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Original article

Intestinal transit rhythm and associated factors during the COVID-19 pandemic: A pilot study



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SUMMARY

Background & aims: Social distancing may lead to changes in lifestyle, such as the reduction in physical exercise practice, dietary changes, weight alterations, as well as intestinal rhythm. Our study aimed to investigate the intestinal transit rhythm of adults during social distancing due to the COVID-19 pandemic, in association with sociodemographic variables, physical activity, nutritional status, frequency of food intake, and water intake.

Methods: Our cross-sectional study comprised an online questionnaire that was shared by the internet concerning demographic information (sex and age); physical activity; anthropometric data (reported weight and height); dietary habits information (food frequency of simple high-carbohydrates foods, whole food, and processed foods; water intake; intestinal transit rhythm). The survey was conducted from April and July 2020. Statistical analysis was performed using Pearson's chi-square test (χ^2) or Fisher's exact test, considering $p < 0.05$.

Results: During social distancing, 72.5% of the respondents presented an adequate intestinal transit rhythm, and 27.5% had inadequate intestinal transit rhythm (19.0% slow and 8.5% rapid intestinal transit rhythm). Intestinal transit rhythm differs between sex, with women presenting significantly higher odds for altered bowel rhythm, compared to men (OR (95% CI) = 2.324 (1.027–5.257); $p = 0.043$). Also, results showed that individuals who frequently ingest simple high carb foods have high prevalence of slow intestinal transit rhythm (63%, $p = 0.032$).

Conclusion: In this study, we found a higher prevalence of adequate intestinal transit during social distancing due to the COVID-19 pandemic. Women had significantly higher odds for altered bowel rhythm, compared to men. Frequent consumption of simple carbohydrates was associated with a higher prevalence of slow intestinal transit rhythm.

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1. Introduction

Social distancing measures due to the coronavirus pandemic (COVID-19) lead to changes in lifestyle, which impacted people's health, including intestinal transit rhythm [1,2]. Recognized as an

“intelligent organ”, the intestine is able to select what is useful from what we eat. Moreover, a healthy gut improves local immunity and acts as a block for pathogenic microorganisms [3]. Due to its importance, prospective studies conducted with humans and animals reinforce that the intestinal microbiome may be related to the appearance of several metabolic diseases, like obesity [4–7].

Considering the relationship between intestinal microbiota and nutritional status, this organ must be monitored, as an alternative for preventing and treating various pathologies [8]. In clinical practice, however, analyzing the intestinal microbiota of humans becomes an expensive and impracticable procedure. As an

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alternative, studies can use other effective and low-cost techniques, such as the Bristol Stool Scale (BSS), to evaluate the intestine [9]. This easy-to-use instrument quickly provides information about intestinal transit and organ function [10].

Research shows that long-term dietary patterns [11–14], age group [15,16], and lifestyle habits [17–19] greatly influence the intestinal microbiota, affecting it in a beneficial or harmful way, such as contributing to a state of intestinal dysbiosis (imbalance of intestinal bacteria), increasing inflammation and favoring the development of many pathologies [20].

Based on the above, the present study aimed to assess the intestinal transit rhythm of adults during social distancing due to the COVID-19 pandemic, in association with sex, age, physical activity, nutritional status, frequency of food intake, and water intake.

2. Material and methods

2.1. Study design and subjects

Cross-sectional study developed with adults (18–59 years) during the controlled-distancing period in Rio Grande do Sul/Brazil, due to the COVID-19 pandemic, between April and July 2020. The inclusion criteria were: i) individuals of both sexes and ii) age 18–59 years old, who accepted spontaneously to participate in the study (by informed consent online) answering an online free to access questionnaire which was made available by social networks. This study was approved by Research Ethics Committee of the University of Santa Cruz do Sul (number #20.20.170), and followed the Declaration of Helsinki guidelines.

2.2. Data collection

The survey was conducted between April and June 2020, with a convenience sample composed by adults (aged from 18 to 59 years old). Previous published literature and surveys were considered to develop this electronic survey, based on households, food security, the economic impact of the COVID-19 pandemic, and personal experiences. The questionnaire was shared on Google's online survey platform and a link was then distributed among peers and friends through emails and other social media (including Instagram™ and Facebook™). Participants of the study were required to read and accept informed consent online to participation of study. The survey was voluntary, confidential and anonymous. The survey covered different thematic areas including sociodemographic factors (gender and age), physical activity (self-reported if practices physical activities or not), weekly training frequency, daily training length, and training local, anthropometric data (self-reported weight and height), food intake, and water intake frequency and the BSS during the period of social distance.

2.2.1. The Bristol Stool Scale

To evaluate the intestinal transit rhythm, the Bristol Stool Scale (BSS) was used and individuals indicated which option most closely resembled their stools. From the BSS, the answers were categorized into: i) slow intestinal transit rhythm (Types 1 and 2), ii) adequate intestinal transit rhythm (Types 3 and 4), and iii) rapid intestinal transit rhythm (Types 5, 6 and 7). According to Lewis and Heaton [9], creators of the BSS, i) type 1, feces present separate and hard granules, causing difficulty in evacuation, ii) type 2, feces are parsley-shaped, but granular, iii) type 3, stools resemble a sausage, but have a crack in its surface, iv) type 4, stools have a sausage shape, with smooth and soft appearance, v) type 5, stools are characterized by soft drops with well demarcated edges, facilitating evacuation, vi) type 6, stools have soft pieces with irregular edges, being pasty and vii) type 7, stools are completely liquid, without

Bristol Stool Scale (BSS)

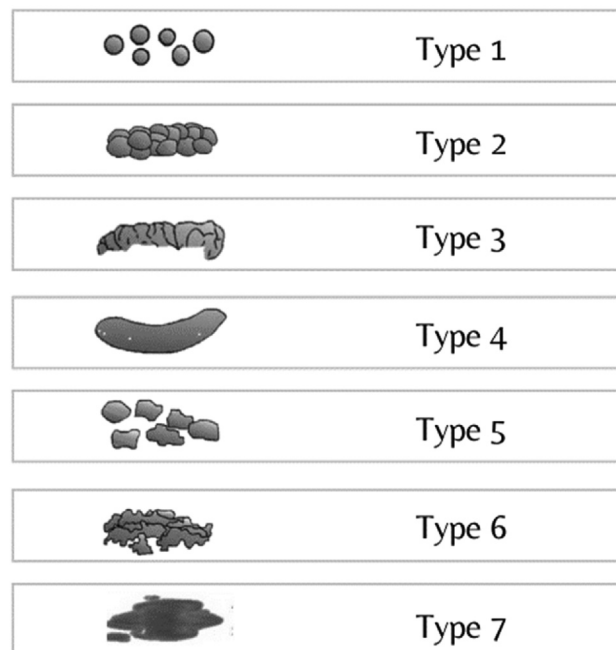


Fig. 1. Feces characteristics and descriptions according to the Bristol Stool Scale.

solid pieces, according to Fig. 1. The bowel rhythm was categorized in adequate and inadequate to analysis. In addition, inadequate intestinal transit rhythm was also classified in slow and rapid intestinal transit rhythm.

2.2.2. Nutritional assessment

Data regarding weight and height were self-reported and used to evaluate the nutritional status through body mass index (BMI) calculation. The nutritional status was classified according to the World Health Organization [21] in eutrophic ($BMI = 18.50–24.99 \text{ kg/m}^2$) and overweight/obesity ($BMI \geq 25.00 \text{ kg/m}^2$).

2.2.3. Food frequency intake and hydric ingestion

The food frequency intake of simple high-carbohydrates foods (e.g., white rice, english potatoes, pasta, breakfast cereal, loaf or french bread), whole food (e.g., whole-grain rice or pasta, quinoa, chia, oats, flaxseed), and processed foods (e.g., sausages, candy, cakes, cookies, soft drink, frozen ready-to-cook food) were evaluated using a quantitative food frequency questionnaire adapted from Fisberg and colleagues [22]. The following options were given: i) no intake, ii) 1 time per month, iii) 1 to 2 times per week, iv) 3 to 4 times per week, or v) 5 to 7 times per week. The answers were reclassified into frequent (3–4 times per week and 5 to 7 times per week) and infrequent intake (do not intake, 1 time per month, and 1 to 2 times per week).

To analyze hydric ingestion per day, data regarding the consumption of water glasses (200 mL) were categorized into: i) insufficient, consumption less than 500 mL/day; ii) regular, between 500 and 2000 mL/day and iii) sufficient, greater than 2000 mL/day, according to the Food Guide for the Brazilian Population [23].

2.3. Statistical analysis

The data analyses were performed using Statistical Package for the Social Sciences software (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY, USA). Categorical variables were expressed as absolute values and percentages.

The association between demographic and dietary characteristics with bowel rhythm was explored using binary logistic regression models, and crude models were presented. Also, to verify the association between demographic and dietary characteristics with rapid and slow bowel rhythm Fisher's exact test was performed for variables with two categories. To analyze variables with three or more categories simultaneously, the chi-square test was used, and in the presence of a significant association, Fisher's exact test was applied as a post-test. Cramer's (V) or Phi (ϕ) were used to evaluate the effect size of the differences and associations. Values of $p < 0.05$ were considered as statistically significant.

3. Results

Of all individuals, 72.5% presented an adequate intestinal transit rhythm and 27.5% presented inadequate intestinal transit rhythm (19.0% presented slow intestinal transit rhythm and 8.5% presented rapid intestinal transit rhythm) during the period of social distancing (Table 1). Women had 2.3 times more chances to present altered bowel rhythm compared to men ($p = 0.043$). However, there was no association between age, physical activity, nutritional status, food intake, nor hydric ingestion with bowel rhythm ($p > 0.05$), as showed in Table 2.

Table 3 shows the association between slow and fast intestinal transit rhythm with the associated factors. It was verified higher prevalence of slow intestinal transit rhythm between individuals who ingested frequently of simple high-carbohydrates foods compared to individuals who ingested infrequently (63%, $p = 0.032$, effect size = 0.29).

Table 1
Characteristics of the sample according to adequate and inadequate bowel rhythm.

Variables	All individuals (n = 142)	Bowel Rhythm	
		Adequate (n = 103)	Inadequate (n = 39)
Sociodemographic variables			
Sex			
Female	108 (76.1)	83 (80.6)	25 (64.1)
Male	34 (23.9)	20 (19.4)	14 (35.9)
Age range			
Up to 40 years	113 (79.6)	84 (81.6)	29 (74.4)
More than 40 years	29 (20.4)	19 (18.4)	10 (25.6)
Education			
Elementary school graduate	4 (2.8)	2 (1.9)	2 (5.1)
High school graduate	56 (39.4)	39 (37.9)	17 (43.6)
Bachelor's degree	82 (57.7)	62 (60.2)	20 (51.3)
Physical exercise during social-distancing			
Inactive	48 (33.8)	34 (33.0)	14 (35.9)
Active	94 (66.2)	69 (67.0)	25 (64.1)
Weekly training frequency^a			
1 to 2 times per week	34 (36.2)	24 (34.8)	10 (40.0)
3–4 times per week	39 (41.5)	28 (40.6)	11 (44.0)
Over 5 times per week	21 (22.3)	17 (24.6)	4 (16.0)
Daily training length^a			
Up to 30 min	42 (44.7)	28 (40.6)	14 (56.0)
30–60 min	46 (48.9)	37 (53.6)	9 (36.0)
Over 60 min	6 (6.4)	4 (5.8)	2 (8.0)
Local of exercise^a			
Outdoor exercise	18 (19.1)	13 (18.8)	5 (20.0)
Exercise at home	63 (67.0)	45 (65.2)	18 (72.0)
Gym	13 (13.8)	11 (15.9)	2 (8.0)
Nutritional status^b			
Eutrophia	41 (61.2)	33 (64.7)	8 (50.0)
Overweight/obesity	26 (38.8)	18 (35.3)	8 (50.0)
Dietetics variables			
Simple high-carbohydrates foods intake			
Infrequent	65 (45.8)	56 (54.4)	21 (53.8)
Frequent	77 (54.2)	47 (45.6)	18 (46.2)
Whole food intake			
Infrequent	100 (70.4)	31 (30.1)	11 (28.2)
Frequent	42 (29.6)	72 (69.9)	28 (71.8)
Processed foods intake			
Infrequent	120 (84.5)	87 (84.5)	33 (84.6)
Frequent	22 (15.5)	16 (15.5)	6 (15.6)
Hydric ingestion			
Insufficient	23 (16.2)	19 (18.4)	4 (10.3)
Regular	93 (65.5)	66 (64.1)	27 (69.2)
Sufficient	26 (18.3)	18 (17.5)	8 (20.5)

^a Sample of 94 individuals realized physical exercise during social-distancing.

^b 67 individuals answered information regarding weight and height.

Table 2
Association between demographic and dietary characteristics with bowel rhythm of individuals on social distancing.

Variables	Bowel Rhythm Altered	
	OR (95% CI)	p
Sex		
Male	1	
Female	2.324 (1.027–5.257)	0.043
Age range		
Up to 40 years	1	
More than 40 years	1.525 (0.636–3.655)	0.345
Education		
Elementary school graduate	1	
High school graduate	0.974 (0.083–11.431)	0.984
Bachelor's degree	0.613 (0.053–7.137)	0.613
Physical exercise during social-distancing		
Inactive	1	
Active	0.880 (0.406–1.905)	0.745
Weekly training frequency^a		
Do not practice	1	
1 to 2 times per week	1.012(0.385–2.657)	0.981
3–4 times per week	0.954 (0.375–2.430)	0.921
Over 5 times per week	0.571 (0.163–2.003)	0.571
Daily training length^a		
Do not practice	1	
Up to 30 min	1.214 (0.497–2.968)	0.670
30–60 min	0.591 (0.227–1.540)	0.282
Over 60 min	1.214 (0.199–7404)	0.833
Local of exercise^a		
Do not practice	1	
Outdoor exercise	0.934 (0.280–3.116)	0.912
Exercise at home	0.971 (0.424–2.224)	0.954
Gym	0.442 (0.087–5.524)	0.326
Nutritional status^b		
Eutrophia	1	
Overweight/obesity	1.833 (0.589–5.709)	0.296
Dietetics variables		
Simple high-carbohydrates foods intake		
Frequent	1	
Infrequent	0.979 (0.467–2.051)	0.979
Whole food intake		
Frequent	1	
Infrequent	0.912 (0.404–2.061)	0.826
Processed foods intake		
Frequent	1	
Infrequent	0.989 (0.353–2.742)	0.982
Hydric ingestion		
Insufficient	1	
Regular	0.515 (0.160–1.654)	0.265
Sufficient	0.474 (0.121–1.850)	0.282

Statistical tests were considered significant if $p < 0.05$.

^a Sample of 94 individuals realized physical exercise during social-distancing.

^b 67 individuals answered information regarding weight and height.

4. Discussion

The present study aimed to investigate intestinal transit rhythm and associated factors during social distancing due to the COVID-19 pandemic. The social distancing resulting from the COVID-19 pandemic has led to changes in the lifestyle of population, including Brazil. These changes may result in three scenarios, such as: i) overweight, due to compulsive eating; ii) weight stabilization, due to an improvement in the eating pattern; and iii) weight loss, due to decreased calorie intake [24]. In addition, the intestinal flora has a great impact on the health of the individual, playing an important role in immunity, genetic, metabolic and structural expression. In this way, tracking the rate of intestinal transit to monitoring the health status of individuals is essential. In addition, unfavorable changes in the intestinal transit rhythm pattern may cause several pathologies [10].

In the present study, there was a higher prevalence of adequate intestinal transit rhythm (72.5%) compared to inadequate intestinal transit rhythm (27.5%). Moreover, women had 2.3 more chances to present altered bowel rhythm compared to men. A study that evaluated the adult population from a Brazilian city, verified that of individuals with slow intestinal transit rhythm (self-reported constipation, 25.2%), women presented a higher prevalence of inadequate intestinal transit rhythm (37.2%) than men (10.2%) [25]. Differences between the sexes can be explained by hormonal changes arising from the increase in estrogen levels during menstrual periods, behavioral, intestinal motility, or sample difference [26,27].

The evaluation of passage of intestinal contents is of great importance in gut physiology, besides being determinant of bowel symptoms. Despite this, intestinal transit time is little measured in clinical practice or in epidemiologic studies. One reason for this is the cumbersome or unpleasant nature of standard techniques for measuring transit time. Because of that, BSS scale was created and validated in 1997 as a useful guide to monitor change in intestinal function, assessing the responsiveness of stool form to change in transit time, using illustrative images representing seven types of stools, according to shape and consistency [9]. BSS scale has been used in several studies [28–31], presenting utility in both clinical practice and research as a simple, fast and low-cost tool for measuring transit time for being a complementary tool for the analysis of the intestinal microbiota [9]. The technique involves no stool handling, and no discomfort except the mild unpleasantness of subjects having to inspect their own feces and decide which of several descriptions fits best [9].

According to Silva and Sabino [32], the onset of slow intestinal transit rhythm has been associated with factors related to aging, insufficient water intake, female sex, physical activity, and a diet poor in fiber-rich foods. Santos et al. [10] evaluated the intestinal transit rhythm of individuals with metabolic syndrome by BSS, and observed that older people (mean age of 69 years) had a higher prevalence of constipation (slow intestinal transit rhythm) when compared to adults (mean age of 50 years), probably due to the physiological changes that happen with advancing age. In contrast, our results showed that, during social distancing, younger individuals (below 40 years old) presented inadequacy of the rapid intestinal transit rhythm, when compared to older individuals (above 40 years old) (74.4% vs. 25.6%). The physiological characteristics do not justify these results; however, it is likely that habits during the pandemic may have influenced the rate of intestinal transit, especially the low water intake of the participants, representing 79.5% of inadequacy (less than 2 L/day). According to the recommendations of the Food Guide for the Brazilian Population [23], water intake will depend on factors, such as age, sex, weight, climate, and physical activity. For individuals, 2 L/day of water may be satisfactory, while for others it is not, each case must be individually evaluated.

The infrequent practice of physical activity has also been associated with excessive calories intake, and may cause the imbalance of the intestinal microbiota (intestinal dysbiosis) [33]. In addition, physical activity has the ability to reduce intestinal transit time, decreasing the time of substances harmful to health in contact with the intestinal microbiota. Lacerda et al. [34] identified that people with a higher level of education understand the importance of physical activity for health. In addition, physical activity practice may improve organ function, increase immunity, anti-inflammatory action, weight control and bone, and muscle strengthening [35–37]. However, in the present study, there was no association between inadequate intestinal transit rhythm and physical activity.

Table 3
Association between demographics and dietary characteristics with rapid and slow bowel rhythm on social distancing.

Variables	All individuals (n = 39)	Bowel Rhythm		p
		Rapid (n = 12)	Slow (n = 27)	
Sex				0.440 ^a
Female	25 (64.1)	7 (58.3)	18 (66.7)	
Male	14 (35.9)	5 (41.7)	9 (33.3)	
Age				0.130 ^a
Up to 40 years	29 (74.4)	7 (58.3)	22 (81.5)	
More than 40 years	10 (25.6)	5 (41.7)	5 (18.5)	
Education				0.589 ^b
Elementary school graduate	2 (5.1)	0 (0.0)	2 (7.4)	
High school graduate	17 (43.6)	6 (50.0)	11 (40.7)	
Bachelor's degree	20 (51.3)	6 (50.0)	14 (51.9)	
Physical exercise during social-distancing				0.440 ^a
Inactive	14 (35.9)	5 (41.7)	9 (33.3)	
Active	25 (64.1)	7 (58.3)	18 (66.7)	
Weekly training frequency^c				0.011
1 to 2 times per week	10 (40.0)	1 (20.0)	9 (45.0)	
3–4 times per week	11 (44.0)	1 (20.0)	10 (50.0)	
Over 5 times per week	4 (16.0)	3 (60.0)	1 (5.0)	
Daily training length^c				0.410
Up to 30 min	14 (56.0)	2 (40.0)	12 (60.0)	
30–60 min	9 (36.0)	3 (60.0)	6 (30.0)	
Over 60 min	2 (8.0)	0 (0.0)	2 (10.0)	
Local of exercise^c				0.758
Outdoor exercise	5 (20.0)	1 (20.0)	4 (20.0)	
Exercise at home	18 (72.0)	4 (80.0)	14 (70.0)	
Gym	2 (8.0)	0 (0.0)	2 (10.0)	
Nutritional status^d				0.862 ^b
Eutrophia	8 (50.0)	3 (60.0)	5 (45.5)	
Overweight/obesity	8 (50.0)	2 (40.0)	6 (55.5)	
Dietetic variables				
Simple high-carbohydrates foods intake				0.032 ^a
Infrequent	19 (48.7)	9 (75.0)	10 (37.0)	
Frequent	20 (51.3)	3 (25.0)	17 (63.0)	
Whole food intake				0.640 ^a
Infrequent	29 (74.4)	9 (75.0)	20 (74.1)	
Frequent	10 (25.6)	3 (25.0)	7 (25.9)	
Processed foods intake				0.140 ^a
Infrequent	34 (87.2)	12 (100.0)	22 (81.5)	
Frequent	5 (12.8)	0 (0.0)	5 (18.5)	
Hydric ingestion				0.301 ^b
Insufficient	4 (10.3)	0 (0.0)	4 (14.8)	
Regular	27 (69.2)	10 (83.3)	17 (63.0)	
Sufficient	8 (20.5)	2 (16.7)	6 (22.2)	

^a According to Fisher's exact test.

^b According to Pearson's chi-square (χ^2) test. Statistical tests were considered significant if $p < 0.05$.

^c Sample of 25 individuals realized physical exercise during social-distancing.

^d 16 individuals answered information regarding weight and height.

Changes in the rate of intestinal transit may cause an increase in the production of pro-inflammatory cytokines, favoring the appearance of metabolic diseases, including obesity [38]. The classic study of Póvoa [39] showed that women with BMI equal to or greater than 25 have double intestinal permeability, when compared to normal weight, identifying an association between excess weight and increased intestinal permeability, through the administration of lactulose, sugar that has absorption in the digestive tract.

Other study identified that individuals with a higher mean BMI (overweight/obesity) had a faster intestinal transit rhythm than eutrophic people [9]. Similarly, our results showed that eutrophic individuals had a higher prevalence of adequate intestinal transit rhythm when compared to overweight/obese people (64.7% vs. 35.3%).

In the present study, slow intestinal transit rhythm was associated with frequent consumption of simple carbohydrates. The fiber functionality presents an important action in positive modulation of gut flora, one of its applications in clinical practice is laxative function, facilitating the intestinal transit rhythm [40].

Moreover, according to Galvão-Alves [41], to maintain the proper intestinal transit rhythm, adequate fiber intake is necessary, associated with adequate water consumption (30–50 mL/kg/day), as this habit generates an increase in fecal volume, stimulating physiologically evacuation.

To maintain a healthy intestinal microbiota, a homeostatic balance of intestinal bacteria is necessary, advocating good lifestyle habits. Lifestyle habits have a direct influence on the colonization of microorganisms, such as age, environment, genetics, diet, etc. On the other hand, an unsuited lifestyle, can lead to intestinal dysbiosis (imbalance of intestinal bacteria), leaving the individual much more susceptible to the development of pathologies. Therefore, the monitoring of intestinal transit rhythm is an important health marker [42,43].

There are some limitations in the present study, among which we can list: the data collected were self-reported (weight and height) and the difficulty of the identification of stool consistency on the BSS, which may be a limitation of this study, since we cannot guarantee total honesty in the responses. In addition, we did not evaluate the composition of the intestinal microbiota that affects

the rate of intestinal transit, leading to dysbiosis and increased intestinal permeability, which could compromise the health status and homeostasis of individuals.

Despite this, the clinical findings of this study are intended to clarify the importance of observing feces as a means of preventing pathologies and boosting the immune response. The findings also underscore the importance of properly nourishing and absorbing nutrients, identifying that poor living and eating habits lead to the imbalance of intestinal bacteria (intestinal dysbiosis) and intestinal hyperpermeability. In addition, reversing dysbiosis becomes an essential lifestyle and diet, as well as reducing the chances of COVID infection. For example, Gu and collaborators [44] evaluated individuals with COVID-19 and verified the presence of three symptoms of intestinal dysbiosis: expressive number of bacteria with pro-inflammatory activity, associated with a reduction in bacteria with anti-inflammatory characteristics and low diversity of the microbiome. Therefore, the BSS scale is a more practical tool for monitor change in intestinal function at home.

The present study showed a high prevalence of adequate intestinal transit during social distancing due to the COVID-19 pandemic. In addition, we also should take into consideration that the COVID-19 pandemic has awakened the global community to think on the health of population due social distancing. In this respect, monitoring the intestinal microbiota, through the analysis of the intestinal transit rhythm, becomes a practical alternative to assess and monitor the health of individuals, with special attention to females, who have a higher prevalence of inadequate intestinal transit rhythm and frequent consumption of simple carbohydrates that was associated with a higher prevalence of slow intestinal transit.

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Author contributions

PM and SIRD designed the research; AMARMIH, CS, DSS, TGS took care of data management; PM took care of data analyses; AMARMIH and PM interpreted the data; AMARMIH and PM wrote the first draft of the manuscript, SIRD contributed significantly to the intellectual content of this first draft; CS, DSS, TGS and CB revised each draft for important intellectual content. All authors read and approved the final manuscript.

Declaration of competing interest

No conflicts are declared.

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