as well i.e., the screening bloodwork required to test stool donors for pathogens and communicable diseases on an ongoing basis may be more of a deterrent for women donors than for men. We did not specifically explore this possibility in our survey. We also did not delve into the specifics of the stool donation process in our survey or provide details regarding FMT program/infrastructure available to facilitate stool donation. For example in Pakistan, a country with low numbers of women blood donors, a survey of over 600 women health-care professionals found 83% of them would be more likely to donate blood if better infrastructure and donation facilities were available for them to donate at work, on-site.⁵⁰ Finally, there may be reasons for gender variability in willingness to donate stool across different cultural and national contexts that were not detected in our study. While our findings suggest that gender differences may affect stool donation, more research is needed to explore this finding in more detail.

Educating the public about FMT, stool donations, and the clinical potential of FMT should be undertaken to promote awareness and to decrease negative perception associated with stool donation. As one respondent puts it: "there is a stigma around feces; most people find it abhorrent and we are not exposed to others' bowel movements very often." As in the previous studies, we found that informing donors about the benefits of their donation will motivate them.³³ In addition, our data indicate that monetary incentives can move peoples' attitude from feeling neutral to being willing to donate. The results of our study are consistent with other studies showing that being a blood donor does improve the

likelihood of becoming a stool donor, in part due to donor familiarity with the blood donation process.^{32,33} Most institutions employ an FMT screening process based on blood donor screening practices, which uses similar donor screening questionnaires and serum laboratory testing to screen for transmissible infectious diseases.

Every aspect of donor screening, stool collection, and donation drop-off and frequency should be made as easy and convenient as possible. Previous studies found that 33–41% of the participants would decline becoming a stool donor due to frequency and duration of donating.^{26,33} This was a common concern of the participants in our study. To recruit more donors, stool donation must be made easier for donors by increasing the number of drop-off locations or decreasing the required frequency of donation. The donation kit should be as user-friendly as possible. Another strategy is for individuals to donate as often as possible between screenings while their donations are held in “quarantine.” Providing time away from stool donation may also minimize donor fatigue.

Our qualitative analysis indicates a possible direction for more in-depth study, particularly relating to motivations for stool donation when family or friends are recipients. A growing body of research related to clinical care incorporates patient and family engagement, but few qualitative studies focus on recruitment for collection of microbial samples such as feces and urine.⁵¹ More research is needed to understand how collaborations between clinicians, patients, and family members can help when recruiting and retaining stool donors.

This study has several strengths. It is multicenter, multinational, and the largest of its kind. The results are robust and did not differ among countries. Analyses were conducted by categorizing willingness to donate on a 1–10 Likert scale. The study is limited by surveys being sent out primarily through a university-affiliated link, with the majority of survey respondents being health-care workers or students at the academic institutions. Another study weakness is the potential of self-selection bias, as the individuals who respond to surveys may be those who are potentially more interested, motivated and willing to consider donation. This may decrease generalizability of the results. This survey was only released in English, limiting the diversity of participants and decreasing

potential applicability to non-English-speaking centers or countries. The survey only asked individuals if they were willing to become stool donors but did not ask if they went through the process of actually becoming a stool donor.

In conclusion, this large multicenter, multinational study has identified important factors which may motivate or deter people from considering stool donation. FMT programs and stool banks should consider strategies which take these variables into consideration, to maximize effectiveness of future efforts in stool donor recruitment and retention.

Methods

Study design and variables

We designed a cross-sectional, questionnaire-based internet survey (Appendix A) to examine the influence of selected characteristics of potential donors on willingness to donate stool. We collected respondents’ demographics: age, sex, occupation, and country of residence. Other characteristics of potential donors were history of blood donation, consideration for organ donation, and FMT-related knowledge and attitudes. Modifiable aspects of stool donation were also assessed: economic compensation, time commitment, and logistics of stool donation. We then asked participants to assess their willingness to donate stool. We also gave them the option of writing additional comments on any motivators or apprehensions not included in this questionnaire.

Questionnaire development

The investigators, including gastroenterologists, infectious disease physicians, and clinical epidemiologists with expertise in FMT, developed a 32-item structured questionnaire through an iterative process. Response options were fixed for 31 questions, with some statements for which respondents were asked to indicate degrees of agreement on a 10-point Likert scale. One question asked for an open-ended response.

Questionnaire dissemination and participant recruitment

The questionnaire was formatted for Google Forms and electronically disseminated through

six academic centers in Canada, the United Kingdom, and the United States: University of Alberta, Queen's University (Kingston, Canada), University of Nottingham, Imperial College London, Indiana University, and Brigham and Women's Hospital/Harvard University. The questionnaire was available for online completion from June 22 to October 31, 2017. Ethics approval was obtained from each participating institution.

A web link to the questionnaire was emailed to students, health-care professionals, and staff affiliated with the academic centers listed above. Additionally, survey information was posted on university and other professional forums, Twitter, Facebook, and campus news websites. Flyers promoting the survey were posted in and around the universities, including at grocery stores and coffee shops. Participants were encouraged to forward the web link to others.

Statistical analysis

Categorical variables were summarized using frequency distributions. Likert scale responses were summarized using median and interquartile range, showing the 25th and 75th percentile of responses. In our primary analysis, the 10-point Likert scale for willingness to donate stool was dichotomized at the median, with responses 8–10 indicating being highly willing to be a donor. This strategy was based on the assumption that the degree of agreement with the statement “I'd be willing to be a stool donor for fecal microbiota transplantation.” corresponded with the degree of willingness to be a stool donor. The dichotomized analysis assumed that survey participants who were highly willing to donate stool and those who were not are two distinct groups. The secondary sensitivity analysis was a linear regression which modeled willingness to donate as a continuous outcome. The linear regression model assumed that willingness to donate stool had a constant linear slope.

Participants who were and were not highly willing to donate stool, based on our dichotomized analysis, were compared using Pearson's chi-square test for categorical variables and the Wilcoxon rank sum test for Likert scale responses. The logistic regression was performed to estimate ORs as measures of the influence of selected factors on willingness to donate

stool. Given the large number of study variables, variables with an unadjusted p -value of 0.25 or lower were included in a multivariable logistic regression model with backward elimination to select important variables associated with willingness to donate stool. Adjusted ORs and CIs were estimated using the final model. In the linear regression model, variables were again selected using backward elimination. Variables with a two-sided $p \leq 0.05$ were considered to be significant.

Qualitative analysis

Analysis of the one open-ended question about motivators or apprehensions pertaining to becoming a stool donor was performed with NVivo 11, a software tool that assists in categorizing, analyzing, and identifying key themes within data. We identified 24 different themes through an iterative analysis process and ultimately collapsed them into 3 main categories.

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BM, JRA, MF, BHM, TM, EOP, KW, and DK designed the study; BM, JRA, TM, BHM, ELP, RC, AJ, RED, BR, KW collected data, HX, KJG, and CM analyzed and interpreted data. BM, AE, HX, KJG, and DK wrote initial manuscript, and all authors worked on revisions.

All authors approved the final version of the article, including authorship list.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.


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References

- Zhang S, Palazuelos-Munoz S, Balsells EM, Nair H, Chit A, Kyaw MH. Cost of hospital management of *Clostridium difficile* infection in United States—a meta-analysis and modelling study. *BMC Infect Dis*. 2016;16(447):1–18. doi:10.1186/s12879-016-1786-6.
- Surawicz CM, Brandt LJ, Binion DG, Ananthakrishnan AN, Curry SR, Gilligan PH, McFarland LV, Mellow M, Zuckerbraun BS. Guidelines for diagnosis, treatment, and prevention of *Clostridium difficile* infections. *Am J Gastroenterol*. 2013;108(4):478–498 quiz 499. doi:10.1038/ajg.2013.4.
- Lessa FC, Mu Y, Bamberg WM, Beldavs ZG, Dumyati GK, Dunn JR, Farley MM, Holzbauer SM, Meek JI, Phipps EC, et al. Burden of *clostridium difficile* infection in the United States. *N Engl J Med*. 2015;372(9):825–834. doi:10.1056/NEJMoa1408913.
- Dubberke ER, Wertheimer AI. Review of current literature on the economic burden of *Clostridium difficile* infection. *Infect Control Hosp Epidemiol*. 2009;30(1):57–66. doi:10.1086/592981.
- Rodrigues R, Barber GE, Ananthakrishnan AN. A comprehensive study of costs associated with recurrent *Clostridium difficile* infection. *Infect Control Hosp Epidemiol*. 2017;38(2):196–202. doi:10.1017/ice.2016.246.
- Heimann SM, Cruz Aguilar MR, Mellinghof S, Vehreschild M. Economic burden and cost-effective management of *Clostridium difficile* infections. *Med Mal Infect*. 2018;48(1):23–29. doi:10.1016/j.medmal.2017.10.010.
- Reigadas Ramirez E, Bouza ES. Economic burden of *Clostridium difficile* infection in European countries. *Adv Exp Med Biol*. 2018;1050:1–12. doi:10.1007/978-3-319-72799-8_1.
- McFarland LV, Elmer GW, Surawicz CM. Breaking the cycle: treatment strategies for 163 cases of recurrent *Clostridium difficile* disease. *Am J Gastroenterol*. 2002;97(7):1769–1775. doi:10.1111/j.1572-0241.2002.05839.x.
- Jiang ZD, Ajami NJ, Petrosino JF, Jun G, Hanis CL, Shah M, Hochman L, Ankoma-Sey V, DuPont AW, Wong MC, et al. Randomised clinical trial: faecal microbiota transplantation for recurrent *Clostridium difficile* infection - fresh, or frozen, or lyophilised microbiota from a small pool of healthy donors delivered by colonoscopy. *Aliment Pharmacol Ther*. 2017;45(7):899–908. doi:10.1111/apt.13969.
- Woodworth MH, Carpentieri C, Sitchenko KL, Kraft CS. Challenges in fecal donor selection and screening for fecal microbiota transplantation: a review. *Gut Microbes*. 2017;8(3):225–237. doi:10.1080/19490976.2017.1286006.
- Gezinski LB, Karandikar S, Carter J, White M. Exploring motivations, awareness of side effects, and attitudes among potential egg donors. *Health Soc Work*. 2016;41(2):75–83. doi:10.1093/hsw/hlw005.
- Quraishi MN, Widlak M, Bhala N, Moore D, Price M, Sharma N, Iqbal TH. Systematic review with meta-analysis: the efficacy of faecal microbiota transplantation for the treatment of recurrent and refractory *Clostridium difficile* infection. *Aliment Pharmacol Ther*. 2017;46(5):479–493. doi:10.1111/apt.14201.
- Moayyedi P, Surette MG, Kim PT, Libertucci J, Wolfe M, Onischi C, Armstrong D, Marshall JK, Kassam Z, Reinisch W, et al. Fecal microbiota transplantation induces remission in patients with active ulcerative colitis in a randomized controlled trial. *Gastroenterology*. 2015;149(1):102–109.e106. doi:10.1053/j.gastro.2015.04.001.
- Rossen NG, Fuentes S, van der Spek MJ, Tijssen JG, Hartman JH, Duflou A, Lowenberg M, van Den Brink GR, Mathus-Vliegen EM, de Vos WM, et al. Findings from a randomized controlled trial of fecal transplantation for patients with ulcerative colitis. *Gastroenterology*. 2015;149(1):110–118.e114. doi:10.1053/j.gastro.2015.03.045.
- Paramsothy S, Kamm MA, Kaakoush NO, Walsh AJ, van Den Bogaerde J, Samuel D, Leong RWL, Connor S, Ng W, Paramsothy R, et al. Multidonor intensive faecal microbiota transplantation for active ulcerative colitis: a randomised placebo-controlled trial. *Lancet*. 2017;389(10075):1218–1228. doi:10.1016/s0140-6736(17)30182-4.
- Lai CY, Sung J, Cheng F, Tang W, Wong SH, Chan PKS, Kamm MA, Sung JYY, Kaplan G, Chan FKL, et al. Systematic review with meta-analysis: review of donor features, procedures and outcomes in 168 clinical studies of faecal microbiota transplantation. *Aliment Pharmacol Ther*. 2019 Feb;49(4):354–363. doi:10.1111/apt.15116.
- Cui B, Feng Q, Wang H, Wang M, Peng Z, Li P, Huang G, Liu Z, Wu P, Fan Z, et al. Fecal microbiota transplantation through mid-gut for refractory Crohn's disease: safety, feasibility, and efficacy trial results. *J Gastroenterol Hepatol*. 2015;30(1):51–58. doi:10.1111/jgh.12727.
- Pinn DM, Aroniadis OC, Brandt LJ. Is fecal microbiota transplantation the answer for irritable bowel syndrome? A single-center experience. *Am J Gastroenterol*. 2014;109(11):1831–1832. doi:10.1038/ajg.2014.295.
- Jayasinghe TN, Chiavaroli V, Holland DJ, Cutfield WS, O'Sullivan JM. The new era of treatment for obesity and metabolic disorders: evidence and expectations for gut microbiome transplantation. *Front Cell Infect Microbiol*. 2016;6:1–15. doi:10.3389/fcimb.2016.00015.
- Vrieze A, Van Nood E, Holleman F, Salojarvi J, Kootte RS, Bartelsman JF, Dallinga-Thie GM, Ackermans MT, Serlie MJ, Oozeer R, et al. Transfer of intestinal microbiota from lean donors increases insulin sensitivity in individuals with metabolic syndrome. *Gastroenterology*. 2012;143(4):913–916.e917. doi:10.1053/j.gastro.2012.06.031.
- Haghikia A, Jorg S, Duscha A, Berg J, Manzel A, Waschbisch A, Hammer A, Lee DH, May C, Wilck N, et al. Dietary fatty acids directly impact

- central nervous system autoimmunity via the small intestine. *Immunity*. 2015;43(4):817–829. doi:10.1016/j.immuni.2015.09.007.
22. Cammarota G, Pecere S, Ianiro G, Masucci L, Curro D. Principles of DNA-based gut microbiota assessment and therapeutic efficacy of fecal microbiota transplantation in gastrointestinal diseases. *Dig Dis*. 2016;34(3):279–285. doi:10.1159/000443362.
 23. Martin CR, Mayer EA. Gut-brain axis and behavior. *Nestle Nutr Inst Workshop Ser*. 2017;88:45–53. doi:10.1159/000461732.
 24. Aroniadis OC, Brandt LJ. Fecal microbiota transplantation: past, present and future. *Curr Opin Gastroenterol*. 2013;29(1):79–84. doi:10.1097/MOG.0b013e32835a4b3e.
 25. Kang DW, Adams JB, Gregory AC, Borody T, Chittick L, Fasano A, Khoruts A, Geis E, Maldonado J, McDonough-Means S, et al. Microbiota transfer therapy alters gut ecosystem and improves gastrointestinal and autism symptoms: an open-label study. *Microbiome*. 2017;5(10):1–16. doi:10.1186/s40168-016-0225-7.
 26. Paramsothy S, Borody TJ, Lin E, Finlayson S, Walsh AJ, Samuel D, van Den Bogaerde J, Leong RW, Connor S, Ng W, et al. Donor recruitment for fecal microbiota transplantation. *Inflamm Bowel Dis*. 2015;21(7):1600–1606. doi:10.1097/MIB.0000000000000405.
 27. Kelly CR, Kahn S, Kashyap P, Laine L, Rubin D, Atreja A, Moore T, Wu G. Update on fecal microbiota transplantation 2015: indications, methodologies, mechanisms, and outlook. *Gastroenterology*. 2015;149(1):223–237. doi:10.1053/j.gastro.2015.05.008.
 28. Burns LJ, Dubois N, Smith MB, Mendolia GM, Burgess J, Edelstein C, Noh A, Alm E, Kassam Z. 499 donor recruitment and eligibility for fecal microbiota transplantation: results from an international public stool bank. *Gastroenterology*. 2015;148(4):S-96–S-97. doi:10.1016/S0016-5085(15)30331-0.
 29. Bakken JS, Borody T, Brandt LJ, Brill JV, Demarco DC, Franzos MA, Kelly C, Khoruts A, Louie T, Martinelli LP, et al. Treating *Clostridium difficile* infection with fecal microbiota transplantation. *Clin Gastroenterol Hepatol*. 2011;9(12):1044–1049. doi:10.1016/j.cgh.2011.08.014.
 30. Edelstein C, Daw JR, Kassam Z. Seeking safe stool: canada needs a universal donor model. *Cmaj*. 2016;188(17–18):E431–E432. doi:10.1503/cmaj.150672.
 31. Dubois N, Ling K, Osman M, Burns L, Mendolia G, Blackler D, Burgess J, Edelstein C, Noh A, Vo E, et al. Prospective assessment of donor eligibility for fecal microbiota transplantation at a public stool bank: results from the evaluation of 1387 candidate donors. *Open Forum Infect Dis*. 2015;2(suppl_1):962. doi:10.1093/ofid/ofv133.678.
 32. Jorgensen SMD, Erikstrup C, Dinh KM, Lemming LE, Dahlerup JF, Hvas CL. Recruitment of feces donors among blood donors: results from an observational cohort study. *Gut Microbes*. 2018;1–11. doi:10.1080/19490976.2018.1458179.
 33. Tariq R, Weatherly R, Kammer P, Pardi DS, Khanna S. Donor screening experience for fecal microbiota transplantation in patients with recurrent *C. difficile* infection. *J Clin Gastroenterol*. 2018;52(2):146–150. doi:10.1097/MCG.0000000000000768.
 34. Allen SC, Lohani M, Hendershot KA, Deal TR, White T, Dixon MD, Pentz RD. Patient perspectives on compensation for biospecimen donation. *AJOB Empir Bioeth*. 2018;9(2):77–81. doi:10.1080/23294515.2018.1460633.
 35. Bagot KL, Murray AL, Masser BM. How can we improve retention of the first-time donor? A systematic review of the current evidence. *Transfus Med Rev*. 2016;30(2):81–91. doi:10.1016/j.tmr.2016.02.002.
 36. Baseer S, Maha Ejaz S, Noori M, Faisal A. Knowledge, attitude, perceptions of university students towards blood donation: an assessment of motivation and barriers. *Isra Med J*. 2017;9:406–410.
 37. Pennings G, de Mouzon J, Shenfield F, Ferraretti AP, Mardesic T, Ruiz A, Goossens V. Socio-demographic and fertility-related characteristics and motivations of oocyte donors in eleven European countries. *Hum Reprod*. 2014;29(5):1076–1089. doi:10.1093/humrep/deu048.
 38. Kenney NJ, McGowan ML. Looking back: egg donors' retrospective evaluations of their motivations, expectations, and experiences during their first donation cycle. *Fertil Steril*. 2010;93(2):455–466. doi:10.1016/j.fertnstert.2008.09.081.
 39. Svanberg AS, Lampic C, Gejervall AL, Gudmundsson J, Karlstrom PO, Solensten NG, Sydsjo G. Gamete donors' motivation in a Swedish national sample: is there any ambivalence? A descriptive study. *Acta Obstet Gynecol Scand*. 2012;91(8):944–951. doi:10.1111/j.1600-0412.2012.01430.x.
 40. Bay B, Larsen PB, Kesmodel US, Ingerslev HJ. Danish sperm donors across three decades: motivations and attitudes. *Fertil Steril*. 2014;101(1):252–257 e251. doi:10.1016/j.fertnstert.2013.09.013.
 41. Chell K, Davison TE, Masser B, Jensen K. A systematic review of incentives in blood donation. *Transfusion*. 2018;58(1):242–254. doi:10.1111/trf.14387.
 42. Bart T, Volken T, Fischer Y, Taleghani BM. Giving blood and enrolling on the stem cell donor registry: ranking of obstacles and motives in Switzerland. *Transfus Med Hemother*. 2014;41(4):264–272. doi:10.1159/000365457.
 43. Charbonneau J, Cloutier MS, Carrier E. Why do blood donors lapse or reduce their donation's frequency? *Transfus Med Rev*. 2016;30(1):1–5. doi:10.1016/j.tmr.2015.12.001.
 44. Purewal S, van Den Akker OB. British women's attitudes towards oocyte donation: ethnic differences and altruism. *Patient Educ Couns*. 2006;64(1–3):43–49. doi:10.1016/j.pec.2005.11.007.

45. Purewal S, van Den Akker OBA. Systematic review of oocyte donation: investigating attitudes, motivations and experiences. *Hum Reprod Update*. 2009;15(5):499–515. doi:10.1093/humupd/dmp018.
46. Provoost V, Pennings G, Van Rompuy F. Non-donors' attitudes towards sperm donation and their willingness to donate. *J Assist Reprod Genet*. 2018;35(1):107–118. doi:10.1007/s10815-017-1036-x.
47. Kent J, Fannin M, Dowling S. Gender dynamics in the donation field: human tissue donation for research, therapy and feeding. *Sociol Health Illn*. 2019;41(3):567–584. doi:10.1111/1467-9566.12803.
48. NHS Blood and Transplant. Supplementary data tables and figures: 2017. In. Wllington House, 133-155 Waterloo Road, London SE1 8UG: Public Health England; 2018:1–35.
49. Bani M, Giussani B. Gender differences in giving blood: a review of the literature. *Blood Transfus*. 2010;8(4):278–287. doi:10.2450/2010.0156-09.
50. Bilal M, Haseeb A, Zahid I, Lashkerwala S, Saeeduddin F, Saad M, Arshad M, Moorpani M, Khan M, Tariq A, et al. Knowledge, attitudes and perceptions among non blood donor female health care professionals. *Glob J Health Sci*. 2015;8(4):203–211. doi:10.5539/gjhs.v8n4p203.
51. Mäkinen EI. Tuning clinical recruitment around cultural taboos in a human microbiome study. *Sci Cult (Lond)*. 2018;27(2):1–24. doi:10.1080/09505431.2018.1508429.