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Stool Patterns of Malaysian Adults with Functional Constipation: Association with Diet and Physical Activity

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ABSTRACT

Introduction: Diet and lifestyle modification is commonly used in constipation management. As there is a dearth of studies on this topic in Malaysia, we aim to elucidate the relations between stool patterns, dietary intake and physical activity levels among adults with functional constipation. **Methods**: From a database collected via surveys at public events, a convenience sample of 100 adults diagnosed with Rome II-defined functional constipation was enrolled in this cross-sectional study. After severity assessment using the Chinese Constipation Questionnaire, subjects completed 2-week bowel movement diaries to determine stool frequency, consistency and output. Dietary intake and physical activity levels were assessed twice using three-day 24-hour diet recalls and International Physical Activity Questionnaire, respectively. Ninety subjects who completed the study were included in the analysis. **Results**: Mean weekly stool frequency was 3.9±1.9 times, consistency score was 2.6±0.6 (range 1.0-4.0), output was 11.0±6.3 balls (40 mm diameter) and severity score was 10.3±3.3 (range 5.0-22.0). Mean daily dietary intakes were: energy 1,719±427kcal, dietary fibre 15.0±4.9g and fluid 2.5±0.8L. The majority of subjects were physically inactive. Stool frequency and output were positively associated with dietary fibre (r_s=0.278, P<0.01; r_s=0.226, P<0.05) and fluid intake (r_s=0.257, P<0.05; OR=3.571, 95% CI [1.202-10.609]). Constipation severity was associated with higher physical activity levels (OR=2.467, 95% CI [1.054-5.777]). **Conclusion**: Insufficient intake of dietary fibre and fluid are associated with aggravated constipation symptoms. Further studies are necessary to confirm usefulness of dietary intervention in treatment of constipation as dietary factors alone may not influence overall severity and stool consistency, an integral element of constipation.

Keywords: Constipation, stool, diet, physical activity, dietary fibre

INTRODUCTION

Functional constipation is a gastrointestinal complaint common in many regions of the world, yet it has not been well studied locally. Associated mainly with infrequent and difficult defecation of small quantities of hard, lumpy and dry stools in absence of

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structural or biochemical abnormalities, functional constipation is often accompanied by a variety of subjective symptoms such as sensation of incomplete evacuation or blockage, bloating, unsuccessful bowel movement attempts, as well as excessive straining during evacuation (Longstreth *et al*., 2006). The prevalence rate in Malaysia has not been investigated, though in other Asian countries such as Taiwan it has been reported to be 8.5% (Lu *et al*., 2006). Stool pattern and common symptoms among Malaysian subjects are also unknown.

While the exact causes of functional constipation are still unclear, various factors may contribute to occurrence of constipation including a diet low in dietary fibre, dehydration, low total caloric intake, lack of physical activity and stress (Leung *et al*., 2011). Increased intake of dietary fibre and fluids has been shown to be beneficial in patients whose intake had been insufficient (Leung *et al*., 2011). In cases of low total caloric intake or lower frequency of meal intake, it has been suggested that a diminished gastrocolic reflex in response to eating may also be a contributing factor to constipation (Bouchoucha *et al*., 2006). In the elderly, decreased physical activity may be somehow related to occurrence of constipation, but many other factors are also likely to be involved (Leung *et al*., 2011).

Currently, the standard therapy for managing functional constipation consists of a combination of laxatives, fibre supplements as well as dietary and lifestyle modification focused mainly on increasing dietary fibre and fluid intake as well as increasing physical activity where necessary (Tack & Muller-Lissner, 2009).

The diet and physical activity levels of adults with functional constipation in Malaysia have not been previously documented and needs to be clarified as a first step towards determining the effectiveness of diet and physical activity modification in the local management of functional constipation. The association between stool patterns and diet or physical activity levels needs to be investigated to identify the key factors that could be targeted for modification, in view of conducting future randomised clinical trials.

This study aims to elucidate the stool pattern in terms of stool frequency, consistency, estimated output volume and constipation severity; dietary intake levels of energy, dietary fibre and fluid, as well as physical activity levels among a sample of adults in the Klang Valley with Rome II-defined functional constipation (Longstreth *et al*., 2006), and the association between these parameters.

METHODS

The data for this study was collected as part of a double-blinded, randomised, placebo-controlled clinical trial for functional constipation, using probiotic *L. casei* strain Shirota as an intervention that was conducted from February to June 2010. The clinical trial was approved by the Research and Ethics Committees of the International Medical University, and followed the Malaysian guidelines for Good Clinical Practice.

Sample selection

A large database obtained via surveys during public events (convenience sampling) containing brief information on stool patterns was broadly screened to identify potential subjects. The potential subjects were invited to attend group screening sessions and all those who responded underwent structured interviews with the researchers followed by a general medical examination by a physician. Those identified with Rome II-defined functional constipation were further screened for eligibility before being invited to participate in the study. The Rome II-defined criteria for functional constipation was used as it has been validated in Asian subjects previously (Kwan *et al*., 2003), although the latest

revised version of the Rome criteria for functional constipation is Rome III (Drossman & Dumitrascu 2006). Under Rome II criteria, subjects must have at least two of six symptoms for a minimum 12 weeks in the preceding year: straining; lumpy or hard stools; sensation of incomplete evacuation; sensation of anorectal blockage; or manual manoeuvres to facilitate defecation in more than 25% of defecations as well as fewer than three defecations per week. Subjects who also met Rome II-defined criteria for irritable bowel syndrome were excluded from functional constipation diagnosis (Longstreth *et al.*, 2006).

The inclusion criteria for the study were Malaysian adults of any gender and ethnicity, aged 18 to 60 years old living in the Klang Valley who met the Rome II criteria for functional constipation (Longstreth *et al.*, 2006) with a constipation severity score of at least 5 points based on the Chinese Constipation Questionnaire (CCQ) score (Chan *et al.*, 2005). Additionally, they must be found to be free of any cardiovascular related diseases, diabetes, cancer, neurological diseases or any other serious illness and must not be physically or mentally handicapped. The subjects were asked not to have any pre-determined plans to be out of town for one week or longer during the scheduled study period. The exclusion criteria included body mass index (BMI) of less than 16 (severe thinness) or 30 and above (obese), pregnant, regular ingestion of probiotic products within the preceding four weeks, regular use of laxatives, intake of anticholinergics, anti-diarrhea medications or antibiotics during the study period, persons with milk protein allergy, persons with constipation of organic or neurological origin and persons with alarm features indicative of colorectal cancer. The group screening and recruitments were conducted from February to April of 2010 at six locations within the Klang Valley. All recruited subjects gave written, informed consent.

Diet and physical activity assessments

Assessments were carried out twice via telephone interviews, with an interval of approximately 2 months in between the first and second assessments. Results shown are the mean values of both assessments. The subjects' dietary intakes were assessed using 24-hour diet recalls for three consecutive days including two week days and one weekend. The data was processed using diet analysis software Nutritionist Pro® (Axxya Software) based on the Food Composition Guide Singapore (Health Promotion Board, Singapore 2003) as the Malaysian database (Tee *et al.*, 1997) did not have values for dietary fibre. Fluid intake included water, all beverages as well as moisture in food. For the diet recalls, actual household measurement units such as rice bowls (small, medium, large) and spoons were shown to subjects during recruitment and photos of the measurement units were provided to subjects beforehand in order to standardise description of food portion sizes during the telephone interviews.

Physical activity levels were measured using the International Physical Activity Questionnaire (IPAQ) (Craig *et al.*, 2003) which allows classification into three levels; low, moderate and high. Stress levels were also measured but the results are not discussed as it is out of the scope of the present paper.

Stool pattern measurements

Subjects were provided bowel movement diaries to keep record of specific details related to their defecations for a period of 2 weeks for purposes of assessment of their stool patterns. Based on the data recorded in the diaries, the frequency of weekly defecations, stool consistency and stool output volume estimations were calculated.

Stool consistency was measured using a modified five-scale Bristol stool form chart (Type 1: separate, hard, nut-like lumps; Type 2: Sausage-shaped but lumpy; Type 3: Like a sausage, either smooth and soft, or with

cracks on the surface; Type 4: Soft blobs with clear cut edges which are easily passed; Type 5: Mushy or watery, liquid stool). The modified five-point scale version of the Bristol stool form scale (Koebnick *et al.*, 2003) was used instead of the standard seven-point scale (Lewis & Heaton, 1997) for its ease-of-use as the subjects would be self-reporting their stool consistency, and it has been used in previous studies on constipation without any difficulty (Koebnick *et al*., 2003). For the purpose of assessment of defecation pattern, loose or watery (non-solid) stools or 'Type 5' stools according to the modified five-scale Bristol stool form chart were analysed and reported separately from solid, formed stools which were considered normal stools. Thus, frequency of defecation, stool consistency and stool quantity estimations reported in the present study reflect the frequency, consistency and quantity involving solid, formed stools only. Stool quantity outputs were estimated based on comparison of stool volume to the size of a standard unit (ping pong ball, 40 mm in diameter) (Matsumoto *et al*., 2006).

The constipation severity CCQ score (Chan *et al*., 2005) was calculated during the screening process using a questionnaire consisting of six items that has been found to be satisfactory in terms of validity and reliability as a self-report measure for constipation severity by a review (McCrea *et al.*, 2008). The six items are (i) severity of false alarm (having the urge but unable to pass stool); (ii) frequency of <3 defecations/week; (iii) severity of incomplete evacuation; (iv) severity of lumpy or hard stools; (v) number of laxatives used; and (vi) severity of abdominal bloating. Items (i), (iii), (iv) and (vi) were rated using a five-point Likert scale. The questionnaire assessed the subjects' constipation severity in the three-month period preceding the screening. The CCQ questionnaire can also discriminate between healthy and constipated subjects with a score of 5 being the cut-off point (Chan *et al*., 2005).

Statistical analysis

The Statistical Package for Social Sciences (SPSS) Version 15.0 was used to analyse the data. Data on diet was processed using diet analysis software Nutritionist Pro® prior to transfer to SPSS. Pearson's product moment correlation test or non-parametric equivalent was used to determine the bivariate relationships between the stool pattern and diet or physical activity. For nominal data, Pearson's Chi-square test or Fisher's exact test was used where appropriate. The significance level used was $P<0.05$ (2-tailed test).

RESULTS

Background characteristics of subjects

Of the 384 potential subjects screened, one hundred participated in the study. Ninety subjects who had complete data in terms of stool pattern records, dietary intake and physical activity levels were included in the analysis. The socio-demographic and physical characteristics of the study subjects in terms of gender, age, ethnicity, education, occupation, weight, height, body mass index and waist-to-hip ratio are shown in Table 1. The majority of the subjects were females with a mean age of 31.8 ± 9.3 years. However, this is not indicative of the population of functional constipation as a whole because the original database from which the subjects were screened was obtained via convenience sampling.

Stool pattern and constipation condition

The constipation background of the study subjects in terms of the duration of constipation, the severity of constipation as well as the stool pattern parameters are shown in Table 2. The duration of constipation refers to the length of time that subjects' perceived they experienced constipation based on their individual understanding of the disorder and not the duration of constipation based on clinical diagnosis.

Table 1. Socio-demographic and physical characteristics of study subjects (n = 90)

Characteristics	*n (%)*	*Mean Ø SD*	*Min - Max*
Gender			
Male	12 (13.3)		
Female	78 (86.7)		
Age group (years)		31.8 ± 9.3	18 - 55
18 - 29	42 (46.7)		
30 - 39	30 (33.3)		
40 - 49	13 (14.4)		
50 - 59	5 (5.6)		
Ethnicity			
Malay	39 (43.3)		
Chinese	44 (48.9)		
Indian	7 (7.8)		
Education (years)			
1 - 6	1 (1.1)		
7 - 11	29 (32.2)		
≥ 12	60 (66.7)		
Occupation			
PMEB	27 (30.0)		
Other white collar	50 (55.6)		
Student	16 (17.8)		
Housewife	7 (7.8)		
Weight (kg)			
Male		66.4 ± 10.8	49.0 - 87.0
Female		56.1 ± 8.3	36.0 - 76.9
Height (m)			
Male		1.70 ± 0.08	1.60 - 1.87
Female		1.58 ± 0.06	1.40 - 1.71
Body mass index (kg/m^2)		22.6 ± 3.3	16.0 - 29.9
Underweight	10 (11.1)		
Normal	58 (64.4)		
Overweight	22 (24.4)		
Waist-to-hip ratio			
Male		0.85 ± 0.08	0.76 - 1.06
Female		0.80 ± 0.06	0.70 - 1.00

PMEB: Professional, Manager, Executive, Businessman

Table 2. Stool pattern and constipation condition of the study subjects (n = 90)

Constipation/defecation related parameters	*n (%)*	*Mean Ø SD*	*Min - Max*
Duration of constipation (years)			
≤ 4	20 (22.2)		
5 - 9	14 (15.5)		
10 - 25	27 (30.0)		
Not aware	25 (27.8)		
Others (for years, regularly etc)	4 (4.4)		
Stool pattern parameters			
Frequency of defecation (times per week)		3.9 ± 1.9	1.0 - 9.5
Stool consistency (score)		2.6 ± 0.6	1.0 - 3.9
Estimated stool quantity (no. of balls per week)		11.0 ± 6.3	2.0 - 31.0
Constipation severity (score)		10.3 ± 3.3	5.0 - 18.0

The majority of the subjects had suffered from constipation for between 5 to 25 years, which confirms the chronic nature of the disorder. A substantial number of subjects were not aware of the fact that they had constipation as they perceived their symptoms to be natural occurrences in the course of normal bowel movement. As such, many of the subjects did not feel the need to seek medical attention for their condition.

During the screening process, the study subjects' constipation severity scores were assessed based on their symptoms during the three-month period prior to the screening using the CCQ scoring system (Chan *et al*., 2005). The mean CCQ score obtained was 10.3 ± 3.3 points out of a possible range of 5 to 22 points. Those with scores of five and below are considered non-constipated and were excluded from participating in the study. The upper limit for the CCQ score which indicates the most severe level of constipation depends on the frequency of laxative intake. As the frequency of laxative intake of more than once a week was one of the study exclusion criteria, the highest CCQ score possible for a study subject was 22.

The mean defecation frequency of 3.9 ± 1.9 times per week was observed among the study subjects. The defecation frequency as discussed in this present study involves only defecations producing solid, formed stool, as 'Type 5' loose, watery (non-solid) stools were considered and reported separately. The mean frequency of defecation of 'Type 5' stools was 0.34 times per week, with 8.0% of all stools (solid and non-solid) being 'Type 5' stools. In terms of stool consistency, the mean score of 2.6 indicates stool that is in between 'Type 2' (sausage-shaped but lumpy) and 'Type 3' (like a sausage, either smooth and soft, or with cracks on the surface). As for the stool quantity, a mean of 11.0 ± 6.3 balls (40 mm diameter) per week or 1.6 balls per day was observed.

Dietary factors

The subjects' dietary intake levels are shown in Table 3. The mean daily energy intake of the study subjects was 1,719±427 kcal with a mean of 2,050±491 kcal among the male subjects and 1,669±396 kcal among the female subjects. The mean daily dietary fibre intake of the study subjects was 15.0±4.9 g and the mean daily fluid intake of the study subjects was 2.5±0.8 L, which includes fluids obtained from consumption of plain water, other beverages and from moisture in food.

Physical activity level

Results of the assessment of the physical activity level of the study subjects are shown in Table 3. The majority of subjects (54.4%) were considered sedentary or physically inactive (categorised as 'low' physical activity level under IPAQ).

Association between stool pattern parameters and diet or physical activity

The four stool pattern parameters measured were tested to determine whether there were any associations between those parameters and diet or physical activity. Results of the Spearman's rank order correlation test are shown in Table 4. For the purpose of conducting the Chi-square and Fisher's exact tests, the stool pattern parameters as well as diet and physical activity levels were categorised as shown in Table 5, together with the results of the Pearson's Chi-square and Fisher's exact tests.

The results suggest there are weak, positive correlations between defecation frequency and dietary fibre (r_s=0.278, P<0.01) as well as fluid intake (r_s=0.257, P<0.05) (OR=2.857, 95% CI [1.019-8.014]). Similarly, stool quantity was positively associated with dietary fibre (r_s=0.226, P<0.05) and fluid intake (OR=3.571, 95% CI [1.202-10.609]). On the other hand, constipation severity in terms of CCQ score was associated with higher physical activity levels (OR=2.467, 95% CI [1.054-5.777]). The results also indicated that there were no statistically significant relationships between any of the stool pattern parameters and energy intake.

Table 3. Diet and physical activity level of the study subjects (n = 90)

Diet and physical activity level	*n (%)*	*Mean Ø SD*	*Min - Max*
Total daily energy intake (kcal)		1,719 ± 427	968 - 2,948
Male		2,050 ± 491	1,189 - 2,701
Female		1,669 ± 396	968 - 2,948
Daily dietary fibre intake (g)		15.0 ± 4.9	6.0 - 30.3
Male		16.4 ± 4.1	10.6 - 25.6
Female		14.7 ± 5.0	6.0 - 30.3
Daily fluid intake (L)		2.5 Ø0.8	1.2 - 4.3
Male		2.6 ± 0.8	1.6 - 4.3
Female		2.5 ± 0.8	1.2 - 4.3
Physical activity (MET mins/week)		1,215 ± 1,449	0 - 9, 021
Low	49 (54.4)		
Moderate	33 (36.7)		
High	8 (8.9)		

MET mins: metabolic equivalent minutes

Table 4. Results of Spearman's correlation tests between stool pattern and diet/physical activity (n = 90)

Parameters	*Correlation coefficient*	*P-value*
Defecation frequency		
Total energy intake	0.167	0.116
Dietary fibre intake	0.278	0.008**
Fluid intake	0.257	0.015*
Physical activity	0.142	0.181
Stool consistency		
Total energy intake	0.104	0.329
Dietary fibre intake	0.168	0.114
Fluid intake	0.006	0.954
Physical activity	-0.023	0.828
Stool quantity output		
Total energy intake	0.147	0.166
Dietary fibre intake	0.226	0.032*
Fluid intake	0.168	0.114
Physical activity	0.182	0.086
Constipation severity score		
Total energy intake	-0.064	0.551
Dietary fibre intake	-0.147	0.165
Fluid intake	0.081	0.451
Physical activity	0.087	0.416

* $P < 0.05$; ** $P < 0.01$

Table 5. Results of Pearson's Chi-square and Fisher's exact tests for independence among stool pattern parameters and diet/physical activity (n = 90)

Parameters	*Chi-square*	*P-value*
Defecation frequency (≥3/week; <3/week)		
Total energy intake (≥RNI; <RNI)	—	0.742
Dietary fibre intake (≥20 g; <20 g)	—	0.530
Fluid intake (≥MDG/FNB; <MDG/FNB)	4.158	0.041*
Physical activity level (Moderate/High; Low)	0.894	0.345
Stool consistency (score>2; score≤2)		
Total energy intake (≥RNI; <RNI)	—	1.000
Dietary fibre intake (≥20 g; <20 g)	—	1.000
Fluid intake (≥MDG/FNB; <MDG/FNB)	0.152	0.697
Physical activity level (Moderate/High; Low)	0.897	0.343
Stool quantity output (>7 balls/week; ≤7 balls/week)		
Total energy intake (≥RNI; <RNI)	—	0.324
Dietary fibre intake (≥20 g; <20 g)	—	0.053
Fluid intake (≥MDG/FNB; <MDG/FNB)	5.625	0.018*
Physical activity level (Moderate/High; Low)	1.434	0.231
Constipation severity score (<Mean; ≥Mean)		
Total energy intake (≥RNI; <RNI)	0.160	0.689
Dietary fibre intake (≥20 g; <20 g)	—	0.140
Fluid intake (≥MDG/FNB; <MDG/FNB)	1.089	0.297
Physical activity level (Moderate/High; Low)	4.403	0.036*

RNI: Recommended Nutrient Intakes; MDG: Malaysian Dietary Guidelines; FNB: Food and Nutrition Board; * $P<0.05$

There were also no significant associations between diet and stool consistency or constipation severity.

DISCUSSION

Defecation pattern of the study subjects showed irregularities that were consistent with constipation. Based on the mean CCQ score obtained, which is 10.3±3.3 points, the study subjects were thought to have relatively mild to moderate levels of functional constipation, with the lowest score being 5 points, which is the cut-off point between healthy and constipated subjects, while the most severe score was 18 points out of a possible 22 points.

On the other hand, defecation frequency that is considered normal can be anywhere in the range of 3 times per day to 3 times per week. So, the mean defecation frequency of 3.9±1.9 times per week as observed among the study subjects can be considered as being on the lower range of normal frequency. In terms of stool consistency, the mean score of 2.6±0.6 indicates stool that is between lumpy stool and normal stool which is sausage-shaped, either smooth and soft, or with cracks on the surface. This would indicate stool consistency bordering between normal and hard stools.

As for the stool quantity, only one other study (Matsumoto *et al.*, 2006) had used the same estimation method as the present study, and the findings, in terms of mean stool quantity or volume, were similar to the present study's results which was 11.0±6.3 balls (40 mm diameter) per week or 1.6 balls per day. In the study by Matsumoto *et al.* (2006) which involved healthy subjects with low defecation frequency, the mean stool quantity among subjects with 4 or less defecations per week was approximately 10.3 balls per week or 1.5 (40 mm diameter) balls per day.

Constipation is associated with low daily stool weight, with different weight levels suggested by different researchers, such as <35g (Longstreth *et al*., 2006) and 50g (Cummings, Bingham 1992). WHO (1990) reported that populations in different countries and from different demographic groups had different mean daily stool weights, with Malaysians shown to have a daily stool output of 170g, 227g, and 465g in urban Indian, urban Chinese and rural Malay ethnic groups respectively.

The method of estimating stool quantity in the present study did not use standard weight measurement units, and thus does not allow the results to be compared to the other studies that use weight measurements. This is because the main objective of the full study was to detect the changes in stool quantity with an intervention, in which case the estimation technique used in the present study was considered adequate. So, although no firm conclusion can be made based on the current study findings, based on general observation, the stool output of the study subjects seem to be indicative of low stool quantity and consistent with constipation.

Overall, the study subjects seemed to have a defecation frequency that was relatively low, stool form or consistency that was relatively hard and estimated stool output quantities that were relatively low when compared to the general, healthy population. However, further studies with healthy controls are needed to confirm these findings.

Looking at the dietary intake of the study subjects, in terms of their total energy intake, the mean intake of 1,719±427 kcal was clearly below the Recommended Nutrient Intakes (RNI) for Malaysian adults (National Coordinating Committee for Food and Nutrition, 2005). Based on the RNI values by gender and age group, only 12.2% of subjects achieved the RNI for energy intake.

The ratio of energy intake to basal metabolic rate (BMR) was used to assess under- and over-reporting of energy intake among the study subjects. The BMR was calculated using the predictive equation developed by Ismail *et al.* (1998). Energy intake (EI) per BMR ratio of below 1.2 was considered as under-reporters (Goldberg *et al.*, 1991), and ratio of 2.4 and above was considered as over-reporters (Black *et al*., 1996). The EI/BMR ratio was determined to be 1.71 with 14.4% of under-reporting and 6.7% of over-reporting.

These mean energy intake level of the study subjects was slightly higher compared to the findings by Mirnalini *et al*. (2008) based on data from the Malaysian Adult Nutrition Survey (MANS) which found that in a sample of the general population, male subjects had a mean energy intake of 1,776 kcal per day and female subjects a mean energy intake of 1,447kcal per day. However, the relatively low values could be attributed to the high prevalence (54.8%) of under-reporting in the MANS study.

On the other hand, the mean daily dietary fibre intake among the study subjects of 15.0±4.9g was also below the levels recommended by the guidelines of the National Coordinating Committee on Food and Nutrition (2010) which is between 20 to 30g. Only 14.4% of the study subjects met the minimum limit of 20g of dietary fibre intake per day. Ng *et al*. (2010) observed similar levels of dietary fibre intake among three samples of Malaysian subjects to be between 10.7g to 16.1g using a variety of diet assessment methods. On the other hand, based on the food consumption data from MANS (Ministry of Health 2006), Ng *et al*. (2010) estimated a much higher mean daily dietary fibre intake of 19.2g among Malaysians by adding up the average amounts of dietary fibre of the food items reportedly consumed by the study population on a daily basis. Regardless, none of the findings reported a mean intake which met the recommended minimum intake of 20g per day by the guidelines of the National Coordinating Committee on Food and Nutrition (2010). Based on the above findings, it cannot be concluded whether the

dietary intake of the constipated subjects was different from that of the general population, although the mean intake level for the present study and the other studies involving Malaysian subjects were all below recommended levels.

The mean daily fluid intake of the study subjects of 2.5±0.8L, including fluids obtained from consumption of all types of beverages and from moisture in food, was also considered inadequate. Water requirement levels were calculated based on the required energy values by age from the RNI for Malaysia (2005) together with the recommendation by the Food and Nutrition Board (1940) that 1mL of water is required for each calorie eaten. Furthermore, as moisture in food accounts for about 20% of total fluid intake (Food and Nutrition Board, 2005), the values were then extrapolated to obtain fluid requirement levels for each study subject based on their gender and age. The levels required ranged between 2.5L to 3.1L per day. Based on these levels, only 33.3% of the study subjects met the required levels for fluid intake.

Based on the findings from MANS, the average intake of plain water was 1.5L for the age group between 18 and 59 years old (Norimah *et al*., 2008). Further, about one to two glasses of other beverages were also consumed daily. Thus, the estimated fluid consumption per day from water and other beverages would be approximately 1.9L. After inclusion of the estimated 20% of moisture from food (Food and Nutrition Board, 2005), the approximate total fluid intake of the MANS study subjects were 2.3L per day. This is quite similar to the mean intake levels of the present study subjects of 2.5±0.8L.

In terms of physical activity levels, the findings from the present study, in which the majority of subjects were female, indicated that 54.4% of subjects were sedentary, and this is similar to findings from large scale studies conducted previously that used similar IPAQ questionnaires such as the National Health and Morbidity Survey III (NHMS III) in 2006 (IPH 2008), whereby the majority of the female subjects (50.5%) were found to be sedentary.

Lower percentages of physical inactivity were found by the MANS study (Poh *et al*., 2010), whereby among the female subjects, 42.6% were considered sedentary. However, the method used to categorise the subjects' physical activity levels was different compared to the present study. In the MANS study, physical activity level (PAL) was calculated as the ratio of total energy expenditure (TEE) to basal metabolic rate (BMR); BMR was calculated using predictive equations (Ismail *et al.*, 1998) while TEE was estimated through factorial calculations based on time allocated and energy cost of various activities.

The dietary intake of the study subjects could be much improved, as only 14.4% had adequate intake of dietary fibre, 12.2% adequate energy and 33.3% sufficient levels of fluid while 54.4% had a sedentary lifestyle. Overall, only 5.6% of the subjects had adequate diets in terms of the three dietary factors mentioned above.

Dietary intake, particularly of dietary fibre and fluids, was found to be positively associated with frequency of defecation and stool output quantity among the study subjects who were adults with functional constipation. There is a possibility that inadequate intake of these dietary factors in particular may have contributed to worsening of the constipation condition. Constipation severity score was found to be associated with higher physical activity levels, although lack of physical activity is usually considered a contributing factor to constipation. However, as physical activity would be expected to increase the level of fluids required by the body, dehydration may explain why higher levels of physical activity could be associated with more severe constipation since fluid intake among the study subjects appear to be inadequate.

With regard to the pertinent dietary factors covered in the present study, no association was observed in relation to stool

consistency and constipation severity. The softening or normalisation of stool consistency and reduction in overall severity of constipation are of great importance in the management of constipation and are commonly used as efficacy endpoint measurements in clinical trials. They can be considered as more important than other symptoms such as stool frequency and output volume in the context of effective management of constipation, as one can still be constipated with normal stool frequency and output volume. Thus, these findings could indicate that standard dietary modification alone may not provide adequate relief of constipation.

Further randomised, controlled studies are needed to confirm whether conventional dietary and physical activity intervention may play a role in alleviating functional constipation among adults. However, overall, the findings of the present study seem to support the continued use of dietary modifications, when appropriate, as part of standard care for individuals with functional constipation in Malaysia as an adjunct to therapy with laxatives and fibre supplements pending further investigations.

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