



Prevalence of gastrointestinal symptoms and their association with psychological problems in youths

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Background: Gastrointestinal symptoms and psychological problems are common in youths, which can negatively affect their lives on physical, mental, and social levels. This cross-sectional study aimed to determine the prevalence of gastrointestinal symptoms in youths and further explore their association with psychological problems.

Methods: Self-reported data on gastrointestinal symptoms and psychological problems in 692 sophomores who majored in education in a high vocational school and 310 recruits who were undergoing basic training in an army in China were retrospectively collected. The self-reported data included demographics, gastrointestinal symptoms, and Symptom Checklist 90 (SCL-90) used for the assessment of psychological problems. Gastrointestinal symptoms surveyed included nausea, emesis, abdominal pain, acid regurgitation, eructation, heartburn, anorexia, abdominal bloating, diarrhea, constipation, hematemesis, and hematochezia. Logistic regression analysis was performed to identify the independent risk factors associated with gastrointestinal symptoms. Odds ratios (ORs) with 95% confidence intervals (CI) were calculated.

Results: The prevalence of gastrointestinal symptoms was 36.7% (n=254) and 15.5% (n=48) in the sophomores and recruits, respectively. Participants with gastrointestinal symptoms had a significantly higher prevalence of total SCL-90 score beyond 160 than those without gastrointestinal symptoms in both sophomores (19.7% *vs.* 3.2%, $P < 0.001$) and recruits (10.4% *vs.* 1.1%, $P < 0.001$). Total SCL-90 score beyond 160 was independently associated with gastrointestinal symptoms in both sophomores (OR = 5.467; 95% CI: 2.855–10.470; $P < 0.001$) and recruits (OR = 6.734; 95% CI: 1.226–36.999; $P = 0.028$).

Conclusions: Gastrointestinal symptoms may be common and strongly associated with psychological problems in youths. Prospective studies should be required to explore the impact of the correction of psychological problems on the improvement of gastrointestinal symptoms.

Keywords: Gastrointestinal symptom; psychological problem; sophomore; recruit; Symptom Checklist 90 (SCL-90)

Submitted Nov 20, 2022. Accepted for publication Jan 04, 2023. Published online Feb 22, 2023.

doi: 10.21037/apm-22-1316

View this article at: <https://dx.doi.org/10.21037/apm-22-1316>

Introduction

The gastrointestinal tract plays a central role in the digestion and absorption of nutrients, and its disorder may cause various gastrointestinal symptoms, primarily including abdominal pain, diarrhea, nausea, and emesis (1). Gastrointestinal symptoms are commonly observed in gastrointestinal functional disorders, such as irritable bowel syndrome, functional diarrhea, and functional constipation (2), and gastrointestinal organic diseases, such as gastritis, inflammatory bowel disease, peptic ulcer, and gastrointestinal cancer (2). Sixty-two percent of the general population have been reported to have at least one gastrointestinal symptom (3). In recent years, a growing number of studies suggest an increasing trend in the prevalence of functional gastrointestinal disorders in youths. Notably, as many as 65% of the youths are experiencing gastrointestinal symptoms, and almost one-third are seeking medical care (4). In addition, gastrointestinal symptoms are one of the most prominent somatic symptoms found in patients with mental disorders, including anxiety, depression, and autism spectrum disorder (5), which can negatively affect the youths on physical, mental, and social levels (6).

At present, over 26 million people worldwide are diagnosed with severe psychological health problems (7), mainly including depression, anxiety, hostility, and paranoid ideation. According to the World Health Organization, approximately 264 million people suffer from anxiety all over the world (8), and almost one-fifth of people experience at least one episode of depressive disorder during their lifetime (9), especially in youths. In China, phobic anxiety, depression, and anxiety are the most common psychological problems in youths (10). Psychological problems are a major precipitating factor for suicide, which is the second cause of death for youths aged 10 to 24 years old in the United States (11). Thus, early detection and correction of psychological problems are crucial among youths (12), and can effectively prevent suicide (13).

Under the action of the brain-gut axis, the digestive system and brain are linked via various bidirectional pathways, and both of them affect each other (14). Psychological problems can lead to increased stress response, inflammation, and arousal of the autonomic nervous system, which cause self-reported gastrointestinal symptoms (15). Gastrointestinal symptoms and psychological problems are often concomitant in youths (16). However, their association has not been well elucidated. Furthermore, the extent to which psychological problems affect gastrointestinal

symptoms and which type of gastrointestinal symptoms is related to psychological problems are still unclear. The purpose of the present cross-sectional study was to determine the prevalence of gastrointestinal symptoms and investigate their association with psychological problems in youths. We present the following article in accordance with the STROBE reporting checklist (available at <https://apm.amegroups.com/article/view/10.21037/apm-22-1316/rc>).

Methods

Study design

Since attendance at college and adjustment to new social settings are considered stress-provoking environments in youths (4), college students and military recruits were selected as the study population. Before the current study was designed, several previous questionnaires-based studies had been learned (17-19), in which only the participants' verbal informed consents were used instead of written informed consents. Two investigators (Cong Wang and Jun Liu) separately conducted face-to-face interviews with two different groups of participants to verbally introduce the objectives and significance of this questionnaire. Only if a participant gave his or her verbal informed consent to participate in the questionnaire survey, this questionnaire would be filled. All participants had been de-identified, when the data were collected and analyzed. All information obtained from these participants would be guaranteed to be kept confidential without any potential effect on them. In May 2021, the self-reported questionnaire about the health status of youths had been sent by an investigator (Cong Wang) using the online application Sojump (Changsha Ran Xing InfoTech Ltd.) to the sophomores majoring in education in a high vocational school, which is a college that trains students with certain higher education, professional skills, and technical knowledge and highlights the practical operation ability of applied technology in teaching, in the Panjin city of Liaoning province. Participants used their mobile phones to complete the online questionnaires. The online application Sojump demonstrated that each participant had a unique Internet Protocol address to avoid repeated filling. Another investigator (Jun Liu) used a paper version to the recruits in an army of the Northern Theater Command. The youths who agreed to fill out the questionnaire were included in this study. If the data in the questionnaires were invalid or unclear, the participants would be excluded. The study protocol was approved by

the Medical Ethical Committee of the General Hospital of Northern Theater Command with an approval number [Y (2021) 099]. The study was performed according to the Declaration of Helsinki (as revised in 2013). The ethics committee exempted the written informed consents due to the retrospective nature of this study.

This self-reported questionnaire is composed of three parts, as follows. (I) Demographics. This part includes age, gender, height, weight, history of surgery and gastrointestinal diseases, personal habits (i.e., smoking, drinking alcohol, drinking tea, drinking coffee, and eating spicy food), lifestyles (i.e., irregular diet, eating out frequently, drinking raw water, and sharing drinking glasses), family characteristics (i.e., living area, number of family members, and annual family income), and family history of gastrointestinal diseases.

(II) Gastrointestinal symptoms. This part mainly includes the presence of gastrointestinal symptoms (i.e., nausea, emesis, abdominal pain, acid regurgitation, eructation, and heartburn). Each question on the symptom was answered by “yes” or “no”.

(III) Psychological conditions. This part was assessed using the SCL-90 (20), which is a symptom self-rating scale composed of 90 items from 9 subscales: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. Each item on the scale was measured on a five-point scale (1= never, 2= light, 3= moderate, 4= quite severe, and 5= severe) based on the severity of psychological conditions. A higher SCL-90 score indicates a worse psychological condition, and a total SCL-90 score beyond 160 indicates a potential psychological problem. And if the total SCL-90 score was beyond 160, the score for each subscale would be further calculated as previously recommended (21).

Statistical analyses

All statistical analyses were performed with IBM SPSS 20.0 (IBM Corp, Armonk, NY, USA) and Microsoft Office Excel 2010 software (Microsoft Corp, Redmond Washington, USA). Continuous variables were expressed as mean \pm standard deviation and median (range). Categorical variables were expressed as frequency (percentage). Non-parametric Mann-Whitney U test was used for continuous variables and Chi-square and Fisher's exact tests were used for categorical variables. Logistic regression analyses were performed to identify

the independent factors associated with gastrointestinal symptoms in youths. Only variables that were statistically significant in the univariate analyses were further included in multivariate analyses. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. A two-sided $P < 0.05$ was considered statistically significant.

Results

Participants

A total of 1,019 participants, including 708 sophomores and 311 recruits, were considered for the study inclusion. Among them, 16 sophomores' and one recruit's records were excluded. Finally, 1,002 participants were eligible, including 692 sophomores and 310 recruits. The median age of the sophomores was 20.0 (range, 16.0–25.0) years old; and 95.1% ($n=658$) were female. The median age of the recruits was 20.0 (range, 17.0–24.0) years old; and 6.5% ($n=20$) were female (Table S1). The prevalence of gastrointestinal symptoms was 36.7% ($n=254$) and 15.5% ($n=48$) in the sophomores and recruits, respectively (Figure 1). The prevalence of total SCL-90 score beyond 160 was 9.2% ($n=64$) and 2.6% ($n=8$) in the sophomores and recruits, respectively.

Difference between participants with and without gastrointestinal symptoms

Sophomores with gastrointestinal symptoms had a significantly higher prevalence of females, history of surgery, gastrointestinal diseases, drinking coffee, eating spicy food, irregular diet, eating out frequently, and sharing drinking glasses, halitosis, family history of gastrointestinal diseases and total SCL-90 score beyond 160 than those without (Table 1).

Recruits with gastrointestinal symptoms had a significantly higher prevalence of history of gastrointestinal diseases, drinking alcohol, drinking coffee, eating spicy food, eating out frequently, drinking raw water, and sharing drinking glasses, halitosis, family history of gastrointestinal diseases and total SCL-90 score beyond 160 than those without (Table 2).

Risk factors for gastrointestinal symptoms

In the sophomore population, univariate logistic regression analysis showed that body mass index, history of surgery,

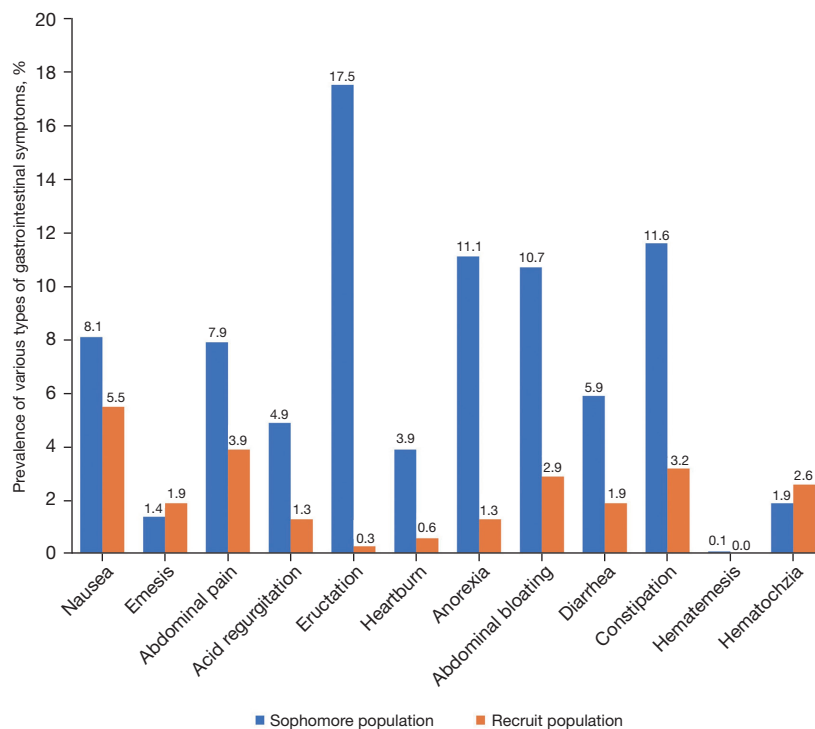


Figure 1 Prevalence of various types of gastrointestinal symptoms.

gastrointestinal diseases, drinking coffee, eating spicy food, irregular diet, eating out frequently, and sharing drinking glasses, halitosis, family history of gastrointestinal diseases and total SCL-90 score beyond 160 (OR =7.423; 95% CI: 4.010–13.740; $P < 0.001$) were significant risk factors of gastrointestinal symptoms. Multivariate logistic regression analysis showed that history of surgery, gastrointestinal diseases, irregular diet, eating out frequently, and sharing drinking glasses and total SCL-90 score beyond 160 (OR =5.467; 95% CI: 2.855–10.470; $P < 0.001$) were independently associated with gastrointestinal symptoms (Table 3).

In the recruit population, univariate logistic regression analysis showed that history of gastrointestinal diseases, drinking alcohol, drinking coffee, eating spicy food, eating out frequently, drinking raw water, and sharing drinking glasses, halitosis, family history of gastrointestinal diseases and total SCL-90 score beyond 160 (OR =10.039; 95% CI: 2.314–43.543; $P = 0.002$) were significant risk factors of gastrointestinal symptoms. Multivariate logistic regression analysis showed that history of gastrointestinal diseases and eating out frequently, halitosis and total SCL-90 score beyond 160 (OR =6.734; 95% CI: 1.226–36.999; $P = 0.028$)

were independently associated with gastrointestinal symptoms (Table 4).

Various types of psychological problems between participants with and without gastrointestinal symptoms

Sophomores with gastrointestinal symptoms had a significantly higher prevalence of obsessive-compulsive, interpersonal sensitivity, depression, anxiety, and hostility than those without. Recruits with gastrointestinal symptoms had a significantly higher prevalence of somatization, obsessive-compulsive, and depression than those without (Table 5).

Prevalence of gastrointestinal symptoms according to the total SCL-90 score

In the sophomore population, the prevalence of gastrointestinal symptoms was increased with the total SCL-90 score. The prevalence was 37.9% ($n = 198$), 38.8% ($n = 19$), 42.9% ($n = 6$), and 100.0% ($n = 1$) in the groups with total SCL-90 scores less than or equal to 160, 161–230, 231–300, and beyond 300, respectively (Figure 2).

Table 1 Difference between sophomores with and without gastrointestinal symptoms

Variables	Overall		With gastrointestinal symptoms		Without gastrointestinal symptoms		P value
	No. Pts	Values	No. Pts	Values	No. Pts	Values	
Age (years)	692	20.00 (16.00–25.00), 20.04±1.38	254	20.00 (16.00–25.00), 19.98±1.25	438	20.00 (16.00–24.00), 20.05±1.40	0.322
Female	692	658 (95.1)	254	247 (97.2)	438	411 (93.8)	0.046
Height (m)	692	1.63 (1.45–1.85), 1.64±0.06	254	1.63 (1.47–1.82), 1.63±0.05	438	1.63 (1.45–1.85), 1.64±0.06	0.263
Weight (kg)	692	54.00 (37.00–80.00), 55.61±9.39	254	53.00 (38.00–80.00), 54.13±8.48	438	54.00 (37.00–80.00), 55.86±9.52	0.182
Body mass index (kg/m ²)	692	20.20 (16.65–32.05), 20.60±2.12	254	19.95 (17.59–29.74), 20.30±2.02	438	20.32 (16.65–32.05), 20.66±2.14	0.186
History of surgery	692	43 (6.2)	254	25 (9.8)	438	18 (4.1)	0.003
History of gastrointestinal diseases	692	99 (14.3)	254	60 (23.6)	438	39 (8.9)	<0.001
History of smoking	692	8 (1.2)	254	5 (2.0)	438	3 (0.7)	0.151
History of drinking alcohol	692	21 (9.4)	254	9 (3.5)	438	12 (2.7)	0.553
History of drinking tea	692	83 (9.4)	254	37 (14.6)	438	46 (10.5)	0.113
History of drinking coffee	692	40 (5.8)	254	22 (8.7)	438	18 (4.1)	0.013
History of eating spicy food	692	367 (53.0)	254	163 (64.2)	438	204 (46.6)	<0.001
History of irregular diet	692	293 (56.7)	254	143 (56.3)	438	150 (34.2)	<0.001
History of eating out frequently	692	171 (24.7)	254	90 (35.4)	438	81 (18.5)	<0.001
History of drinking raw water	692	349 (50.4)	254	131 (51.6)	438	218 (49.8)	0.647
History of sharing drinking glasses	692	64 (9.2)	254	33 (13.0)	438	31 (7.1)	0.010
Halitosis	692	66 (9.5)	254	33 (13.0)	438	33 (7.5)	0.018
Living in the countryside	692	376 (54.3)	254	127 (50.0)	438	249 (56.8)	0.081
Number of family members	692	4.00 (2.00–9.00), 3.84±1.12	254	4.00 (2.00–9.00), 3.76±1.14	438	4.00 (2.00–9.00), 3.85±1.12	0.436
Annual family income <50,000 RMB	692	455 (65.8)	254	172 (67.7)	438	283 (64.6)	0.407
Family history of gastrointestinal diseases	692	23 (3.3)	254	15 (5.9)	438	8 (1.8)	0.004
SCL-90 score >160	692	64 (9.2)	254	50 (19.7)	438	14 (3.2)	<0.001

Data are presented as median (range), mean ± SD or frequency (percentage). SD, standard deviation; RMB, ren min bi; SCL, symptom checklist.

Table 2 Difference between recruits with and without gastrointestinal symptoms

Variables	Overall		With gastrointestinal symptoms		Without gastrointestinal symptoms		P value
	No. Pts	Median (range), mean \pm SD or frequency (percentage)	No. Pts	Median (range), mean \pm SD or frequency (percentage)	No. Pts	Median (range), mean \pm SD or frequency (percentage)	
Age (years)	310	20.00 (17.00–24.00), 19.77 \pm 1.41	48	20.00 (18.00–24.00), 19.92 \pm 1.44	262	20.00 (17.00–24.00), 19.75 \pm 1.40	0.578
Female	310	20 (6.5)	48	6 (12.5)	262	14 (5.3)	0.064
Height (m)	310	1.75 (1.60–1.96), 1.76 \pm 0.06	48	1.74 (1.60–1.91), 1.75 \pm 0.07	262	1.76 (1.60–1.96), 1.76 \pm 0.06	0.267
Weight (kg)	310	69.00 (51.00–100.00), 69.63 \pm 8.46	48	68.00 (55.00–100.00), 69.56 \pm 9.51	262	69.0 (51.00–95.00), 69.65 \pm 8.28	0.667
Body mass index (kg/m ²)	310	22.30 (17.00–29.40), 22.52 \pm 2.17	48	22.25 (18.90–27.50), 22.70 \pm 2.26	262	22.40 (17.00–29.40), 22.49 \pm 2.16	0.815
History of surgery	310	82 (26.5)	48	11 (22.9)	262	71 (27.1)	0.546
History of gastrointestinal diseases	310	14 (4.5)	48	10 (20.8)	262	4 (1.5)	<0.001
History of smoking	310	60 (19.4)	48	10 (20.8)	262	50 (19.1)	0.778
History of drinking alcohol	310	29 (9.4)	48	9 (18.8)	262	20 (7.6)	0.015
History of drinking tea	310	73 (23.5)	48	14 (29.2)	262	59 (22.5)	0.318
History of drinking coffee	310	26 (8.4)	48	8 (16.7)	262	18 (6.9)	0.024
History of eating spicy food	310	127 (41.0)	48	28 (58.3)	262	99 (37.8)	0.008
History of irregular diet	310	26 (8.4)	48	7 (14.6)	262	19 (7.3)	0.092
History of eating out frequently	310	52 (16.8)	48	18 (37.5)	262	34 (13.0)	<0.001
History of drinking raw water	310	59 (19.0)	48	15 (31.3)	262	44 (16.8)	0.019
History of sharing drinking glasses	310	9 (2.9)	48	5 (10.4)	262	4 (1.5)	0.006
Halitosis	310	15 (4.8)	48	10 (20.8)	262	5 (1.9)	<0.001
Living in the countryside	310	200 (64.5)	48	29 (60.4)	262	171 (65.3)	0.518
Number of family members	310	4.00 (1.00–8.00), 3.73 \pm 0.97	48	4.00 (2.00–8.00), 3.85 \pm 1.20	262	4.00 (1.00–7.00), 3.71 \pm 0.92	0.604
Annual family income <50,000 RMB	310	147 (47.4)	48	26 (54.2)	262	121 (46.2)	0.309
Family history of gastrointestinal diseases	310	13 (4.2)	48	6 (12.5)	262	7 (2.7)	0.002
SCL-90 score >160	310	8 (2.6)	48	5 (10.4)	262	3 (1.1)	0.003

SD, standard deviation; RMB, ren min bi; SCL, symptom checklist.

Table 3 Logistic regression analyses for risk factors of gastrointestinal symptoms in sophomores

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	P value	OR	95% CI	P value
Age (years)	2.318	0.995–5.403	0.051			
Gender (female vs. male)	0.980	0.876–1.096	0.719			
Height (m)	0.190	0.014–2.541	0.209			
Weight (kg)	0.984	0.967–1.001	0.059			
Body mass index (kg/m ²)	0.925	0.857–0.998	0.046	0.933	0.858–1.015	0.105
History of surgery (yes vs. no)	2.547	1.361–4.768	0.003	2.491	1.244–4.991	0.010
History of gastrointestinal diseases (yes vs. no)	3.164	2.042–4.904	<0.001	2.156	1.324–3.511	0.002
History of smoking (yes vs. no)	2.912	0.690–12.287	0.146			
History of drinking alcohol (yes vs. no)	1.304	0.542–3.139	0.554			
History of drinking tea (yes vs. no)	1.453	0.914–2.310	0.114			
History of drinking coffee (yes vs. no)	2.213	1.163–4.210	0.016	1.416	0.681–2.944	0.352
History of eating spicy food (yes vs. no)	2.055	1.495–2.823	<0.001	1.369	0.957–1.958	0.085
History of irregular diet (yes vs. no)	2.474	1.802–3.396	<0.001	1.750	1.232–2.486	0.002
History of eating out frequently (yes vs. no)	2.419	1.700–3.441	<0.001	1.828	1.233–2.712	0.003
History of drinking raw water (yes vs. no)	0.930	0.683–1.268	0.648			
History of sharing drinking glasses	1.960	1.169–3.287	0.011	1.971	1.120–3.468	0.019
Halitosis (yes vs. no)	1.833	1.101–3.051	0.020	1.258	0.705–2.244	0.437
Living in the countryside (yes vs. no)	0.759	0.557–1.035	0.082			
Number of family members	1.063	0.927–1.219	0.384			
Annual family income <50,000 RMB (yes vs. no)	1.149	0.828–1.595	0.407			
Family history of gastrointestinal diseases (yes vs. no)	3.373	1.410–8.072	0.006	1.631	0.602–4.418	0.336
SCL-90 score >160 (yes vs. no)	7.423	4.010–13.74	<0.001	5.467	2.855–10.470	<0.001

OR, odds ratio; CI, confidence interval; RMB, ren min bi; SCL, symptom checklist.

Various types of gastrointestinal symptoms among participants with a total SCL-90 score beyond and less than or equal to 160

In the sophomore population, the prevalence of nausea, emesis, abdominal pain, acid regurgitation, eructation, heartburn, anorexia, abdominal bloating, diarrhea, constipation, and hematochezia was significantly higher in the group with a total SCL-90 score beyond 160 than in the group with a total SCL-90 score less than or equal to 160.

In the recruit population, the prevalence of abdominal pain, anorexia, abdominal bloating, constipation, and hematochezia was significantly higher in the group with a total SCL-90 score beyond 160 than in the group with a

total SCL-90 score less than or equal to 160 (Table 6).

Discussion

A major finding of our study was that the prevalence of gastrointestinal symptoms in youths was high, and the prevalence of gastrointestinal symptoms was lower in the recruits than those in the sophomores (15.5% vs. 36.7%). Several potential explanations are made for this phenomenon. Firstly, gastrointestinal symptoms are gender-specific. Females have a higher prevalence of gastrointestinal symptoms (22), probably because estrogens directly affect the intestinal microbes and immune cells (23),

Table 4 Logistic regression analyses for risk factors of gastrointestinal symptoms in recruits

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	P value	OR	95% CI	P value
Age (years)	1.088	0.877–1.350	0.445			
Gender (female vs. male)	2.531	0.921–6.953	0.072			
Height (m)	0.082	0.001–10.530	0.312			
Weight (kg)	0.999	0.963–1.036	0.941			
Body mass index (kg/m ²)	1.044	0.907–1.202	0.551			
History of surgery (yes vs. no)	0.800	0.387–1.653	0.546			
History of gastrointestinal diseases (yes vs. no)	16.947	5.069–58.836	<0.001	15.945	4.204–60.475	<0.001
History of smoking (yes vs. no)	1.116	0.521–2.390	0.778			
History of drinking alcohol (yes vs. no)	2.792	1.186–6.574	0.019	0.799	0.231–2.764	0.723
History of drinking tea (yes vs. no)	1.417	0.713–2.815	0.320			
History of drinking coffee (yes vs. no)	2.711	1.105–6.651	0.029	2.267	0.749–6.862	0.147
History of eating spicy food (yes vs. no)	2.305	1.233–4.310	0.009	1.441	0.664–3.126	0.356
History of irregular diet (yes vs. no)	2.184	0.864–5.521	0.099			
History of eating out frequently (yes vs. no)	4.024	2.025–7.994	<0.001	2.897	1.207–6.954	0.017
History of drinking raw water (yes vs. no)	2.252	1.128–4.494	0.021	1.478	0.615–3.550	0.382
History of sharing drinking glasses	7.500	1.937–29.042	0.004	3.016	0.471–19.339	0.244
Halitosis (yes vs. no)	13.526	4.386–41.717	<0.001	18.962	5.376–66.881	<0.001
Living in the countryside (yes vs. no)	0.812	0.432–1.528	0.519			
Number of family members	1.161	0.853–1.581	0.342			
Annual family income <50,000 RMB (yes vs. no)	1.377	0.743–2.544	0.310			
Family history of gastrointestinal diseases (yes vs. no)	5.204	1.667–16.243	0.005	3.403	0.651–17.791	0.147
SCL-90 score >160 (yes vs. no)	10.039	2.314–43.543	0.002	6.734	1.226–36.999	0.028

OR, odds ratio; CI, confidence interval; RMB, ren min bi; SCL, symptom checklist.

and the menstrual cycle affects gastrointestinal transit duration (24), then leading to gastrointestinal symptoms. In our study, the sophomore population had a predominance of females. Secondly, the daily management of the sophomores is less strict than that of recruits, so they may have more unhealthy lifestyles that lead to the occurrence of gastrointestinal symptoms. Thirdly, the recruits should meet strict criteria for conscription of the troops, and those with poor physical fitness will be eliminated (25).

The prevalence of sophomores who experienced gastrointestinal symptoms was lower in our study than in previous studies. It was 36.7% in our sophomore population, but 51.2% in 127 university students of Canada (26),

64.2% in 668 university students of Switzerland (27), and 65% in 715 university students of Korea (28). Such a difference may be related to the heterogeneity in regions, ethnicities, living conditions, and sample size among studies. Similarly, the prevalence of gastrointestinal symptoms was lower in our recruit population than in fighting forces previously reported. It was 15.5% in our recruit population, but 25% in veterans from the United States who participated in the Persian Gulf War (29). Gastrointestinal symptoms in recruits may be related to an increase in segmental gastrointestinal permeability during combat training (30). Military soldiers aged 17 to 25 years old need to go through numerous high-intensity training,

Table 5 Various types of psychological problems between participants with and without gastrointestinal symptoms

Variables	Overall		With gastrointestinal symptoms		Without gastrointestinal symptoms		P value
	No. Pts	Frequency (percentage)	No. Pts	Frequency (percentage)	No. Pts	Frequency (percentage)	
Sophomores							
Somatization	692	4 (0.6)	254	3 (1.2)	438	1 (0.2)	0.143
Obsessive-compulsive	692	11 (1.6)	254	11 (4.3)	438	0 (0.0)	<0.001
Interpersonal sensitivity	692	6 (0.9)	254	6 (2.4)	438	0 (0.0)	0.002
Depression	692	14 (2.0)	254	14 (5.5)	438	0 (0.0)	<0.001
Anxiety	692	8 (1.2)	254	8 (3.1)	438	0 (0.0)	<0.001
Hostility	692	6 (0.9)	254	6 (2.4)	438	0 (0.0)	0.002
Phobic anxiety	692	2 (0.3)	254	2 (0.8)	438	0 (0.0)	0.134
Paranoid ideation	692	2 (0.3)	254	2 (0.8)	438	0 (0.0)	0.134
Psychoticism	692	1 (0.1)	254	1 (0.4)	438	0 (0.0)	0.367
Recruits							
Somatization	310	2 (0.6)	48	2 (4.2)	262	0 (0.0)	0.024
Obsessive-compulsive	310	2 (0.6)	48	2 (4.2)	262	0 (0.0)	0.024
Interpersonal sensitivity	310	2 (0.6)	48	1 (2.1)	262	1 (0.4)	0.286
Depression	310	2 (0.6)	48	2 (4.2)	262	0 (0.0)	0.024
Anxiety	310	1 (0.3)	48	1 (2.1)	262	0 (0.0)	0.155
Hostility	310	0 (0.0)	48	0 (0.0)	262	0 (0.0)	NA
Phobic anxiety	310	0 (0.0)	48	0 (0.0)	262	0 (0.0)	NA
Paranoid ideation	310	0 (0.0)	48	0 (0.0)	262	0 (0.0)	NA
Psychoticism	310	0 (0.0)	48	0 (0.0)	262	0 (0.0)	NA

NA, not available.

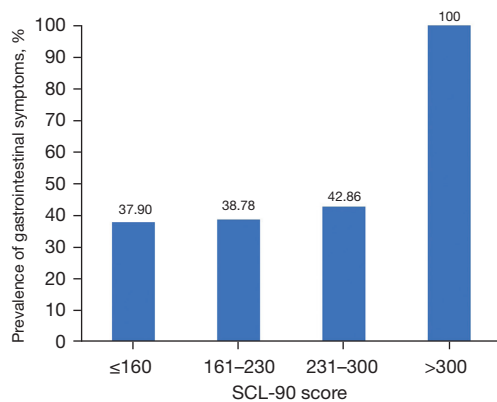


Figure 2 Prevalence of gastrointestinal symptoms according to the total SCL-90 score. SCL-90, symptom checklist 90.

and have a higher prevalence of *Helicobacter pylori* infection than civilians of the same age (31), which may cause gastrointestinal symptoms (32).

Another finding of our study was that the total SCL-90 score beyond 160 was independently associated with gastrointestinal symptoms in both sophomore and recruit populations. Such an association between gastrointestinal symptoms and psychological problems should be mainly attributed to the brain-gut axis (33), which functions via three major pathways. Firstly, psychological problems activate the Hypothalamic-Pituitary-Adrenal (HPA) axis, increasing the levels of glucocorticoid and gastrin, thereby leading to endocrine and gastrointestinal dysfunction (34). On the other hand, abdominal pain leads to anxiety- and

Table 6 Various types of gastrointestinal symptoms between participants with a total SCL-90 score beyond 160 and those with a total SCL-90 score less than or equal to 160

Variables	Overall		SCL-90 score >160		SCL-90 score ≤160		P value
	No. Pts	Frequency (percentage)	No. Pts	Frequency (percentage)	No. Pts	Frequency (percentage)	
Sophomores							
Nausea	692	56 (8.1)	64	19 (29.7)	628	37 (5.9)	<0.001
Emesis	692	10 (1.4)	64	4 (6.2)	628	6 (1.0)	0.009
Abdominal pain	692	55 (7.9)	64	20 (31.2)	628	35 (5.6)	<0.001
Acid regurgitation	692	34 (4.9)	64	13 (20.3)	628	21 (3.3)	<0.001
Eructation	692	121 (17.5)	64	26 (40.6)	628	95 (15.1)	<0.001
Heartburn	692	27 (3.9)	64	12 (18.8)	628	15 (2.4)	<0.001
Anorexia	692	77 (11.1)	64	25 (39.1)	628	52 (8.3)	<0.001
Abdominal bloating	692	74 (10.7)	64	25 (39.1)	628	49 (7.8)	<0.001
Diarrhea	692	41 (5.9)	64	14 (21.9)	628	27 (4.3)	<0.001
Constipation	692	80 (11.6)	64	15 (23.4)	628	65 (10.4)	0.002
Hematemesis	692	1 (0.1)	64	1 (1.6)	628	0 (0.0)	0.092
Hematochezia	692	13 (1.9)	64	4 (6.2)	628	9 (1.4)	0.025
Recruits							
Nausea	310	17 (5.5)	8	2 (25.0)	302	15 (5.0)	0.065
Emesis	310	6 (1.9)	8	1 (12.5)	302	5 (1.7)	0.146
Abdominal pain	310	12 (3.9)	8	2 (25.0)	302	10 (3.3)	0.034
Acid regurgitation	310	4 (1.3)	8	0 (0.0)	302	4 (1.3)	1.000
Eructation	310	1 (0.3)	8	0 (0.0)	302	1 (0.3)	1.000
Heartburn	310	2 (0.6)	8	0 (0.0)	302	2 (0.7)	1.000
Anorexia	310	4 (1.3)	8	2 (25.0)	302	2 (0.7)	0.003
Abdominal bloating	310	9 (2.9)	8	3 (37.5)	302	6 (2.0)	0.001
Diarrhea	310	6 (1.9)	8	0 (0.0)	302	6 (2.0)	1.000
Constipation	310	10 (3.2)	8	2 (25.0)	302	8 (2.6)	0.024
Hematemesis	310	0 (0.0)	8	0 (0.0)	302	0 (0.0)	NA
Hematochezia	310	8 (2.6)	8	2 (25.0)	302	6 (2.0)	0.015

SCL, symptom checklist; NA, not available.

depression-like behaviors via the HPA axis (35). Secondly, when people have psychological problems, the balance between the limbic system and the hypothalamus is broken, which affects the vagal tone and decreases the circular muscle contractility, thereby delaying gastric emptying (36). On the other hand, when people have gastrointestinal symptoms, the vagus nerve transmits

signals from the gastrointestinal tract to the central nervous system to regulate cognition and affect emotion (37). Thirdly, the central nervous system indirectly regulates the composition and function of intestinal microbes by releasing cytokines and antimicrobial peptides (38). On the other hand, the imbalance of intestinal flora will cause the dysfunction of bacteria in the brain-gut axis, decreasing

5-hydroxytryptamine content in the hippocampus and brain-derived neurotrophic factor mRNA expression, which will cause psychological problems (39).

Our study also found that depression and anxiety are the most common psychological problems in youths according to the psychological scale. Some previous studies explored the correlation between gastrointestinal symptoms and psychological problems. Both studies by Ballou *et al.* (40) and Lu *et al.* (41) demonstrated a close association of depression with diarrhea. Both studies by Cunningham *et al.* (42) and Aggarwal Dutta *et al.* (43) suggested a correlation between anxiety and functional abdominal pain. Additionally, depression and anxiety might be associated with severe nausea and vomiting (44) and functional constipation (45) (Table S2). Some psychological interventions, such as music therapy, are promising to improve psychological health and are helpful for preventing and treating psychological problems in youths (46), thereby improving gastrointestinal symptoms.

Our study had some limitations. Firstly, the study was performed based on a questionnaire survey without any objective evaluation. Participants' response to the questionnaire survey was potentially unreliable. Secondly, existing and validated questionnaires, such as the GI-PROMIS scales (5), could not fully cover what we want to know or address the specific objectives of our study, so the present questionnaires had to be specially designed in our study. We should acknowledge that its credibility and validity are not sufficient. Thirdly, diet, such as vitamin D (47), may influence both mood and gastrointestinal symptoms. But dietary questions had not been specified in our questionnaire yet. Fourthly, the population characteristics, especially living environments and gender, were very different between the two independent cohorts of youths. However, the findings from the two cohorts were very similar, providing more solid evidence for supporting the association of gastrointestinal symptoms with psychological problems in youths. Fifthly, some questions regarding personal habits and lifestyles are often subjective and a bit ambiguous. Timeframe or frequency of irregular diet, eating out, or sharing drinking glasses had not been specified in our questionnaire yet.

Conclusions

Based on the current findings, gastrointestinal symptoms may be common in youths and are strongly associated with psychological problems. In the future, prospective cohort

studies are necessary to observe whether psychological problems are potential causes of gastrointestinal symptoms and explore whether the improvement of psychological problems can alleviate gastrointestinal symptoms.

Acknowledgments

We thank all the participants who have participated in this study.

Funding: None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at <https://apm.amegroups.com/article/view/10.21037/apm-22-1316/rc>

Data Sharing Statement: Available at <https://apm.amegroups.com/article/view/10.21037/apm-22-1316/dss>

Peer Review File: Available at <https://apm.amegroups.com/article/view/10.21037/apm-22-1316/prf>

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://apm.amegroups.com/article/view/10.21037/apm-22-1316/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study protocol was approved by the Medical Ethical Committee of the General Hospital of Northern Theater Command with an approval number [Y (2021) 099]. The study was performed according to the Declaration of Helsinki (as revised in 2013). All participants gave verbal informed consent to participate in the study, and the ethics committee of the hospital exempted the written informed consents due to the retrospective nature of this study.

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Cite this article as: Liu T, Liu J, Wang C, Zou D, Wang C, Xu T, Ci Y, Guo X, Qi X. Prevalence of gastrointestinal symptoms and their association with psychological problems in youths. *Ann Palliat Med* 2023;12(2):311-323. doi: 10.21037/apm-22-1316

Table S1 Difference between sophomore and recruit groups

Variables	Overall		Sophomore group		Recruit group		P value
	No. Pts	Median (range), Mean \pm SD or frequency (percentage)	No. Pts	Median (range), Mean \pm SD or frequency (percentage)	No. Pts	Median (range), Mean \pm SD or frequency (percentage)	
Age (years)	1002	20.00 (16.00–25.00), 19.96 \pm 1.39	692	20.00 (16.00–25.00), 20.04 \pm 1.38	310	20.00 (17.00–24.00), 19.77 \pm 1.41	<0.001
Female (%)	1002	678 (67.7%)	692	658 (95.1%)	310	20 (6.5%)	<0.001
Height (m)	1002	1.66 (1.45–1.96), 1.67 \pm 0.08	692	1.63 (1.45–1.85), 1.64 \pm 0.06	310	1.75 (1.60–1.96), 1.76 \pm 0.06	<0.001
Weight (kg)	1002	60.00 (37.00–100.00), 59.95 \pm 11.18	692	54.00 (37.00–80.00), 55.61 \pm 9.39	310	69.00 (51.00–100.00), 69.63 \pm 8.46	<0.001
Body mass index (kg/m ²)	1002	20.94 (16.65–32.05), 21.20 \pm 2.31	692	20.20(16.65–32.05), 20.60 \pm 2.12	310	22.30 (17.00–29.40), 22.52 \pm 2.17	<0.001
History of surgery (%)	1002	125 (12.5%)	692	43 (6.2%)	310	82 (26.5%)	<0.001
History of gastrointestinal diseases (%)	1002	113 (11.3%)	692	99 (14.3%)	310	14 (4.5%)	<0.001
History of smoking (%)	1002	68 (6.8%)	692	8 (1.2%)	310	60 (19.4%)	<0.001
History of drinking alcohol (%)	1002	50 (5.0%)	692	21 (9.4%)	310	29 (9.4%)	<0.001
History of drinking tea (%)	1002	156 (15.6%)	692	83 (9.4%)	310	73 (23.5%)	<0.001
History of drinking coffee (%)	1002	66 (6.6%)	692	40 (5.8%)	310	26 (8.4%)	0.131
History of eating spicy food (%)	1002	494 (49.3%)	692	367 (53.0%)	310	127 (41.0%)	<0.001
History of irregular diet (%)	1002	319 (31.8%)	692	293 (56.7%)	310	26 (8.4%)	<0.001
History of eating out frequently (%)	1002	223 (22.3%)	692	171 (24.7%)	310	52 (16.8%)	0.005
History of drinking raw water (%)	1002	408 (40.7%)	692	349 (50.4%)	310	59 (19.0%)	<0.001
History of sharing drinking glasses (%)	1002	73 (7.3%)	692	64 (9.2%)	310	9 (2.9%)	<0.001
Halitosis (%)	1002	81 (8.1%)	692	66 (9.5%)	310	15 (4.8%)	0.012
Living in the countryside (%)	1002	426 (42.5%)	692	376 (54.3%)	310	200 (64.5%)	0.003
Number of family members	1002	4.00 (1.00–9.00), 3.81 \pm 1.08	692	4.00 (2.00–9.00), 3.84 \pm 1.12	310	4.00 (1.00–8.00), 3.73 \pm 0.97	0.470
Annual family income <50,000 RMB (%)	1002	602 (60.1%)	692	455 (65.8%)	310	147 (47.4%)	<0.001
Family history of gastrointestinal diseases (%)	1002	36 (3.6%)	692	23 (3.3%)	310	13 (4.2%)	0.470
SCL-90 score >160 (%)	1002	72 (7.2%)	692	64 (9.2%)	310	8 (2.6%)	<0.001
Gastrointestinal symptoms (%)	1002	302 (30.1%)	692	254 (36.7%)	310	48 (15.5%)	<0.001

SD, standard deviation; RMB, ren min bi; SCL, symptom checklist.

Table S2 Characteristics of included studies

First author (year)	Country	Study design	Number of patients	Type of gastrointestinal symptoms	Type of psychological problems
Aggarwal Dutta(43) (2021)	USA	Cross-sectional	110	Abdominal pain	Anxiety
Liu(45) (2021)	China	Case-control	337	Functional constipation	Depression and anxiety
Lu(41) (2020)	China	Cross-sectional	410	Diarrhea	Depression
Ballou(40) (2019)	USA	Cohort	5160	Chronic diarrhea and constipation	Depression
Beyazit(44) (2018)	USA	Case-control	166	Nausea and vomiting	Depression and anxiety
Cunningham(42) (2015)	USA	Cross-sectional	100	Abdominal pain	Anxiety