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Original Article

Relationship between irritable bowel syndrome, psychological comorbidities and the consumption of high-fructose corn syrup in a low-income community in a food desert area

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SUMMARY

Background & aim: Hypersensitivity to fructose-containing foods including those containing high fructose corn syrup (HFCS) contributes to the worsening of irritable bowel syndrome (IBS) symptoms. There is scarcity of healthy food options in food desert areas. This may result in increased HFCS consumption in its residents. Thus there is a critical need to evaluate HFCS consumption of IBS patients, especially in socioeconomically challenged communities. The aim of this study was to explore the extent and origins of HFCS consumption in IBS patients that will help in the management of this disease.

Methods: We carried out a retrospective chart review of 969 IBS patients for demographics and medical and psychiatric comorbidities. We then collected information about dietary HFCS intake from a subset of IBS patients and control subjects using USDA-database-driven-surveys that included 398 HFCS-rich food items.

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Control subjects lacked history of gastrointestinal symptoms/disorders.
Results: 84% and 78% of IBS patients were female and Caucasian, respectively. 82% IBS patients were >40 years old. All IBS patients had at least one psychological comorbidity: depression, anxiety, bipolar, PTSD or psychosis; depression (66%) and anxiety (54%) being the most common. Overall HFCS intake was significantly higher in IBS patients compared to control subjects ($p > 0.0001$), which occurred *via* beverages, breakfast foods, jams, jellies, syrup, and desserts. Beverages contributed (76%) to the highest HFCS consumption observed in the IBS-diarrhea patients.
Conclusion: Our study is first to show a significantly high consumption of HFCS in IBS patients suffering from socioeconomic challenges and underscores the urgent need for provider-driven patient education regarding dietary interventions. This intervention is pivotal to avoid exacerbation of gastrointestinal symptoms as well as that of co-existing psychological comorbidities.

1. Introduction

Irritable bowel syndrome (IBS) is the most commonly diagnosed and debilitating functional gastrointestinal disorder that presents with chronic abdominal discomfort and altered bowel habits [1]. It accounts for approximately one-third of all gastroenterology referrals [2–4]. Several factors including food and fructose sensitivity contribute to the pathophysiology of IBS [5,6]. This makes the treatment and management of IBS complicated. A growing focus of clinical research has been to improve IBS symptomatology through dietary modifications [7,8]. Hypersensitivity to certain foods, specifically fructose malabsorption can lead to an exacerbation of IBS symptoms [9–15]. Fructose is present in high amount in the artificial sweetener, high-fructose corn syrup (HFCS). HFCS can thus exacerbate IBS [12]. Currently, HFCS represents >40% of sweeteners added to foods and beverages [16]. HFCS is also considered part of the FODMAP family (fermentable-oligosaccharides–disaccharides–monosaccharides–polyols). IBS patients may respond favorably to low-FODMAP diets [17,18].

Our hospital system is located in Camden city, New Jersey, with 37.4% of residents living below the poverty line with a median household income of $26,105, while that for the entire country is $54,462 [19]. The unemployment rate is double than that for the entire country. The highest-attained educational level in Camden for high school or equivalent is 67.7% against the national average of 88%. Camden is considered to be a 'food desert' [20]. Residents have limited dietary choices due to the lack of access to fresh, healthy and affordable food items. They may thus gravitate to readily-available and inexpensive food products that contain HFCS. We hypothesize that HFCS consumption is higher in IBS patients in food dessert communities similar to our community. In order to effectively treat IBS, identifying key food triggers may aid in symptomatic management and individualized treatment options. Here we explored the extent and origins of HFCS consumption in IBS patients to help manage this disease.

IBS patients are likely to have psychiatric co-morbidities such as anxiety, depression and post-traumatic-stress-disorder (PTSD) [3,21]. Stress and sedentary lifestyle are also associated with IBS [22]. The compounded effect of these biopsychosocial factors should be considered in the diagnostic evaluation of these patients. IBS can be exacerbated by psychological conditions and these conditions in turn can be worsened by IBS. Patient communities similar to ours may be predisposed to some of these psychological comorbidities due to the strain imposed by socioeconomic challenges. In the present study, we thus also explored the existence of psychological comorbidities in IBS patients as

those predisposed to IBS may either have a history of mental health issues or may develop mental health issues. Treatment of the psychological and gastrointestinal manifestations of IBS and examination of interventions on the diet of vulnerable populations are crucial to prevent the exacerbation of symptoms.

2. Methods

2.1. Study design

This observational study was approved by the Cooper University Hospital (CUH) Institutional Review Board (IRB) (17-079EX). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

2.2. Survey instrument

The survey was designed by three investigators (S.P, J.D. and A.M). The content of the survey was streamlined to maintain adequate attention and be completed in less than ten minutes. The survey is included as Supplementary File 1. The survey had two key components, (i) demographic, lifestyle and clinical data and (ii) questionnaire for consumption of HFCS-rich foods. The survey included questions pertinent to demographics (sex, gender, ethnicity/race), lifestyle (residence, education level, marital status, household income, number of people in household, smoking and drinking), clinical (height, weight, type of IBS, colonoscopy/endoscopy, medications, hypertension, diabetes, cholesterol, psychological comorbidities, food triggers for IBS, FODMAP diet and recreational drug usage). We reviewed the medical records of the participating patients to confirm demographic and clinical details. We used the United States Department of Agriculture (USDA) data to identify foods particularly high in HFCS and included the 398 food items listed as high in HFCS in our survey.

2.3. Study population

We collected data from IBS patients treated at the CUH, Camden, NJ. The study was carried out in two parts, (i) collection of retrospective data from IBS patient charts from five years and (ii) collection of data *via* surveys from IBS patients currently being treated. Patients with confirmed diagnosis of IBS and treated at the Cooper Digestive Health Institute were eligible. Using the hospital's electronic medical record system (EPIC), we collected retrospective chart data from patients treated for IBS at CUH between 01/01/2012–05/02/2017. IBS subtypes were determined based on the ROME IV criteria as (i) with constipation (IBS-C); (ii) with diarrhea (IBS-D); (iii) mixed IBS (IBS-M), or (iv) unclassified IBS [23,24]. ICD codes for IBS used included K58.0, K58.1 and K58.9. We excluded data from patients who did not have adequate diagnosis and IBS treatment documentation. We noted the demographic and treatment history of each of these patients from EPIC. We included this information in separate columns in an excel sheet. This excel template was approved by the CUH IRB and was used as the datasheet for analysis.

The next step included the collection of IBS patient's surveys. Patients diagnosed with IBS between January 1st, 2018 and June 30th, 2020 and treated at CUH were recruited for collection of surveys. Patients who are less than 18 years of age, pregnant women and patients who are unable to consent were excluded. No particular preference was given to demographics or any other patient characteristics while recruiting. We recruited all those who were willing to participate. All patients who provided surveys gave written informed consent as per the guidelines set by IRB. The majority of the patients were local residents. Asymptomatic, healthy control individuals with no previous and current history of gastrointestinal symptoms, IBS or other gastrointestinal disorders, surgeries, or antibiotic use (within 3 months), and who were not taking any medications (except oral contraceptive pills or multivitamins) were recruited. Only individuals who were asymptomatic and had a normal physical examination were eligible to participate as control subjects. Similar to above, we recruited all the

eligible individuals who were willing to complete the surveys. The control subjects were affiliated with the Camden community in that they went to school or worked in the region but were not residents of Camden proper. We would like to note that the focus of the surveys was collection of information about consumption of HFCS in subset of IBS patients and control subjects as this information is not routinely noted in the EPIC charts. Subjects did not receive compensation for completing the surveys.

2.4. Statistical analysis

We completed the data from retrospective chart review of 969 IBS patients to obtain demographics, social history, medical and psychiatric comorbidities for patients diagnosed with IBS. We then collected surveys from IBS patients currently being treated and control subjects for information on their HFCS consumption. 122 IBS patients and 50 control subjects agreed to participate and completed the surveys. Patients recorded the frequency of consumption of each of the food items included in the survey. These food items were then stratified into 13 groups – baking and cooking; beverages; breakfast foods; candy, jam's jellies and syrups; condiments; processed snacks; dairy; processed fruits and vegetables; frozen foods; processed meats; soups and desserts. The details of how the 398 foods were categorized into 13 groups are given in Supplementary Table 1. The amount of HFCS per food item was quantified using a coefficient created by Glinsmann et al. [25]. The amount of HFCS g/month was calculated for each subject. The mean amounts of HFCS consumption for the control patients, total IBS patients, IBS-C group, IBS-D group and IBS-M groups were compared using analysis of variance (ANOVA) on ranks. ANOVA on ranks is statistically designed for situations in which the normality of residuals assumption has been violated. For individual food categories, HFCS consumption is reported as g/month for individual food categories. A p-value of ≤ 0.05 was determined to be statistically significant. Statistical analyses were carried out using SASv9.4 (SAS Institute, Cary, NC).

3. Results

3.1. Patient demographics and coexisting psychological comorbidities

Fig. 1 details the overall organization of this study. Prior studies have established that there is an increased risk of developing IBS in Caucasians, women, patients over the age of 40 and those with psychiatric comorbidities [26–29]. With this in mind, we completed a retrospective chart review of 969 IBS patients and carried out data analysis on multiple demographic factors including sex, age, race, and marital status. We also collected information about body mass index (BMI), smoking and alcohol consumption, the presence or absence of medical comorbidities such as hypertension, diabetes and high cholesterol as well as psychiatric comorbidities such as depression, anxiety, PTSD and psychosis. As dietary information is not routinely collected in the EPIC charts, we then collected surveys from a subset of IBS patients to assess their consumption of HFCS. We collected surveys from 122 IBS patients and 50 control subjects. For both of these groups, we recruited all those who were willing to participate in the period stated. Although the focus of the surveys was to collect information about the consumption of HFCS, we also documented demographic characteristics of survey participants. We focused primarily on the consumption of specific food items within broader food categories that contain HFCS for the surveys.

The demographic data from the retrospective chart review and survey data are presented in Table 1. There was a predominance of female patients in chart review (83.5%) and surveys (81%). In both IBS groups from the chart review and survey data, a majority of the patients were above 40 years of age, 81.5% and 71 %, respectively. There was also a predominance of Caucasian patients in our chart review (78.4%) and surveyed patients (83.6%). A majority of these patients were non-smokers. As seen from the Table, 23.8% of the IBS patients had diabetes. We considered that diabetes itself can exert GI symptoms. Patients were not given a diagnosis of IBS if their symptoms were associated with diabetes and were therefore not included in the study. Only patients with a diagnosis of IBS by Rome IV criteria are included in this study. For a majority of patients (698 patients), specific IBS type was not documented in the EPIC charts. Of those specified (271 patients), IBS-D was most common (44%). IBS subtype was documented for all the 122 surveyed patients. IBS-D was also the most common (42.6%)

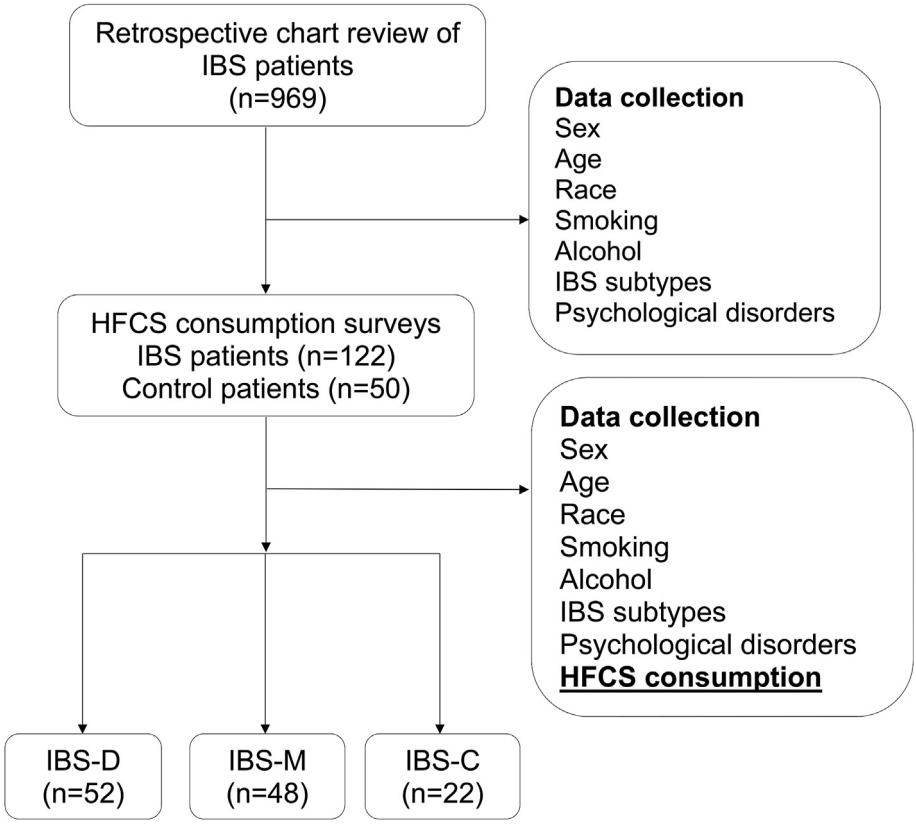

Figure 1. Overall scheme of the research project.

subtype in the patients who completed surveys. The average BMI of IBS patients in both the retrospective chart review (BMI: 29.3) and surveys was higher (BMI: 28.43) than that of control patients (BMI: 25). Average BMI of all the subjects was in the overweight category. Almost all of the IBS patients included in the chart review had at least one of the psychological comorbidities such as, depression (520 patients), anxiety (643 patients), PTSD (88 patients), bipolar (93 patients), and psychosis (22 patients). Depression and anxiety were also commonly seen in the subset of IBS patients who participated in surveys; depression (44 patients), anxiety (59 patients), PTSD (7 patients), bipolar (2 patients), and psychosis (0 patients).

3.2. Consumption of high fructose corn syrup in participating subjects

The primary focus of this study was to determine the relationship between IBS and HFCS consumption. By analyzing the completed patient surveys, we were able to quantify the average amount of HFCS consumed in grams over a one-month period. Food items were categorized into thirteen principal food categories. Fig. 2 shows the total HFCS consumption from all food categories in control subjects and IBS patients. We observed a significantly higher consumption of HFCS in IBS patients (948.28 g/month) as compared to control subjects (393.74 g/month). This was true within the specific subtypes as well for IBS-C (885.96 g/month), IBS-D (1149.85 g/month), and IBS-M (758.47 g/month). Next, we explored the source of HFCS consumption in control subjects *versus* IBS patients to see if there are any major differences in their dietary habits by comparing the consumption of specific food categories. Fig. 3 is a visual representation of average HFCS consumed within each of the thirteen

Table 1
Characteristics and medical comorbidities of IBS patients and control subjects

Characteristics	Number of patients (chart review)	Number of surveyed patients	Number of control patients
	n=969 (%)	n=122 (%)	n=50 (%)
Sex			
F	809 (83.5)	99 (81.1)	25 (50.0)
M	160 (16.5)	23 (18.9)	25 (50.0)
Age			
18–30	61 (6.3)	22 (18.0)	21 (42.0)
31–40	113 (11.7)	13 (10.7)	9 (18.0)
41–50	164 (16.9)	26 (21.3)	7 (14.0)
51–60	193 (19.9)	21 (17.2)	8 (16.0)
61–70	184 (19)	22 (18.0)	5 (10.0)
71–79	118 (12.2)	17 (13.9)	0 (0)
80+	131 (13.5)	1 (0.8)	0 (0)
Race			
African American	121 (12.5)	11 (9.0)	2 (4.0)
Hispanic	67 (6.9)	4 (3.3)	0 (0)
Caucasian	760 (78.4)	102 (83.6)	23 (46.0)
Asian	2 (0.20)	2 (1.6)	23 (46.0)
Other	16 (1.7)	3 (2.5)	2 (4.0)
Marital status			
Widowed	143 (14.8)	8 (6.56)	0 (0)
Single	267 (27.6)	32 (26.23)	27 (54.0)
Separated/divorced	138 (14.2)	18 (14.75)	0 (0)
Married	419 (43.2)	64 (52.46)	23 (46.0)
IBS subtype			
IBS-diarrhea	120	52 (42.6)	None
IBS-constipation	107	22 (18.0)	None
IBS-mixed	44	48 (39.3)	None
Not specified	698		
Hypertension			
Yes	542 (55.9)	39 (31.97)	8 (16.0)
No	409 (42.4)	83 (68.03)	42 (84)
No data available	18 (1.86)		
Diabetes			
Yes	231 (23.8)	18 (14.88)	0 (0)
No	472 (48.7)	103 (85.12)	50 (100)
No data available	266 (27.45)		
High cholesterol			
Yes	180 (18.6)	40 (32.79)	4 (8.0)
No	283 (29.2)	82 (67.21)	46 (92.0)
No data available	506 (52.2)		
Average BMI	29.3	28.43	25
Depression			
Yes	520 (53.7)	44 (36.67)	4 (8.0)
No	403 (41.6)	76 (63.33)	46 (92.0)
No data available	46 (4.7)		
Anxiety			
Yes	643 (66.3)	59 (48.36)	1 (2.0)
No	263 (27.1)	63 (51.64)	49 (98.0)
No data available	63 (6.5)		
PTSD			
Yes	88 (9.1)	7 (5.79)	1 (2)
No	43 (4.44)	114 (94.21)	49 (98.0)
No data available	838 (86.5)		
Bipolar			
Yes	93 (9.9)	2 (1.65)	0 (0)
No	14 (1.4)	119 (98.35)	50 (100)
No data available	862 (89.6)		
Psychosis			
Yes	22 (2.3)	0 (0)	0 (0)
No	81 (8.36)	121 (100)	50 (100)

Table 1 (*continued*)

Characteristics	Number of patients (chart review)	Number of surveyed patients	Number of control patients
	n=969 (%)	n=122 (%)	n=50 (%)
No data available	866 (89.4)		
Smoking			
Yes	152 (15.7)	17 (13.9)	0 (0)
No	805 (83.1)	105 (86.0)	50 (100)
Alcohol			
Yes	358 (36.9)	56 (45.9)	36 (72.0)
No	592 (61.1)	66 (54.0)	14 (28.0)

principle food categories for both control subjects and IBS patients. While beverages contributed significantly to HFCS intake in both groups, its contribution was more in IBS patients (66%) as compared to the control subjects (38%). HFCS consumption was highest in the IBS-D patients and most of that was contributed by beverages (76%). In the overall IBS group of patients, additional 10% of HFCS consumption was contributed by jams, jellies and syrups. There was a greater consumption of dairy foods containing HFCS (30%) in control subjects, which was 7% in overall IBS patients. Table 2 shows statistical analysis of these data. As mentioned above, a significantly higher ($p < 0.0001$) consumption of HFCS in the overall IBS patients was seen as compared to control subjects. This was also seen for all the three specific subtypes, IBS-C, IBS-D, and IBS-M ($p = 0.0033$, $p < 0.0001$, $p = 0.0005$, respectively). Beverages contributed significantly to HFCS intake in IBS patients compared to control subjects (p-value < 0.0001). Overall, significantly higher HFCS consumption occurred *via* beverages, breakfast foods, jams, jellies, syrup, and desserts for all the three types of IBS patients as compared to control subjects, while no significance difference was observed in the consumption of condiments, frozen foods, and processed meats between all three types of IBS patients and control patients. HFCS consumption from the candy category was significantly higher in

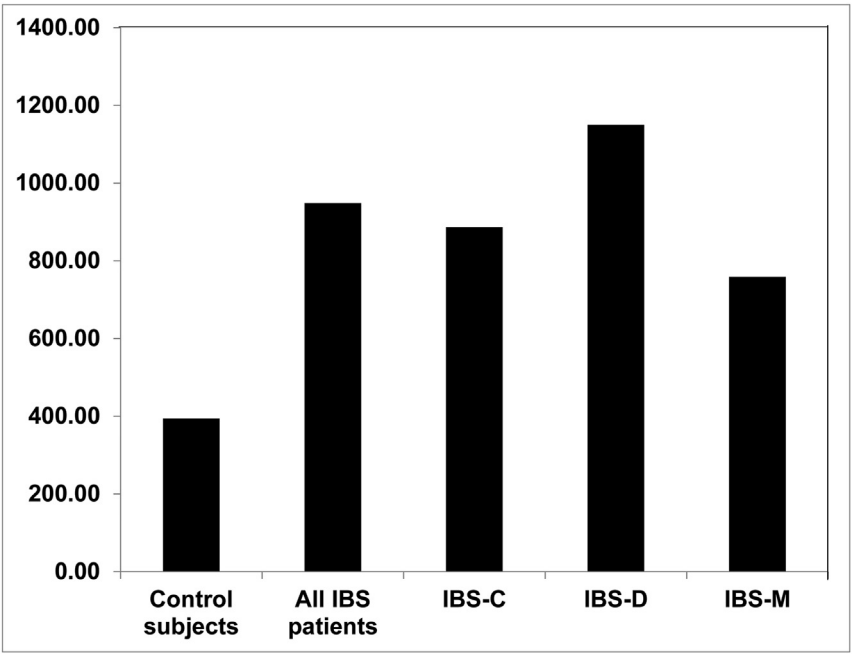

Figure 2. Average HFCS consumption (g/month) in control subjects *versus* IBS patients.

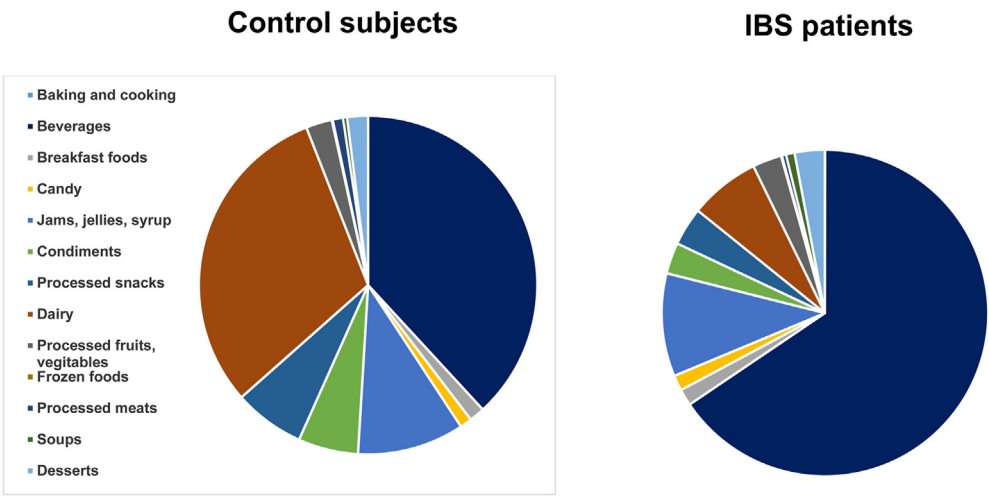

Figure 3. Schematic representation of average HFCS consumption (g/month) within specific food categories in control subjects *versus* IBS patients.

the IBS-D patients compared to control subjects ($p = 0.0458$), while IBS-C patients consumed more processed snacks rich in HFCS as compared to control subjects ($p = 0.0265$). IBS-mixed patients consumed a higher amount of HFCS-rich, processed fruits and vegetables compared to control subjects ($p = 0.005$). Both IBS-C and IBS-M patients consumed significantly higher HFCS from soups as compared to control subjects ($p = 0.0199$ and $p = 0.0015$, respectively). We did not observe a reverse correlation between age and fructose consumption in our participating subjects.

4. Discussion

To build a comprehensive understanding of the factors influencing progression of IBS in a medically underserved, low-income community, it is imperative to consider a number of variables ranging from patient demographics, coexisting medical conditions and dietary habits. We analyzed the HFCS consumption in IBS patients because of the scarcity of healthy and fresh food options in the surrounding community, qualifying Camden as a 'food desert'. Recognizing the origins of HFCS consumption in IBS

Table 2
Average HFCS consumption (g/month) within specific food categories in control patients *versus* IBS patients

Food categories	Control subjects	All IBS patients	*p* value	IBS-C	*p* value	IBS-D	*p* value	IBS-M	*p* value
Total HFCS	393.74	948.28	<0.0001	885.96	0.0033	1149.85	<0.0001	758.47	0.0005
Baking and cooking	0.01	0.14	0.009	0.34	0.111	0.09	0.0865	0.12	0.0055
Beverages	150.05	620.68	<.0001	328.93	0.0422	877.95	<0.0001	475.69	0.0001
Breakfast foods	5.81	15.52	0.0008	21.59	0.0062	13.6	0.0045	14.81	0.0124
Candy	4.48	14.5	0.1972	2.55	0.7073	31.1	0.0458	2.33	0.6907
Jams, jellies, syrup	40.12	96.63	0.0006	159.85	0.0004	83.48	0.0075	81.9	0.0164
Condiments	22.57	29.22	0.4348	48.81	0.267	23.54	0.7536	26.39	0.5055
Processed snacks	26.65	35.91	0.097	45.12	0.0265	30.47	0.325	37.58	0.2393
Dairy	120.36	66.23	0.0014	127.45	0.3089	63.3	0.0028	41.35	0.0028
Processed fruits and vegetables	9.8	27.17	0.0069	21.22	0.1092	23.69	0.0632	33.65	0.005
Frozen foods	0.35	0.86	0.1221	0.38	0.9102	0.87	0.1896	1.07	0.0522
Processed meats	3.87	3.93	0.7149	2.15	0.7526	4.38	0.5228	4.27	0.7851
Soups	1.54	8.03	0.0083	10.48	0.0199	3.38	0.2947	11.94	0.0015
Desserts	7.82	28.32	0.0008	50.38	0.0025	20.69	0.0179	26.47	0.0041

patients will allow designing individualized, economically feasible treatment options that will help manage this disease and prevent exacerbation of symptoms including those of associated psychiatric comorbidities. A recent report also discussed the need for personalized medicine approach to diet for IBS patients [30].

The predominance of females and Caucasian ethnicity seen in our IBS patients is consistent with literature reported [1,27]. A majority of our IBS patients are >40 years, and have BMI consistent with overweight. Almost all of the IBS patients have at least one psychological comorbidity; depression and anxiety are the most common. IBS negatively impacts the quality of life. A survey-based study carried out with residents in low-income neighborhoods showed that IBS patients scored lower than healthy subjects for social, emotional, and physical functioning measures and PTSD was associated with IBS [31]. Anxiety and depression have also been associated with IBS [21,32]. Consistent with a study that reported a correlation between depression and IBS-diarrhea [33], we observed that 117 out of the 120 IBS-diarrhea patients (Table 1) had depression.

There is a need for health care providers to consider the dietary aspects of therapy for patients with functional gastrointestinal symptoms. This will lead to better patient outcomes [34]. Lower income can impact the ability to drive to supermarkets and the ability to purchase healthier foods because of lack of transportation and walkable options. Decreased consumption of fresh and healthy foods in low-income areas is thus associated with low availability and access. These factors are compounded in areas that are 'food deserts' and may have serious consequences for its resident IBS patients. There is no available data regarding HFCS consumption in food dessert areas and its association with IBS. Our study is first to show a significantly high consumption of HFCS in IBS patients living in food dessert areas. Overall, significantly higher HFCS consumption occurred *via* beverages, sugary breakfast foods, jams, jellies, syrup, and desserts for all the three types of IBS patients as compared to control subjects, while no significant difference was observed for the consumption of condiments, frozen foods, and processed meats. This is consistent with a previous report that as income decreases, consumption of added sugar increases. A US national health interview survey showed that the intake of added sugars was inversely related to age, educational status, and family income [35]. Association between ultra-processed food consumption and IBS was shown by a study exploring effect of these foods on functional disorders [36]. We were also able to distinguish the major food categories contributing to this increased consumption for each of the three IBS types. Although, the underlying reasons for these differences are not clear, one may make certain deductions. For example, consumption of beverages was highest in IBS-D patients. A majority (76%) of their HFCS intake is from beverages. It is possible that the IBS-D patients drink more beverages to compensate for the fluid loss and resultant thirst they experience due to diarrhea. It is also possible that the increased consumption of HFCS *via* beverages is making diarrhea worse, leading to a vicious cycle. The dietary choices of IBS subtypes may thus be responsible for making the symptoms worse. HFCS consumption from the candy was significantly higher in the IBS-D patients compared to control subjects. This may exacerbate the diarrhea symptoms. IBS-C patients consumed more processed snacks. Processed foods can exacerbate constipation.

The interrelationship between IBS, HFCS and psychological comorbidities in a low-income, food desert community is hypothesized in Fig. 4. IBS can be exacerbated by psychological conditions such as stress, anxiety, depression *etc.* and these conditions in turn can be worsened by IBS. Existence of these psychological conditions may lead to increased consumption of HFCS-containing sugar-rich foods as comfort foods, which in turn will have detrimental effect on the gastrointestinal manifestations of IBS. We observed higher consumption of HFCS and higher instances of psychological comorbidities in IBS patients. The interplay between IBS and these factors may play a role in the course of the disease, affecting clinical management of patients. Our observations are consistent with outcomes of a cross-sectional questionnaire-based study that showed that the participants that were employed and were working had better knowledge and attitudes about the foods containing corn syrup than the unemployed participants [37].

As the next step in improving IBS patient care, we plan to convey the results of this study to our physicians. We will create a list of suggestions for alternative economically feasible, low HFCS-containing food sources for each IBS type. The diet guidelines will be created in the form of easy-to-follow, color-coded flow charts and made available to our clinical community. For example, water can be suggested as an option to reduce intake of beverages. Another nutrient that will warrant

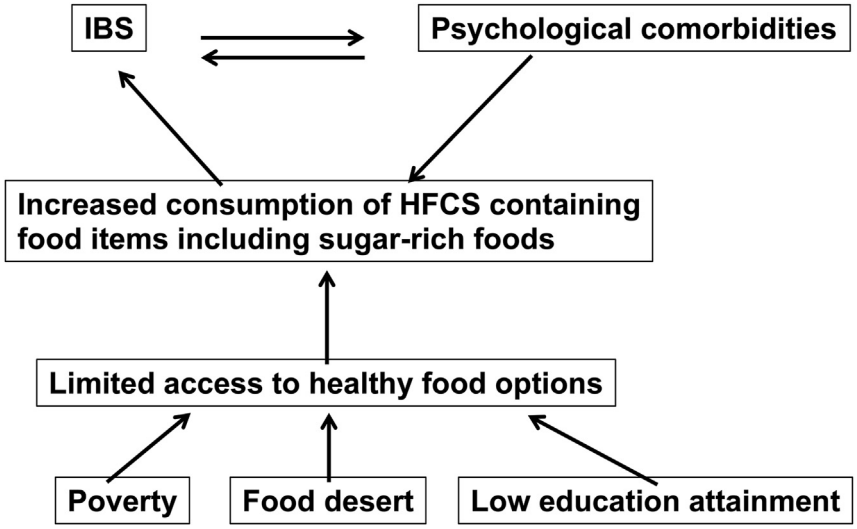

Figure 4. Hypothesized interrelationship between IBS, HFCS and psychological comorbidities in a low-income, food desert community.

discussion is fiber. Fiber is believed to confer beneficial effects in IBS patients, possibly through its colonic fermentation with production of short-chain fatty acids or its action as a prebiotic [38]. Although intake of fiber *via* fresh fruits and vegetables may not be a practical solution in 'food desert' communities, alternate sources of fiber such as dried beans can be considered. Our data provides evidence-based support for counseling IBS patients with respect to their diet as part of a multi-faceted treatment plan to avoid exacerbation of gastrointestinal symptoms as well as that of co-existing psychological comorbidities. In a national survey in which over 1500 United States gastro-enterologists participated, only a minority of gastroenterologists stated that they refer their IBS patients to a registered dietitian for nutrition counseling [39]. As diet can exacerbate GI symptoms in IBS patients, there is a strong support for the role for dietary therapy in IBS patients. Gastroenter-ologists participating in this survey expressed a favorable view of the value and effectiveness of dietary intervention in IBS patients. Our study underscores the urgent need for provider-driven patient education regarding dietary interventions, especially in the communities suffering from socioeconomic challenges.

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This study was not funded.

Statement of authorship

N. P. and C. D. contributed equally to the work; S. P. and J. D. designed and coordinated the study; C. D. collected the retrospective patient chart data, calculated HFCS content of food items and carried out statistical analysis; S. P., J. D. and A.M. created the survey; A. M. and S. Pt. helped with patient recruitment; N. P. and L.N. conducted patient surveys and collected data from surveys; J. G. carried out statistical analysis; S. P. and J. D. interpreted the analyzed data; S. P. was responsible for overall direction of the project and wrote the final draft of the manuscript. All authors approved the final version of the article. The study was conducted at Cooper Medical School of Rowan University-Cooper University Hospital, NJ, USA.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nutos.2022.10.001.

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