**Name of journal: World Journal of Gastroenterology**

**ESPS Manuscript NO: 10518**

**Columns:**  **OBSERVATIONAL STUDY**

**Functional gastrointestinal disorders in eating disorder patients: Altered distribution and predictors using ROME III compared to ROME II criteria**

Wang X *et al.* Functional gastrointestinal disorders in eating disorder patients

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**Received:** April 4, 2014 **Revised:** May 20, 2014

**Accepted:** June 21, 2014

**Published online:**

**Abstract**

**AIM**: To compare the prevalence of Functional gastrointestinal disorders (FGIDs) using ROME III and ROME II and to describe predictors of FGIDs among ED patients.

**METHODS**: Two similar cohorts of female ED inpatients, aged 17-50 years, with no organic gastrointestinal or systemic disorders, completed either the ROME III (*n =* 100) or the ROME II (*n =* 160) questionnaire on admission for ED treatment. The two ROME cohorts were compared on continuous demographic variables (*e.g.,* age, BMI) using Student’s *t*-tests, and on categorical variables (*e.g.,* ED diagnosis) using *χ*2-tests. The relationship between ED diagnostic subtypes and FGID categories was explored using *χ*2-tests. Age, BMI, and psychological and behavioural predictors of the common (prevalence greater than 20%) ROME III FGIDs were tested using logistic regression analyses.

**RESULTS**: The criteria for at least one FGID were fulfilled by 83% of the ROME III cohort, and 94% of the ROME II cohort. There were no significant differences in age, BMI, lowest ever BMI, ED diagnostic subtypes or ED-related quality of life (QOL) scores between ROME II and ROME III cohorts. The most prevalent FGIDs using ROME III were postprandial distress syndrome (PDS) (45%) and irritable bowel syndrome (IBS) (41%), followed by unspecified functional bowel disorders (U-FBD) (24%), and functional heartburn (FH) (22%). There was a 29% or 46% increase (depending on presence or absence of cyclic vomiting) in functional gastroduodenal disorders because of the introduction of PDS in ROME III compared to ROME II. There was a 35% decrease in functional bowel disorders (FBD) in Rome III (excluding U-FBD) compared to ROME II. The most significant predictor of PDS was starvation (*P =* 0.008). The predictor of FH (*P =* 0.021) and U-FBD (*P =* 0.007) was somatisation, and of IBS laxative use (*P =* 0.025). Age and BMI were not significant predictors. The addition of the 6-months duration of symptoms requirement for a diagnosis in ROME III added precision to many FGIDs.

**CONCLUSION**: ROME III confers higher precision in diagnosing FGIDs but self-induced vomiting should be excluded from the diagnosis of cyclic vomiting. Psychological factors appear to be more influential in ROME II than ROME III.

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**Key words:** Anorexia nervosa; Bulimia nervosa; Eating disorders; Gastrointestinal diseases; Irritable bowel syndrome

**Core tip:** We compared the prevalence, behavioural and psychological predictors of functional gastrointestinal disorders using ROME III and ROME II questionnaires in two similar cohorts of eating disorder patients. We found the added timeframe requirement in ROME III added precision in diagnosing many Functional gastrointestinal disorders (FGIDs). We also found certain FGIDs in ROME III are predicted by eating behaviours and appear to have less psychological input compared to ROME II. These findings suggest that abnormal eating behaviours may play a more direct role in the disturbed physiology (both sensation and motility) of the gastrointestinal tract and hence the pathogenesis of certain FGIDs.

Wang X, Luscombe GM, Boyd C, Kellow J, Abraham S. Functional gastrointestinal disorders in eating disorder patients: Altered distribution and predictors using ROME III compared to ROME II criteria. *World J Gastroenterol* 2014; In press

**INTRODUCTION**

Functional gastrointestinal disorders (FGIDs) are prevalent and affected individuals have poorer quality of life[1-5]. These disorders are different from other GI disorders because structural abnormalities are subtle or cannot be demonstrated by formal investigation. Therefore the diagnosis of FGIDs has mainly relied on the use of self-report questionnaires[6,7]. With increasing interest and understanding in these disorders, various questionnaires have been designed and revised over the years to best reflect their true prevalence[6,7].

The main types of eating disorders include anorexia nervosa (restricting type AN-R or binge purge type AN-P), bulimia nervosa (BN) and eating disorders not otherwise specified (restricting type EDNOS-R or binge purge type EDNOS-P). Abnormal eating disorder related behaviours include restriction of food intake, binge eating, purging and excessive exercise[8]. Eating disorder (ED) patients frequently report GI symptoms including bloating, nausea, epigastric discomfort, and a sensation of fullness. These symptoms may not only lead to unnecessary diagnostic tests but more importantly the refusal of food intake and justification for continuing their disordered eating. We have previously studied the prevalence and characteristics of FGIDs using ROME II and found that patients with eating disorders exhibited a broad spectrum of different FGIDs[9]. Furthermore, we have observed a relationship between pelvic floor dysfunction and abdominal bloating and distension in ED patients[10].

ROME III adult diagnostic criteria for FGIDs were published in 2006 and preserved the majority of the diagnoses previously found in ROME II while significant changes were made in the gastroduodenal disorders group[6,7]. Functional dyspepsia has two new subdivisions in the ROME III diagnostic criteria: postprandial distress syndrome (PDS) and epigastric pain syndrome (EPS)[6]. There is a more detailed classification of vomiting syndromes including exclusion of DSM-IV diagnosed ED patients from functional vomiting, but not cyclic vomiting syndrome. In addition, rumination syndrome is now categorised as a functional gastroduodenal disorder whereas previously it was classified as a functional eosophageal disorder. There is also a more detailed classification of the functional biliary tract and sphincter disorders. The most significant change to the Rome III classification is an additional requirement of chronicity for a diagnosis, that is, the symptoms must be present for the last 3 months, with symptom onset at least 6 months prior to diagnosis. In contrast, using ROME II, symptoms present during 12 weeks (3 months, which may not necessarily be consecutive) in the previous year would fulfil the diagnostic criteria.

Since publication of the ROME III criteria, research has focused on one or a few FGIDs[11-14]. No study has described all of the FGIDs by ROME III in a single publication, especially in the context of eating disorders. Only few papers have described individual FGIDs using ROME III in patients with EDs[15].

The aims of the study were 1. to describe the prevalence and psychological and behavioural predictors of FGIDs among eating disorder patients using ROME III criteria and 2. to compare their prevalence with FGIDs in a similar group of ED patients using ROME II criteria. We were also interested in the prevalence of FGID categories and individual FGIDs with and without the 6-month requirement of ROME III to determine if this was a factor in any altered prevalence of FGIDs.

**MATERIALS AND METHODS**

***Subjects***

One hundred consecutive female inpatients in a specialized Eating Disorder Unit for treatment of their ED in 2011-2012, aged 17-50 years, with no major medical (celiac disease, endometriosis, diabetes) or major psychiatric illness (bipolar depression) were included in the study. A second cohort of 160 consecutive eating disorder patients who completed the ROME II during inpatient treatment in the same unit for previous studies[9,16] were also included in this study. On admission, all patients were asked to complete psychological and eating disorder related questionnaires, and the ROME III symptom questionnaire (details below). All patients also underwent routine clinical evaluation including blood tests (haematology, biochemistry, thyroid function) and specific investigations to exclude organic gastrointestinal disease where appropriate.

Ethics approval was granted by the Human Ethics Committee of the Northside Clinic.

***Questionnaires***

The self-reported questionnaires comprised the following: (1) the ROME modular questionnaire[6,7] for gastrointestinal symptoms; (2) psychological questionnaires, namely the Eysenck Neuroticism Scale, from the Eysenck Personality Questionnaire[17], the Beck Depression Inventory[18], the State-Trait Anxiety Inventory[19] and the somatisation subscale from the Brief Symptom Inventory[20];and (3) specific eating disorder questionnaires, namely the Eating and Exercise Examination (EEE)[21,22], an efficient, self-report, and computer-reported standardized examination of eating and exercise behaviours, attitudes and feelings. The EEE includes the QOL related to eating disorders (QOL ED)[23,24], and the Eating Attitudes Test (EAT)[25], a 40-itemmeasure of overall eating disorder pathology. The eating disorder behaviours were: self-induced vomiting, laxative use, binge eating (episodes of overeating felt to be out of control), starvation (eight waking hours per day without eating), and exercise, measured as average days per month for the previous 3 mo.

The specific categories of predictors of FGIDs were (1) psychological characteristics, *i.e.,* somatisation, neuroticism, state and trait anxiety, depression, EAT score; (2) eating disordered behaviours (average in previous 3 mo) including food restriction, exercise, starvation (more than 8 waking hours without eating), binge eating (eating 5 or more standard servings of food in one episode, associated with a feeling of being out of control), laxative use, self-induced vomiting; and (3) demographic characteristics including age, current BMI and lowest ever BMI.

***Statistical analysis***

The two ROME cohorts were compared on continuous demographic variables (*e.g.,* age, BMI) using Student’s *t*-tests, and on categorical variables (*e.g.,* ED diagnosis) using *χ*2-tests. The relationship between ED diagnostic subtypes (AN-R, AN-P, EDNOS-R, and EDNOS-P and BN combined) and FGID categories was also explored using *χ*2-tests.

Age, BMI, and psychological and behavioural predictors of the presence or absence of the common (prevalence greater than 20%) ROME III FGIDs and the presence of more than three FGID diagnoses were tested using logistic regression analysis. The prevalence of greater than 20% was chosen in order to obtain adequate numbers for statistical analysis. Initially three logistic regressions were conducted: with age and BMI; the behavioural variables; and the psychological variables. The significant predictors from each of these analyses were entered into a final logistic regression. Alpha was set at *P <* 0.05 for all analyses. Statistical analysis was performed using IBM SPSS Statistics for Windows (Version 20.0., Armonk, NY: IBM Corp).

**RESULTS**

***Descriptive details and ED diagnoses***

The descriptive and ED diagnoses of the ROME III and ROME II cohorts are shown in Table 1. There are no significant differences between the two cohorts on any of the continuous measures or ED diagnostic subtypes (all *P* > 0.05).

***Prevalence of FGID categories***

The prevalence of FGID categories for ROME III (with and without 6-month requirement) and ROME II are shown in Table 2. For ROME III functional gastroduodenal disorders prevalences are given with and without cyclic vomiting included and functional bowel disorders with and without unspecified bowel disease. There was a significant difference between the ED diagnostic subgroups for presence of gastroduodenal disorders (*χ*2 = 9.67, *υ* = 3, *P =* 0.022) which no longer remained after cyclic vomiting was excluded (Table 3). There were no significant differences in prevalence of functional oesophageal disorders, functional bowel disorders or anorectal disorders between the four ED diagnostic subtypes.

***Prevalence of individual FGIDs***

The prevalence of individual FGIDs for ROME III (with and without the 6-month criteria) and ROME II are shown in Table 4. The following diagnoses are only applicable to the ROME II cohort and have been removed from the ROME III: Unspecified Functional Abdominal Pain (2.5%), Gallbladder Dysfunction (1.8%), Sphincter of Oddi Dysfunction (0%), Levator Ani Syndrome (5.6%), and Pelvic Floor Dyssynergia (5.6%).

***Predictors of commonly occurring FGIDs***

Only four FGIDs occurred in 20% or more of patients. The predictors of these are shown in Table 5.

**DISCUSSION**

This is the first study of all categories of FGIDs using ROME III in ED patients and the first to compare prevalence based on ROME II and ROME III criteria[12,13]. The introduction with ROME III of the requirement of presence of symptoms for at least 6 months is a key influence in the differences observed in prevalence of individual FGIDs in patients with ED.

PDS, a new FGID, was common in ED patients and the most significant predictor was starvation. This finding could be explained by the physiological repercussions of severe food restriction, such as delayed gastric emptying[26-28]. This is consistent with the recent finding of Santonicola *et al*[15], that there is a significant higher propensity for AN patients to have early satiety compared to BN patients. What occurred first cannot be determined; it could be starvation leading to impaired gastric emptying leading to PDS or it could be discomfort on eating for other reasons, including psychological, resulting in semistarvation because of fear of PDS symptoms of fullness and discomfort. Because these are eating disorder patients both could be true. PDS is also weakly predicted by depression, the greater the depressive symptoms the greater the likelihood of PDS. When starvation and depression are occurring together it is hard to ascertain, which came first, particularly among eating disorder patients as both are common.

Our data also suggests less exercise is associated with PDS. This is in keeping with our previous study that there was a worsening of oesophageal disorders in among patients undertaking excessive, intense exercise as a means of weight control[16]. The amount and intensity of exercise of eating disorder patients can be extreme[23] and could result in upper gastrointestinal problems which commonly occur in marathon runners[29]. This should not be interpreted to mean light to moderate exercise should not be undertaken, in fact the reverse is true, moderate exercise improves depression[30].

It is likely that the intermittent or long term negative energy balance in these patients results in an alteration of GI motility and that this leads to further food restriction in order to prevent resultant GI symptoms[31]. That is, the symptoms provoked by eating in the presence of dysmotility result in the reinforcement and continuation of the disordered eating.

Another key finding was that IBS was prevalent in both cohorts. IBS was only weakly predicted by laxative use (not abuse) in the ROME III cohort, whereas, in previous studies using ROME II criteria IBS was predicted by somatisation and anxiety[8]. This suggests the ROME III criteria, with the inclusion of the 6-mo criteria and the exclusion of unspecified bowel disorders (U-FBD), are more specific for the IBS symptom cluster. It is possible that laxative use may prime or condition the GI tract to IBS symptoms.

U-FBD was present in 24 percent of ROME III patients. We observed that somatisation was associated with decreased odds of U-FBD. Perhaps those who are lower on the somatisation spectrum will not report sufficient symptoms to qualify for a specific FGID, and thus become classified as U-FBD. In Boyd *et al*[8] more than three FGIDs present in ROME II was strongly predicted by neuroticism (indicative of psychopathology) whereas in the current study there were no predictors despite the presence of more than three ROME III FGIDs in 34 percent of patients. This finding again may relate to the improved precision of the criteria for FGIDs when the 6-month time stipulation is used. Fluctuations in appearance and disappearance of FGIDs in ED patients have been reported for ROME II FGID[32]. The imprecision of ROME II diagnostic clusters and the capacity to diagnose based on acute or less temporally stable symptoms, could explain the relationship between presence of multiple FGIDs and neuroticism. The precision of ROME III diagnoses and requirement for more ‘chronic’ or temporally stable symptoms would explain the loss of association with multi-morbidity and neuroticism in the ROME III sample.

FH was predicted by somatisation in both ROME II and ROME III. In ROME III there was a substantial increase in functional gastroduodenal disorders of 46%. This was reduced to 29% if cyclic vomiting was not included in the diagnosis. There was a significant difference between the ED diagnostic subgroups for presence of gastroduodenal disorders with the patients who purge (self-induce vomiting) being more likely to report gastroduodenal disorders. This difference no longer remains after cyclic vomiting was excluded. This suggests that self-induced vomiting should not be included in cyclic vomiting as it is giving an inflated and misleading prevalence of this disorder. There was also decrease in functional bowel disorders of 11%; this decrease was 35% after unspecified bowel disease was removed.

The study would have benefited by a larger cohort of patients completing the ROME III and follow-up over 12 mo to investigate the stability of the FGIDs now with the introduction of requirement of the presence of symptoms for 6 months or more. One potential weakness of the study is the reliance on self-report data. Although there were no differences between the two cohorts they were both inpatients at a specialised clinic and therefore not representative of all eating disorder patients.

Using the ROME III criteria in an ED patient sample, specific abnormal eating related behaviours such as starvation, exercise and laxative use are associated with the presence of certain FGIDs. These findings are consistent with the notion that FGIDs can arise from long term abnormal eating and the altered neuronal and hormonal physiology in the gastrointestinal tract[33,34]. Higher emotional states such as prolonged stress may predispose and then sensitise individuals to express their feelings as gut symptoms and in the long term abnormal eating reinforces the altered physiological states[35].

**CONCLUSION**

ROME III confers higher precision in diagnosing FGIDs particularly with the inclusion of the chronicity requirement of symptom onset at least 6 months prior, compared to 3 mo with ROME II. It would be improved if self-induced vomiting was excluded from cyclic vomiting syndrome in addition to its exclusion from functional vomiting. Two of the new ROME III criteria, PDS and U-FBD, are prevalent among ED patients. Starvation, less exercise and depression predicted PDS, and somatisation U-FBD. As found previously for ROME II laxative use predicted IBS and somatisation FH[9,16]. ROME III appears to have less psychological input to the diagnosis of FGIDs than ROME II.

**COMMENTS**

***Background***

Functional gastrointestinal disorders are a group of conditions that represent altered sensation, motility and function of the gastrointestinal system. The pathogenesis of functional gastrointestinal disorders (FGIDs) is not fully elucidated and their diagnosis relies heavily on exclusion of organic causes and carefully designed self-report questionnaires. Gastrointestinal symptoms are common in patients with eating disorders and represent adversities during the treatment and outcome.

***Research frontiers***

Since the publication of ROME III diagnostic criteria for adult FGIDs, research has focused on its utility and application and most of the publications focused on one or two types of FGIDs. Systematic examination and characterisation of all FGIDs using ROME III criteria have not been conducted in patients with eating disorders. In this publication, the authors studied and characterised the prevalence and certain characteristics of FGIDs in a group of patients with eating disorders.

***Innovations and breakthroughs***

This is the first report to examine all types of FGIDs in the eating disorder population and authors have found that compared to ROME II, the new ROME III results in higher precision in the diagnosis of FGIDs. Interestingly, certain FGIDs in ROME III appear to have more input from altered eating behaviours than psychological factors compared to the ROME II counterparts.

***Applications***

The authors findings suggest altered gut physiology as a more important factor in the pathogenesis of FGIDs and research in eating disorder patients offers a unique niche to the understanding of altered gut physiology and its interaction with psychological factors.

***Terminology***

Eating disorders are a group of diagnoses that are characterised by abnormal eating behaviours and associated psychological and physiological changes. Anorexia nervosa, bulimia nervosa and eating disorders not otherwise specified are subtypes of eating disorders. Functional oesophageal, gastroduodenal, bowel, abdominal pain and anorectal disorders are subgroups of functional gastrointestinal disorders classified in ROME III diagnostic criteria.

***Peer review***

The authors compared the prevalence of various FGIDs in patients with eating disorders using ROME III to those in ROME II diagnostic criteria and demonstrated higher precision of certain diagnoses using ROME III criteria. The authors also showed certain FGIDs are associated with abnormal eating behaviours. The study offers some interesting aspect to the understanding of the pathogenesis of FGIDs.

**REFERENCES**

1 **Koloski NA**, Talley NJ, Boyce PM. Epidemiology and health care seeking in the functional GI disorders: a population-based study. *Am J Gastroenterol* 2002; **97**: 2290-2299 [PMID: 12358247 DOI: 10.1111/j.1572-0241.2002.05783.x]

2 **Thompson WG**, Irvine EJ, Pare P, Ferrazzi S, Rance L. Functional gastrointestinal disorders in Canada: first population-based survey using Rome II criteria with suggestions for improving the questionnaire. *Dig Dis Sci* 2002; **47**: 225-235 [PMID: 11837727 DOI: 10.1023/A: 1013208713670]

3 **Drossman DA**, Li Z, Andruzzi E, Temple RD, Talley NJ, Thompson WG, Whitehead WE, Janssens J, Funch-Jensen P, Corazziari E. U.S. householder survey of functional gastrointestinal disorders. Prevalence, sociodemography, and health impact. *Dig Dis Sci* 1993; **38**: 1569-1580 [PMID: 8359066 DOI: 10.1007/BF01303162]

4 **Koloski NA**, Talley NJ, Boyce PM. The impact of functional gastrointestinal disorders on quality of life. *Am J Gastroenterol* 2000; **95**: 67-71 [PMID: 10638561 DOI: 10.1111/j.1572-0241.2000.01735.x]

5 **Trivedi KH,** Schlett CD, Tribble DR, Monteville MR, Sanders JW, Riddle MS. The impact of post-infectious functional gastrointestinal disorders and symptoms on the health-related quality of life of US military personnel returning from deployment to the Middle East. *Dig Dis Sci* 2011; **56**: 3602-3609 [DOI: 10.1007/s10620-011-1766-z]

6 **Drossman DA.** Rome III: the functional gastrointestinal disorders, 3rd edn. McLean, VA: Degnon Associates, 2006.

7 **Drossman DA.** Rome II: the functional gastrointestinal disorders. 2nd ed. McLean, VA: Degnon Associates, 2000.

8 **American Psychiatric Association.** Diagnostic and statistical manual of mental disorders. 4th ed. Washington, DC, 1994.

9 **Boyd C**, Abraham S, Kellow J. Psychological features are important predictors of functional gastrointestinal disorders in patients with eating disorders. *Scand J Gastroenterol* 2005; **40**: 929-935 [PMID: 16170899 DOI: 10.1080/00365520510015836]

10 **Abraham S**, Luscombe GM, Kellow JE. Pelvic floor dysfunction predicts abdominal bloating and distension in eating disorder patients. *Scand J Gastroenterol* 2012; **47**: 625-631 [PMID: 22486766 DOI: 10.3109/00365521.2012.661762]

11 **Videlock EJ**, Chang L. Irritable bowel syndrome: current approach to symptoms, evaluation, and treatment. *Gastroenterol Clin North Am* 2007; **36**: 665-85, x [PMID: 17950443 DOI: 10.1016/j.gtc.2007.07.002]

12 **Dorn SD**, Morris CB, Hu Y, Toner BB, Diamant N, Whitehead WE, Bangdiwala SI, Drossman DA. Irritable bowel syndrome subtypes defined by Rome II and Rome III criteria are similar. *J Clin Gastroenterol* 2009; **43**: 214-220 [PMID: 19623100 DOI: 10.1097/MCG.0b013e31815bd749]

13 **Engsbro AL**, Simrén M, Bytzer P. The Rome II and Rome III criteria identify the same subtype-populations in irritable bowel syndrome: agreement depends on the method used for symptom report. *Neurogastroenterol Motil* 2012; **24**: 604-11, e266 [PMID: 22420629 DOI: 10.1111/j.1365-2982.2012.01908.x]

14 **Vakil N**, Halling K, Ohlsson L, Wernersson B. Symptom overlap between postprandial distress and epigastric pain syndromes of the Rome III dyspepsia classification. *Am J Gastroenterol* 2013; **108**: 767-774 [PMID: 23567354 DOI: 10.1038/ajg.2013.89]

15 **Santonicola A**, Siniscalchi M, Capone P, Gallotta S, Ciacci C, Iovino P. Prevalence of functional dyspepsia and its subgroups in patients with eating disorders. *World J Gastroenterol* 2012; **18**: 4379-4385 [PMID: 22969202 DOI: 10.3748/wjg.v18.i32.4379]

16 **Abraham S**, Kellow J. Exploring eating disorder quality of life and functional gastrointestinal disorders among eating disorder patients. *J Psychosom Res* 2011; **70**: 372-377 [PMID: 21414458 DOI: 10.1016/j.jpsychores.2010.11.009]

17 **Eysenck HJ,** Eysenck SBG. Manual of the Eysenck Personality Questionnaire (Junior and Adult). Kent: Seven Oaks, 1975.

18 **Beck AT**, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Arch Gen Psychiatry* 1961; **4**: 561-571 [PMID: 13688369 DOI: 10.1001/archpsyc.1961.01710120031004]

19 **Spielberger CD,** Gorsuch RL, Lushene RE. Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press, Inc, 1970.

20 **Derogatis LR**, Melisaratos N. The Brief Symptom Inventory: an introductory report. *Psychol Med* 1983; **13**: 595-605 [PMID: 6622612 DOI: 10.1017/S0033291700048017]

21 **Abraham S,** Lovell N. Eating and exercise examination: computerised. 4th ed. Melbourne: Ashwood Medical, 1999.

22 **Abraham S**, Lovell N. Research and clinical assessment of eating and exercise behaviour. *Hosp Med* 1999; **60**: 481-485 [PMID: 10605538 DOI: 10.12968/hosp.1999.60.7.1152]

23 **Abraham S.** Eating disorders, the facts. 6th ed. Oxford University Press, 2008.

24 **Abraham SF**, Brown T, Boyd C, Luscombe G, Russell J. Quality of life: eating disorders. *Aust N Z J Psychiatry* 2006; **40**: 150-155 [PMID: 16476133 DOI: 10.1111/j.1440-1614.2006.01762.x]

25 **Garner DM**, Garfinkel PE. The Eating Attitudes Test: an index of the symptoms of anorexia nervosa. *Psychol Med* 1979; **9**: 273-279 [PMID: 472072 DOI: 10.1017/S0033291700030762]

26 **Zipfel S**, Sammet I, Rapps N, Herzog W, Herpertz S, Martens U. Gastrointestinal disturbances in eating disorders: clinical and neurobiological aspects. *Auton Neurosci* 2006; **129**: 99-106 [PMID: 16962383 DOI: 10.1016/j.autneu.2006.07.023]

27 **Corvilain B**, Abramowicz M, Féry F, Schoutens A, Verlinden M, Balasse E, Horowitz M. Effect of short-term starvation on gastric emptying in humans: relationship to oral glucose tolerance. *Am J Physiol* 1995; **269**: G512-G517 [PMID: 7485502]

28 **Robinson PH**, Stephenson JS. Dietary restriction delays gastric emptying in rats. *Appetite* 1990; **14**: 193-201 [PMID: 2369115 DOI: 10.1016/0195-6663(90)90087-O]

29 **Simons SM**, Kennedy RG. Gastrointestinal problems in runners. *Curr Sports Med Rep* 2004; **3**: 112-116 [PMID: 14980141 DOI: 10.1249/00149619-200404000-00011]

30 **Cooney GM,** Dwan K, Greig CA, Lawlor DA, Rimer J, Waugh FR, McMurdo M, Mead GE. Exercise for depression. *Cochrane Database Syst Rev* 2013; CD004366 [DOI: 10.1002/14651858.CD004366.pub6]

31 **Abraham SF**, Boyd C, Luscombe G, Hart S, Russell J. When energy in does not equal energy out: disordered energy control. *Eat Behav* 2007; **8**: 350-356 [PMID: 17606232 DOI: 10.1016/j.eatbeh.2006.11.010]

32 **Boyd C**, Abraham S, Kellow J. Appearance and disappearance of functional gastrointestinal disorders in patients with eating disorders. *Neurogastroenterol Motil* 2010; **22**: 1279-1283 [PMID: 20718945 DOI: 10.1111/j.1365-2982.2010.01576.x]

33 **Baynes KC**, Dhillo WS, Bloom SR. Regulation of food intake by gastrointestinal hormones. *Curr Opin Gastroenterol* 2006; **22**: 626-631 [PMID: 17053440 DOI: 10.1097/01.mog.0000245537.43142.63]

34 **Inui A**, Asakawa A, Bowers CY, Mantovani G, Laviano A, Meguid MM, Fujimiya M. Ghrelin, appetite, and gastric motility: the emerging role of the stomach as an endocrine organ. *FASEB J* 2004; **18**: 439-456 [PMID: 15003990 DOI: 10.1096/fj.03-0641rev]

35 **Janssen P**. Can eating disorders cause functional gastrointestinal disorders? *Neurogastroenterol Motil* 2010; **22**: 1267-1269 [PMID: 21105315 DOI: 10.1111/j.1365-2982.2010.01621.x]

**P-Reviewers:** Daniel F, Hsieh CC, Sun XD **S-Editor:** Qi Y **L-Editor: E-Editor:**

**Table1** **Descriptive details and diagnoses of the ROME III and ROME II cohorts1**

|  |  |  |
| --- | --- | --- |
| **Descriptive details** | **ROME III cohort**  ***n =* 100** | **ROME II cohort**  ***n =* 160** |
|  | Mean ± SD | Mean ± SD |
| Age (yr) | 25.1 ± 7.9 | 24.7± 6.4 |
| Current BMI kg/m2 | 18.5 ± 3.8 | 18.2 ± 3.6 |
| Lowest BMI kg/m2 | 15.9 ± 2.9 | 15.7 ± 4.2 |
| QOL ED score2 | 16.0 ± 3.5 | 16.3 ± 3.2 |
| ED diagnoses | % | % |
| AN-R | 27 | 26 |
| AN-P | 20 | 20 |
| BN | 9 | 18 |
| EDNOS-R | 14 | 11 |
| EDNOS-P | 30 | 25 |

1No significant differences between cohorts for descriptive details or diagnoses; 2Range 0 to 24, > 7 indicative of the presence of an ED. AN-R: Anorexia nervosa- restricting; AN-P: Anorexia nervosa- purging; BN: Bulimia nervosa; EDNOS-R: Eating disorder not otherwise specified- restricting; EDNOS-P: Eating disorder not otherwise specified- purging.

**Table 2 Prevalence of functional gastrointestinal disorders categories for ROME III (with and without 6-mo requirement) and ROME II (with 3-mo requirement)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **ROME III cohort**  ***n =* 100** | | **ROME II cohort**  ***n =* 160** |
|  | **With**  **6-mo requirement** | **With**  **3-mo requirement** | **Present 3 mo or more** |
| Region | % | % | % |
| 1. Functional Esophageal Disorders | 34 | 55 | 40 |
| 1. Functional Gastroduodenal Disorders | 62 | 79 | 16 |
| Without cyclic vomiting | 45 | 60 |  |
| 1. Functional Bowel Disorders | 77 | 98 | 88 |
| Without unspecified bowel disease | 53 | 80 |  |
| 1. Functional Abdominal Pain Syndrome | 3 | 6 | 4 |
| 1. Functional Gallbladder and Sphincter of Oddi Disorders | 0 |  | 2 |
| 1. Functional Anorectal Disorders1 | 16 | 20 | 35 |
| Total |  |  |  |
| At least one FGID | 83 |  | 94 |
| At least 3 FGIDs | 34 |  | 36 |

1Two ROME III functional gastrointestinal disorders (FGIDs) within the functional anorectal disorder category are for 3 mo only (and F1. Functional Fecal Incontinence not included).

**Table 3 Prevalence of individual functional gastrointestinal disorders present in ROME III with and without 6-month presence requirement and the prevalence of these in ROME II**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **ROME III**  ***n =* 100** | | **ROME II**  ***n =* 160** |
|  | **With**  **6-mo requirement** | **With**  **3-morequirement** | **Present 3 mo or more** |
|  | % | % | % |
| A1. Functional Heartburn1 | 22 | 26 | 24 |
| A2. Functional Chest Pain of Presumed Esophageal Origin1 | 8 | 17 | 4 |
| A3. Functional Dysphagia1 | 6 | 16 | 9 |
| A4. Globus1 | 1 | 2 | 5 |
| B1. Functional Dyspepsia1 | 0 | 57 | 7 |
| B1a. Postprandial Distress Syndrome1 | 45 | 72 | - |
| B2a. Aerophagia1 | 14(a,b combined) | 18(a,b  combined) | 11 |
| B2b. Unspecified Excessive Belching1 | - |
| B3a. Chronic idiopathic nausea1 | 10 | 14 | - |
| B3c. Cyclic vomiting syndrome | 17 | 19 | - |
| B4. Rumination Syndrome in Adults1 | 7 | 7 | 2 |
| C1. Irritable Bowel Syndrome1 | 41 | 57 | 45 |
| C2. Functional Bloating1 | 1 | 3 | 30 |
| C3. Functional Constipation1 | 11 | 27 | 26 |
| C5. Unspecified Functional Bowel Disorder1 | 24 | 18 | - |
| F1. Functional Fecal Incontinence (3mo) | 15 | 15 | 11 |
| F2a. Chronic Proctalgia1 | 5 | 5 | - |
| F2b. Proctalgia Fugax (3 mo) | 11 | 11 | 21 |

1FGID in ROME III and ROME II; B3b. Functional vomiting1 is excluded for ED patients. Prevalences of individual FGID < 5 excluded from table, B1b: Epigastric pain syndrome1; C4: Functional diarrhea1; D: Functional abdominal pain syndrome; E: Functional gallbladder and sphincter of oddi disorders; E1: Functional gallbladder disorder; E2: Functional biliary sphincter of oddi disorder; E3: Functional pancreatic sphincter of oddi disorder; F3: Functional defecation disorders.

**Table 4** **Prevalence of functional gastrointestinal disorders categories for ROME III (with 6-mo requirement) by ED sub-types**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **ROME III Cohort** | | | | |
|  | **AN-R** | **AN-P** | **BN** | **EDNOS-R** | **EDNOS-P** |
|  | ***n =* 27**  **%** | ***n =* 20**  **%** | ***n =* 9**  **%** | ***n =* 14**  **%** | ***n =* 30**  **%** |
| 1. Functional Esophageal Disorders | 14.8 | 35.0 | 33.3 | 42.9 | 46.7 |
| 1. Functional Gastroduodenal Disorders | 44.4 | 75.0 | 88.9 | 42.9 | 70.0 |
| Without cyclic vomiting | 44.4 | 60.0 | 44.4 | 35.7 | 40.0 |
| 1. Functional Bowel Disorders | 63.0 | 85.0 | 77.8 | 85.7 | 80.0 |
| Without unspecified bowel disease | 40.7 | 65.0 | 55.6 | 50.0 | 56.7 |
| 1. Functional Abdominal Pain Syndrome | 7.4 | 5.0 | 0.0 | 0.0 | 0.0 |
| 1. Functional Anorectal Disorders1 | 7.4 | 10.0 | 11.1 | 35.7 | 20.0 |
| Total |  |  |  |  |  |
| At least one FGID | 70.4 | 95.0 | 88.9 | 85.7 | 83.3 |
| At least 3 FGIDs | 18.5 | 40.0 | 33.3 | 35.7 | 43.3 |

1Functional fecal incontinence not included. AN-R: Anorexia nervosa- restricting; AN-P: Anorexia nervosa- purging; BN: Bulimia nervosa; EDNOS-R: Eating disorder not otherwise specified- restricting; EDNOS-P: Eating disorder not otherwise specified- purging; NB: Functional gallbladder and sphincter of oddi disorders were absent for the entire sample.

**Table 5 Behavioural and psychological predictors of the commonly occurring ROME III functional gastrointestinal disorders among ED patients**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ROME III FGID** | **Predictors** | **B** | **Wald** | ***υ*** | ***P*** | **Odds Ratio** | **95%CI** | |
| A1. Functional Heartburn | Somatisation | 0.13 | 5.31 | 1 | 0.021 | 1.14 | 1.02 | 1.27 |
| B1a. Postprandial Distress Syndrome | Starvation | 0.58 | 6.99 | 1 | 0.008 | 1.79 | 1.16 | 2.76 |
|  | Exercise | -0.57 | 6.23 | 1 | 0.013 | 0.56 | 0.36 | 0.88 |
|  | Depression | 0.67 | 4.73 | 1 | 0.030 | 1.07 | 1.01 | 1.14 |
| C1. Irritable Bowel Syndrome | Laxatives | 0.46 | 5.05 | 1 | 0.025 | 1.58 | 1.06 | 2.35 |
| C5. Unspecified Functional Bowel Disorder | Somatisation | -0.19 | 7.21 | 1 | 0.007 | 0.83 | 0.73 | 0.95 |

N.B. Age, BMI: Binge eating behaviour, vomiting, depression and state and trait anxiety did not predict any common functional gastrointestinal disorders (FGIDs). There were no significant predictors of presence of three or more FGIDs.