Intraoperative Determination of the Actual Length of the Small and Large Intestine and its Relation to Anthropometric Variables in the Egyptian Population

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Introduction: The primary function of small bowel is digestion and absorption of dietary components after they leave the stomach. The enlarged surface area of small intestine enables complete digestion of food stuffs. Investigators has correlated the length of small bowel with age, gender, height, and weight.

Aim of work: To asses intraoperatively the small bowel length measurements and analysis of demographic predictors of increased length.

Patients and methods: This cross-sectional study was conducted in Emergency Department of Cairo University hospital from January 2021 to June 2021. We included 160 patients who have been admitted to general surgery department of Kasr Alainy who were indicated for abdominal surgery. Measurement the of the small bowel is expressed in centimeters, starting at ligament of Treitz and ending at the ileocecal junction using a sterile 10 cm-tape applied to the anti-mesenteric border of un stretched small intestine.

Results: The current study showed that there was very high positive correlation according to weight and height while BMI shows no significant correlation between them. We also found that there were highly statistically significant differences between sex groups according to age, height, BMI and Total small bowel length. In males, there was very high positive significant correlation according to weight and height. In females, there was very high positive significant correlation according to height.

Conclusion: Length of the small bowel in humans is pertinent to advances in deep enteroscopy and existing surgical applications such as intestinal bypass and prevention of short gut syndrome.

Key words: Bowel, anthropometric variables, total small bowel length (TSBL), Egyptian population.

Introduction

The length of the small intestine varies from 3 to 8.5 meters. The average length is considered to be approximately 5 meters.[1]

The variation in the intestinal length in humans is a topic of interest. Differences in measurement techniques, small study groups, and large inter-individual variation have contributed to the uncertainty associated with defining a normal range of intestinal length. Estimation of small bowel length is relevant for many years to plan small bowel resections as the development of malabsorption is closely related to the total length of small intestine that remains after surgery.[2,3]

Measurement of small bowel length is relevant in planning bariatric surgery because the efficacy and incidence of malnutrition are closely associated with the length of the bilio-pancreatic (BP) limb, the common channel, and the total length of the small bowel. This advancement in knowledge regarding bariatric surgery has generated renewed interest in the importance of the length of the small bowel in this patient population.[4,5]

Despite its great importance in surgical approaches, little definitive information is available on human gut tract length in Egyptian population. Previous studies have correlated small bowel length with various measures like sex, age, weight, height and ethnic background. Better knowledge of these relationships may aid in avoidance of surgical complications.[6]

Prediction of the total small bowel length (TSBL) could be useful to avoid intraoperative measurements, which might consume extra time particularly in laparoscopic procedures in morbidly obese individuals. A CT scan–based prediction method has been proposed in the literature but without validation. There is significant controversy on the role of anthropometry as predictive parameters to the total small bowel length (TSBL).[7,8]

Patients and methods

We conducted a prospective cross section study that included 160 patients (100 males, 60 females) presented to Kasr Alainy hospital with indication for open abdominal exploration.

Inclusion criteria

Adult Patients aged ≥ 18 years, presenting with indication for open abdominal exploration such as blunt or penetrating abdominal trauma, Incarcerated or strangulated para umbilical hernia.

Exclusion criteria

Patients aged less than 18 years. Patients presented with gastrointestinal tract malignancy. Patients presented with Peritonitis. Patients with

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history of Previous abdominal operation to avoid intestinal adhesions which may affect the proper measurement of the small bowel length.

Study procedures: All Patients enrolled in our study were be assessed on admission: -

History Taking, hemodynamic assessment, general and abdominal examination.

Imaging: X ray (Chest erect and abdomen), ultra sound and CT.

Laboratory investigations: CBC, Na, k, urea, creatinine, ALT, AST, RBS and HbA1C.

Unstable cases such us abdominal stab with eviscerated bowel or Full from height will be rushed to the Operating room.

Intraoperative findings: Measurement the of the small bowel was expressed in centimeters, starting at ligament of Treitz and ending at the ileocecal junction, using a sterile 10 cm- tape applied to the anti-mesenteric border of un stretched small intestine.

Spasmolytic (Visceralgine 5 mg/2 ml IV) was taken on induction of anesthesia to reduce the contractions of the small bowel.

All measurements were obtained by 2 trained surgeons to increase the accuracy of measurement.

Results

The study included 60 females and 100 males representing 37.7% and 62.3 %, respectively, of the study population. The mean age was 46.34±16.022 years, weight = 80.49±8.302 kg, height = 170.13±9.150 cm, and BMI = 28.02±4.112 kg/m2. The measurement of the TSBL in the study participants yielded a mean of 412.62±54.938 cm ranging from 310 to 560 cm as shown in **(Table 1).**

Causes of admission

Patient admitted were mainly due to stab abdomen 32 patients (20%), Incarcerated Para umbilical hernia 21 patients (13.12%) , Road Traffic Accident 19 patients (11.87%), Fall from height 18 patients (11.25%) , Incarcerated inguinal hernia 12 patients (7.5%), Mesenteric Vascular Occlusion 10 patients (6.25%) as shown in **(Table 2).**

(Table 3) shows that correlation between total small bowel length (TSBL) and the measured variables in the study and it show that there was very high positive correlation according to weight and height while BMI shows no significant correlation between them.

(Table 4) shows that comparison between gender groups according to baseline variables assessed for this study and it show highly statistically significant differences between sex groups according to age, height, BMI and total small bowel length (TSBL).

(Table 5) shows correlation between total small bowel length (TSBL) and the measured variables in male and it shows that there was very high positive significant correlation according to weight and height.

(Table 6) shows correlation between total small bowel length (TSBL) and the measured variables in female and it shows that there was very high positive significant correlation according to height.

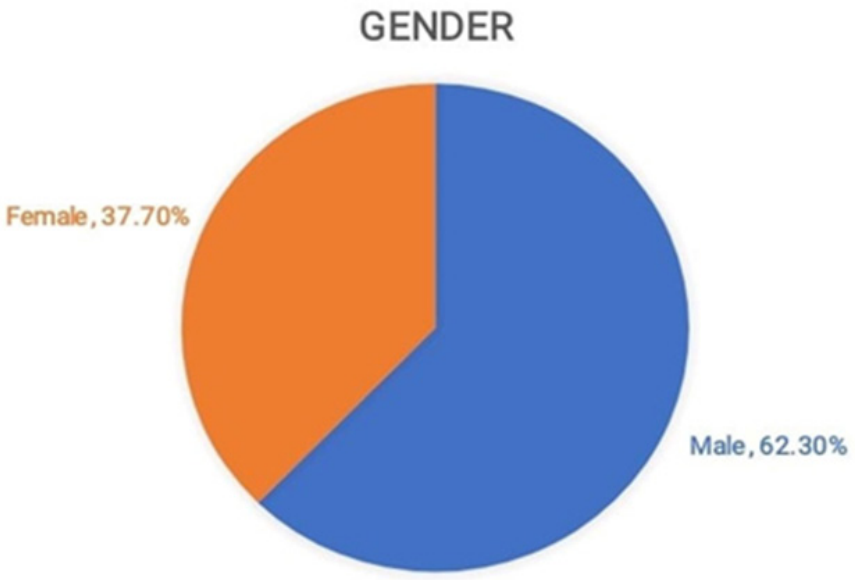

Fig 1: Pie chart showing gender distribution among the included patients.

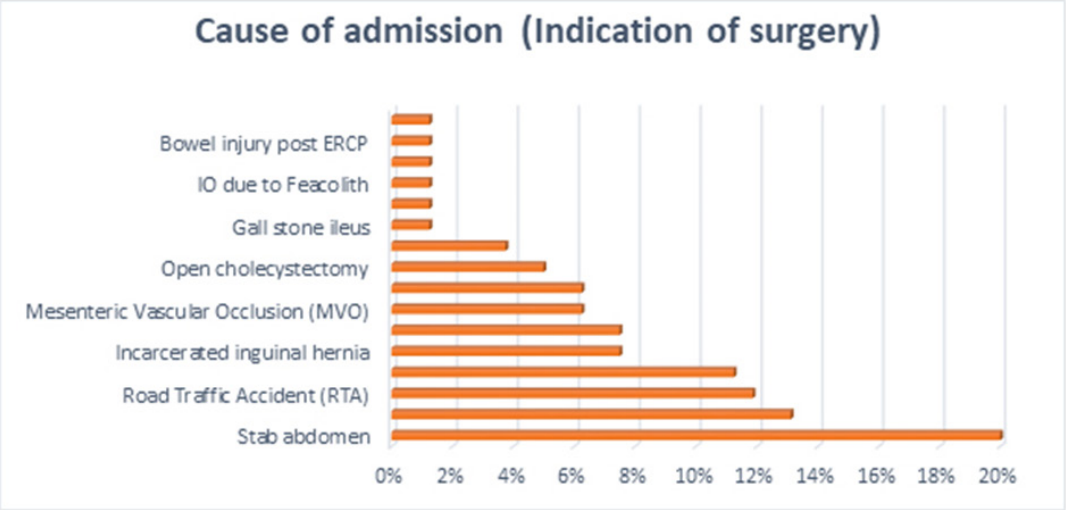

Fig 2: Cause of admission (Indication of surgery).

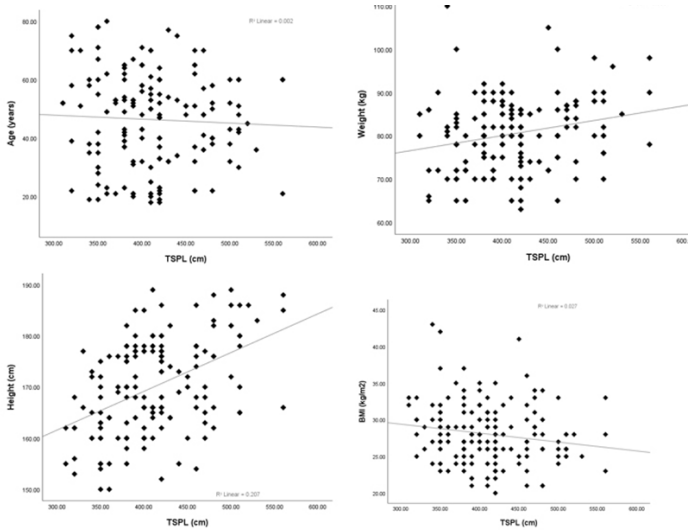

Fig 3: Correlation between TSBL and measured variables in the study.

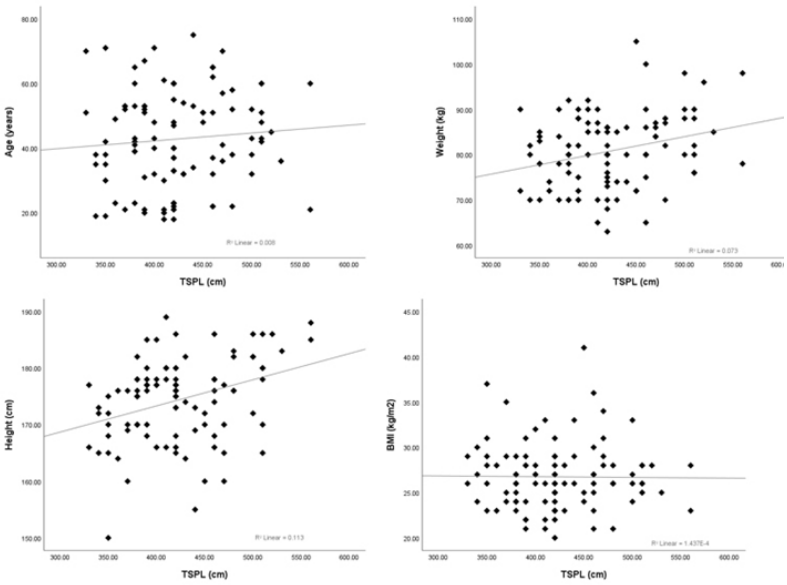

Fig 4: Correlation between TSBL and the measured variables in male.

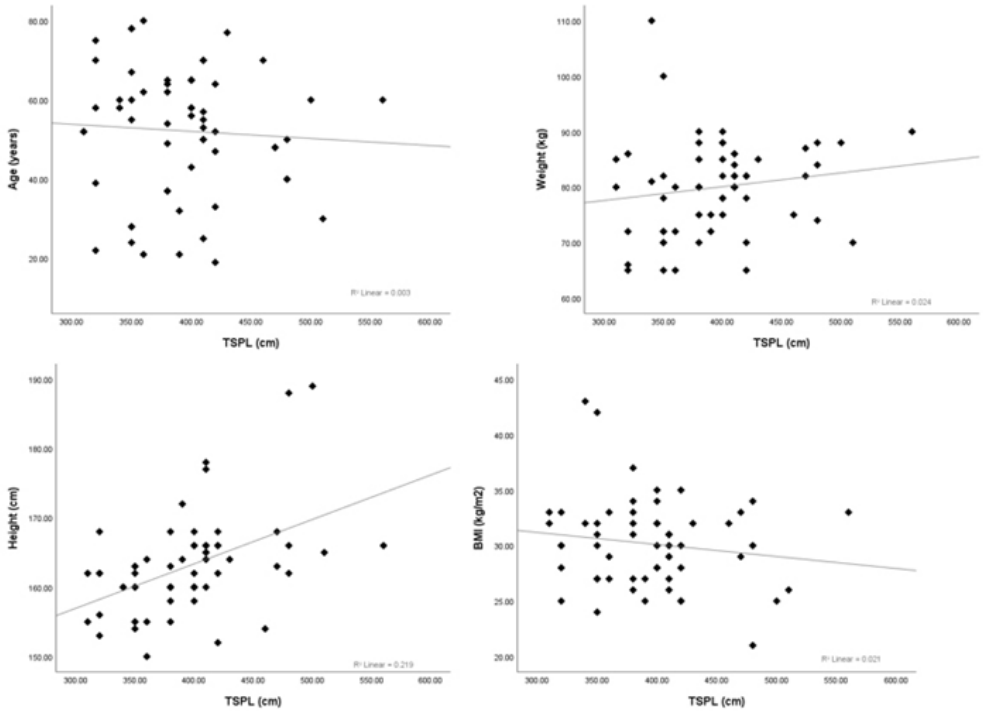

Fig 5: Correlation between TSBL and the measured variables in female.

Table 1: Descriptive statistics of the quantitative baseline variables assessed for this study

	Number	Percent
Age (years)		
Range	18-80	
Mean±S.D.	46.34±16.022	
Sex		
Male	100	62.5
Female	60	37.5
Weight		
Range	63-110	
Mean±S.D.	80.49±8.302	
Height		
Range	150-189	
Mean±S.D.	170.13±9.150	
BMI		
Range	20-43	
Mean±S.D.	28.02±4.112	
TSBL		
Range	310-560	
Mean±S.D.	412.62±54.938	

Table 2: Causes of admission among the included patients

		Count	Percent
Cause of admission (n%)	Stab abdomen	32	20%
	Incarcerated Para umbilical hernia	21	13.12%
	Road Traffic Accident (RTA)	19	11.87%
	Fall from height (FFH)	18	11.25%
	Incarcerated inguinal hernia	12	7.5%
	Strangulated inguinal hernia	12	7.5%
	Mesenteric Vascular Occlusion (MVO)	10	6.25%
	Complicated appendicitis	10	6.25%
	Open cholecystectomy	8	5%
	Diverticulosis	6	3.75%
	Gall stone ileus	2	1.25%
	Bowel injury postoperative	2	1.25%
	Intestinal obstruction due to Fecolith	2	1.25%
	Ogilvie syndrome	2	1.25%
	Bowel injury post ERCP	2	1.25%
	Biliary leakage	2	1.25%

Table 3: Correlation between TSBL and the measured variables in the study

	TSBL			
	Pearson's		Spearman's rho	
	r	P	R	P
Age (years)	-0.047	0.557	-0.062	0.432
Weight	0.231	0.003*	0.212	0.007*
Height	0.455	<0.001*	0.434	<0.001*
BMI	-0.163	0.040*	-0.168	0.034*

Table 4: Comparison between gender groups according to baseline variables assessed for this study

	Gender		U	P value
	Female	Male		
Age				
Range	19 – 80	18 – 75	1987.00	<0.001*
Mean±S.D.	52.18±16.205	42.84±14.924		
Weight				
Range	65 – 110	63 – 105	2818.50	0.521
Mean±S.D.	79.93±8.8.578	80.83±8.156		
Height				
Range	150 – 189	150 – 189	739.50	<0.001*
Mean±S.D.	162.98±7.240	174.42±7.327		
BMI				
Range	21 – 43	20 – 41	1464	<0.001*
Mean±S.D.	30.17±3.962	26.74±3.653		
TSPL				
Range	310 – 560	330 – 560	2032.50	0.001*
Mean±S.D.	394.00±52.889	423.80±53.329		

Table 5: Correlation between total small bowel length (TSBL) and the measured variables in male

	TSBL			
	Pearson's		Spearman's rho	
	r	P	R	P
Age (years)	0.087	0.390	0.097	0.339
Weight	0.270	0.007*	0.229	0.022*
Height	0.337	0.001*	0.311	0.002*
BMI	-0.012	0.906	0.012	0.907

Table 6: Correlation between total small bowel length (TSBL) and the measured variables in female

	Total small bowel length (TSBL)			
	Pearson's		Spearman's rho	
	r	P	R	P
Age (years)	-0.058	0.658	-0.098	0.339
Weight	0.153	0.242	0.196	0.134
Height	0.468	<0.001*	0.486	<0.001*
BMI	-0.145	0.270	-0.109	0.406

Discussion

Regarding the quantitative baseline variables assessed for this study, our results showed that there were 60 females and 100 males representing 37.5% and 62.5 %, respectively, of the study population. The mean age was 46.34±16.022 years, weight = 80.49±8.302 kilograms, height = 170.13±9.150 centimeters. The measurement of the TSBL in the study participants yielded a mean of 412.62±54.938 cm ranging from 310 to 560 cm.

Compared this study to others, according to ethnic background. The current study was supported by Bekheit et al.[9] conducted on Egyptian population, reporting the normal total bowel length in living adult humans and correlation with the anthropometric parameters. This study included 606 participants (380 females and 226 males). Their mean age was 39.8 ± years, the mean TSBL was 630 ± 175 cm ranging from 250 to 1300 cm.

Also, the study by Almalki et al.[10] conducted on Taiwanese patients, mean age was 38.6±12.0 years and BMI was 38.9±7.6. Small bowel length varied widely among patients (Mean 739.8 + 115.7 cm, range 380–1050 cm). Compared to Egyptian population in our study ranging from 310 to 560 cm. It is possible that Asian people have longer small bowel length than people of other races.

As well the study by Tacchino, et al.[11] aimed to evaluate small bowel length (SBL). The study enrolled 443 Italian patients out of them 342 were females (78%). The mean age was 37.7±10.4 years, the mean SBL of 443 patients undergoing laparotomy was 690 ± 93.7 cm (Range 350–1049 cm). also, greater than mean small bowel length in Egyptian population. Compared to our study, Varut et al.,[12] aimed to Evaluate the length of small bowel (SB) in Thai patients, the study enrolled 48 patients. There were 27 men and 21 women, with an average age of 60 years (Range 28-88). The average length of SB was 428±105 cm (Range 169-745).

Also, Raines et al.,[13] aimed to estimate of small bowel length. The study enrolled 91 French patients, with male/female ratio of 51/40, the mean BMI was 29.45 ± 8.38. Small bowel length was found to vary widely between individuals (Average 998.52 cm, range 630–1510 cm).

Furthermore, Teitelbaum et al.[14] aimed to present a series of intraoperative SBL measurements taken in North American patients undergoing laparotomy. Specific attention is paid to analyzing potential patient-specific predictors of SBL. The study enrolled 240 patients. 127 patients were female (53%). The mean age was 55 (Range 20–86) years, mean height was 169 (Range 138–196) cm and mean weight was 77 (Range 41–175) kg. Mean SBL from the ligament of Treitz to ileocecal value was 506±105 (Range 285–845) cm.

Compared to previous studies, our study predict that the Egyptian population has shorter mean small bowel length (SBL), 412.62±54.938 cm ranging from 310 to 560 cm. compared to other populations of different ethnic background. Regarding the correlation between total small bowel length (TSBL) and the measured variables in the study, we found that there was very high positive correlation

according to weight and height while BMI shows no significant correlation between them.

The study by Bekheit et al.[9] reported that there was very weak (i.e., negligible) positive but statistically significant correlation between the total small bowel length (TSBL) and both weight and height. There was no significant correlation between the TSBL and BMI or the age on the other hand. This was partially agreed with our results.

Also, supporting our study, Almalki et al.[10] in linear regression analysis revealed a significant association between small bowel length and body height, body weight, and waist circumference, but not significantly correlated with age.

As well, Tacchino et al.[11] in multivariate linear regression analysis model to predict SBL reported that sex, age, height, and weight showed a significant correlation (P < .00001).

The study by Purandare et al.[15] reported that there was no significant correlation between BMI and TSBL.

In addition, Raines et al.,[13] in a linear regression analysis demonstrated a statistically significant relationship between small bowel length and height (regression coefficient = 0.0561, P-value = 0.0238). A linear relationship between small bowel length and weight or BMI was not observed.

As well, Teitelbaum et al.,[14] reported that height was positively associated with increased SBL (P < 0.001). A multivariate linear regression model using patient sex, age, height and weight was significant (P= 0.001) and the predictors explained 8% of the variance in SBL. In this model, only height was independently predictive of increased SBL (P = 0.03). This was partially agreed with our results.

Hosseinpour et al.[16] reported that there was no significant correlation between height and small intestinal length.

Comparison between gender groups according to baseline variables assessed for this study showed that there were highly statistically significant differences between sex groups according to age, height, BMI and TSBL. where TSBL was significally longer in males compared with females.

However, the study by Bekheit et al.[9] on the assessment of the gender influence on the various anthropometric measures and the total small bowel length (TSBL), reported that males had significantly higher weight and were significantly taller compared with females. There was no difference in the BMI or age between males and females. However, the total small bowel length (TSBL) was significantly longer in males compared with females. The mean TSBL in males was 661.5 ± 186 cm versus 612 ± 164 cm. they also noted that the correlation between TSBL and height is stronger in males than females but with no statistical difference. This comes in agreement with our study.[17]

Also, in agreement with our results Almalki et al.[10] reported that there was statistically significant association between sex and small bowel length.

Similarly, the study by Teitelbaum et al.[14] reported that Male sex and height had positive correlations with SBL. In men, height had a positive association with SBL (r = 0.20, P = 0.03), whereas in women there was no correlation between height and SBL (r = 0.06, P = 0.51). In men, age had a trend toward a positive correlation with SBL (r = 0.17, P = 0.08), whereas in women age was negatively correlated with SBL (r = 20.18, P = 0.04). A multivariate linear regression model using sex, age, height and weight to predict SBL was significant (P = 0.001) and explained 8% of the variance in SBL. Increased height was the only significant independent predictor of increased SBL (P = 0.03) in this model.

Similar results were reported by recent study conducted by Hosseinpour and Behdad A.[16] where mean intestinal length was longer in females (468 cm) than males (459 cm). On the contrary, studies conducted by Nordgren et al.[18] and Teitelbaum et al.[14] reported that males had longer intestinal length than females.

Conclusion

Length of the small bowel in humans is pertinent to advances in deep enteroscopy and existing surgical applications such as intestinal bypass and prevention of short gut syndrome. The current study showed that the mean total small bowel length (TSBL) in the studied cases was 412.62±54.938 cm ranging from 310 to 560 cm. Which was lower than average small bowel length (SBL) of other population of different ethnic background, the current study showed that there was very high positive correlation according to weight and height while BMI shows no significant correlation between them. We also found that there were highly statistically significant differences between sex groups according to age, height, BMI and TSBL. In males, there was very high positive significant correlation according to weight and height. In females, there was very high positive significant correlation according to height.

References

1. Minko E, Pagano A, Caceres N, Tony Adar T, Márquez S: Human intestinal tract length and relationship with body height. ***FASEB J.*** 2014; 28: 916.4.

2. Sonali AK, Maitreyee MM: Variability of small bowel length: Correlation with height, waist

circumference, and gender Sonali. ***Italian Journal of Anatomy and Embryology.*** 2018; 123: 312-319.

3. Smyth GB: Effects of age, sex, and post mortem interval on intestinal lengths of horses during development. ***Equine Vet. J.*** 1988; 20: 104-108.

4. Schiller Lawrence R, Pardi Darrell S, Spiller R, Semrad CE, Surawicz CM; Giannella RA, Krejs GJ, Farthing JG, Sellin JH: Gastro 2013 APDW/ WCOG Shanghai Working Party Report: Chronic diarrhea: Definition, classification, diagnosis. ***Journal of Gastroenterology and Hepatology.*** 2014; 29(1): 625.

5. Sinha R, Trivedi D, Murphy PD, Fallis S: Small intestinal length measurement on MR enterography: Comparison with in vivo surgical measurements. ***AJR Am. J. Roentgenol.*** 2014; 203: W274-W279.

6. Quan V, Cooper FPM, Bekheit M: The influence of total bowel length on gastric bypass outcomes. ***Mini-Invasive Surg.*** 2017: 958.

7. Tiberi A, Pesi B, Giudici F, Zambonin D, Nelli T: Cupellini C, Ficari F, Cianchi F, Scaringi S. Laparoscopic ileo-colic resection and right hemicolectomy for Crohn's disease and colon cancer: a preliminary comparative study on post-operative outcome. ***Updates Surg.*** 2020; 72(3): 821-826.

8. Tran T, Sundaram CP, Bahler CD, Eble JN, Grignon DJ, Monn MF, Simper NB, Cheng L: Correcting the shrinkage effects of formalin fixation and tissue processing for renal tumors: Toward standardization of pathological reporting of tumor size. ***J. Cancer.*** 2015; 6: 759-766.

9. Bekheit M, Ibrahim MY, Tobar W, Galal I, Elward AS: Correlation between the total small bowel length and anthropometric measures in living humans: Cross-sectional study. ***Obesity Surgery.*** 2020; 30(2):681-6.

10. Almalki OM, Soong TC, Lee WJ, Chen JC, Wu CC, Lee YC: Variation in small bowel length and its influence on the outcomes of sleeve gastrectomy. ***Obesity Surgery.*** 2021; 31(1): 36-42.

11. Tacchino RM: Bowel length: Measurement, predictors, and impact on bariatric and metabolic surgery. ***Surg. Obes. Relat. Dis.*** 2015; 11: 328-334.

12. Lohsiriwat V, Wiangphoem N, Lohsiriwat S: The length of small bowel in Thai patients. ***J Med Assoc Thai.*** 2014; 97(5): 525-9.

13. Raines D, Arbour A, Thompson HW, Figueroa Bodine J, Joseph S: Variation in small bowel length: factor in achieving total enteroscopy? ***Digestive Endoscopy.*** 2015; 27(1): 67-72.

14. Teitelbaum EN, Vaziri K, Zettervall S, Amdur RL: Orkin BA. Intraoperative small bowel length measurements and analysis of demographic predictors of increased length. ***Clinical Anatomy.*** 2013; 26(7): 827-32.

15. Purandare A, Phalgune D, Shah S: Variability of length of small intestine in Indian population and its correlation with type 2 diabetes mellitus and obesity. ***Obesity Surgery.*** 2019; 29(10): 3149-53.

16. Hosseinpour M, Behdad A: Evaluation of small bowel measurement in alive patients. ***Surg Radiol Anat.*** 2008; 30:6435

17. Hounnou G, Destrieux C, Desme J, Bertrand P, Velut S: Anatomical study of the length of the human intestine. ***Surg. Radiol. Anat.*** 2002; 24: 290-294.

18. Nordgren S, McPheeters G, Svaninger G: Small bowel length in inflammatory bowel disease. ***Int J Color Dis.*** 1997; 12: 2304.