

Research Progress on TCM Syndrome Differentiation of Functional Constipation and Application & Prospect of Factor Analysis

Liupeng Zhan¹, Yi Li^{2,*}

¹Shaanxi University of Chinese Medicine, Xianyang 712046, Shaanxi, China

²Affiliated Hospital of Shaanxi University of Chinese Medicine, Xianyang 712000, Shaanxi, China

*Correspondence Author

Abstract: *Functional Constipation (FC) is a globally prevalent functional intestinal disorder that severely impairs patients' quality of life. Modern medicine has not fully clarified its pathogenesis, with limited therapeutic effects and a high risk of drug dependence. Traditional Chinese Medicine (TCM) features holistic regulation and treatment based on syndrome differentiation for FC, yet issues such as non-standardized TCM syndrome diagnosis and inconsistent syndrome classification greatly hinder the promotion and application of TCM. As a multivariate statistical method, factor analysis can effectively reveal the internal structure of complex systems and shows great potential in the standardization and objectification of TCM syndrome research. This paper systematically reviews the research status of FC in modern medicine, the understanding of etiology and pathogenesis as well as research progress on syndrome differentiation of FC in TCM, and the application of factor analysis in TCM syndrome studies. Meanwhile, existing problems in current research and future prospects are analyzed. It aims to provide references for in-depth research on TCM syndromes of FC and promote the standardized development of TCM diagnosis and treatment for this disease.*

Keywords: Functional Constipation, TCM Syndrome, Factor Analysis, Standardization, Objectification, Research Progress.

1. Overview

Functional Constipation (FC) refers to a functional intestinal disorder complying with the Rome IV diagnostic criteria. It is characterized by difficult defecation, decreased defecation frequency (less than 3 times per week), dry and hard stools or a sense of incomplete defecation, excluding secondary constipation caused by organic intestinal lesions and diseases of other systems [1]. As a common digestive disease worldwide, the prevalence of FC keeps rising year by year, with an overall global prevalence rate of over 10%. The incidence increases sharply with age, reaching 22% among people aged over 60 [2]. Additionally, FC shows an obvious gender difference: the prevalence in females is approximately 1.32 times that in males, which may be associated with female physiological structure, hormonal fluctuations and pelvic floor muscle function [3]. Though FC is not life-threatening, long-term defecation abnormalities seriously affect patients' daily life and may trigger mental problems such as anxiety and depression.

Modern medicine holds that the onset of FC is related to multiple factors including colonic transit dysfunction, defecation disorders, abnormal nerve regulation, psychological factors and dietary and living habits, while its exact pathogenesis remains unclear [4]. At present, modern medicine mainly adopts symptomatic treatments for FC, including laxatives, gastrointestinal prokinetic agents and osmotic laxatives [5]. These drugs can only relieve symptoms temporarily, and long-term use easily leads to drug dependence, electrolyte disorders and other adverse reactions, resulting in unsatisfactory long-term efficacy [6].

In TCM, FC falls into the categories of "constipation", "difficult defecation" and "spleen constipation". TCM has accumulated abundant theoretical and clinical experience in

the diagnosis and treatment of FC. By holistically regulating visceral functions and improving intestinal conduction dysfunction, TCM presents the advantages of definite curative effect, few adverse reactions and low recurrence rate in treating FC. Clinical studies have verified that its efficacy is significantly superior to that of Western medicine alone [7]. Nevertheless, the research on TCM syndromes of FC faces multiple challenges, among which the most prominent is the lack of standardized syndrome diagnosis. Due to inconsistent research methods, strong subjectivity in syndrome judgment and the absence of quantitative indicators, syndrome classification varies greatly across different studies, making it difficult to form unified diagnostic criteria. This not only affects the efficacy evaluation of TCM for FC, but also restricts the international promotion of TCM [8].

Factor analysis, a multivariate statistical approach, can extract a small number of potential common factors from numerous observed variables to reveal the internal structural relationships between variables, realizing data dimensionality reduction and simplification. It is especially applicable to the research on multi-dimensional and complex systems such as TCM syndromes [9]. In recent years, factor analysis has been successfully applied to TCM syndrome research of various diseases including rheumatoid arthritis and liver cirrhosis, providing an effective method for the standardization and objectification of TCM syndromes [10-11]. However, the application of this method in TCM syndrome research of FC is still in the exploratory stage, lacking systematic and standardized large-sample and multi-center clinical studies. Therefore, a systematic review of the research status of FC in modern medicine, progress in TCM syndrome research and the application prospect of factor analysis is of great significance for advancing the standardization of TCM syndrome research on FC.

2. Research Progress of Functional Constipation in Modern Medicine

2.1 Definition and Diagnostic Criteria

The diagnosis of FC is mainly based on the Rome Criteria, which was first released in 1988 and revised for multiple times. The currently adopted Rome IV Criteria have become the globally recognized diagnostic standard for functional intestinal disorders [12]. According to the Rome IV Criteria, the diagnosis of FC requires meeting two or more of the following symptoms for at least 3 months (not necessarily consecutive) within the past 6 months: 1) decreased defecation frequency (less than 3 times per week); 2) dry and hard stools; 3) difficult defecation (including straining, incomplete defecation and reliance on auxiliary defecation); 4) a sense of anorectal obstruction during defecation. Meanwhile, secondary constipation caused by organic intestinal lesions (e.g., colorectal cancer, polyps, inflammatory bowel disease), endocrine and metabolic diseases (e.g., hypothyroidism, diabetes), neurological diseases (e.g., Parkinson's disease, spinal cord injury) and medications (e.g., opioids, antidepressants) must be excluded [13].

Compared with the Rome III Criteria, the Rome IV Criteria further clarify the core symptoms of FC and elaborate various manifestations of difficult defecation. The required duration of symptoms was adjusted from "at least 6 months within the past 12 months" to "at least 3 months within the past 6 months", which is more in line with clinical practice and improves diagnostic sensitivity [13]. In addition, the Rome IV Criteria classify FC into four subtypes: slow transit constipation, defecation disorder constipation, mixed constipation and normal transit constipation. Different subtypes differ in pathogenesis and treatment regimens, laying a foundation for individualized treatment [8].

2.2 Epidemiological Characteristics

Epidemiological studies show that the prevalence of FC varies across regions worldwide, which may be related to regional differences in dietary structure, living habits and race [14]. Developed countries generally have a higher prevalence: the prevalence of FC among adults is 15%–20% in the United States and 10%–15% in European countries [2]. In China, the prevalence of FC is also rising year by year. National multi-center epidemiological surveys indicate that the prevalence among Chinese adults is 8%–12%, and the rate is higher in urban populations than in rural areas. This is closely associated with insufficient dietary fiber intake, sedentary lifestyles and high life pressure among urban residents [15].

The prevalence of FC increases markedly with age. The incidence is relatively low among children and adolescents, standing at 3%–5% [16], while it reaches 22% in people over 60 years old and exceeds 30% in those over 80 [17]. The high prevalence among the elderly is mainly attributed to slowed colonic transit, declined pelvic floor muscle function, intestinal flora imbalance, inadequate intake of dietary fiber and water, as well as the impacts of chronic diseases and long-term medication [18]. Moreover, gender disparity is a notable epidemiological feature: females have a significantly higher prevalence than males, especially among young and

middle-aged groups. Possible causes include the complex structure of female pelvic floor muscles, the influence of estrogen fluctuations on intestinal peristalsis, and pelvic floor damage caused by pregnancy and childbirth [19].

2.3 Pathogenesis

2.3.1 Abnormal Colonic Transit Function

Slowed colonic transit is one of the leading pathogeneses of FC, accounting for 40%–50% of all FC cases. The main causes include weakened contractile function of colonic smooth muscle cells, abnormal secretion of intestinal neurotransmitters (e.g., decreased acetylcholine and increased norepinephrine), and insufficient production of short-chain fatty acids due to intestinal flora imbalance [20].

2.3.2 Defecation Disorders

Defecation disorders are primarily manifested as pelvic floor muscle dysfunction, which accounts for 30%–40% of FC cases. During normal defecation, pelvic floor muscles (such as puborectalis and anal sphincter) relax coordinatively to facilitate stool excretion. However, in FC patients, these muscles contract abnormally instead of relaxing, resulting in anorectal obstruction and difficult defecation.

2.3.3 Abnormal Nerve Regulation

Intestinal peristalsis and defecation are regulated jointly by the enteric nervous system, autonomic nervous system and central nervous system, forming a complex "gut-brain axis" regulatory network. Known as the "intrinsic brain" of the intestine, the enteric nervous system contains a large number of neurons and can independently regulate intestinal peristalsis, secretion and absorption. FC patients suffer from reduced neurons and abnormal release of neurotransmitters in the enteric nervous system, leading to disordered regulation of intestinal peristalsis [20]. In addition, dysfunction of the autonomic nervous system (e.g., excessive sympathetic nerve excitation) and abnormal processing of intestinal sensory signals by the central nervous system (e.g., visceral hypersensitivity) are also closely linked to the onset of FC.

2.3.4 Psychological Factors

Psychological factors play an important role in the development of FC. Negative emotions such as anxiety and depression can affect intestinal function via the gut-brain axis, resulting in slowed colonic transit and pelvic floor muscle dysfunction [21]. On the one hand, psychological stress activates the hypothalamic-pituitary-adrenal axis, increasing glucocorticoid secretion and inhibiting intestinal peristalsis. On the other hand, negative emotions interfere with the central nervous system's perception of intestinal sensory signals, amplifying patients' subjective feeling of difficult defecation and forming a vicious cycle of "constipation-anxiety-constipation".

2.3.5 Dietary and Living Habits

Insufficient intake of dietary fiber and water is a major risk factor for FC. Dietary fiber absorbs water, increases stool

volume and stimulates colonic peristalsis to promote defecation. Modern people tend to consume excessive refined grains and meat with inadequate dietary fiber intake, leading to small stool volume and insufficient stimulation for colonic peristalsis, which eventually induces constipation.

2.4 Current Status of Treatment

2.4.1 Pharmacological Treatment

Medication is the first-line treatment for FC, mainly including osmotic laxatives, stimulant laxatives, bulk-forming laxatives and gastrointestinal prokinetic agents. Osmotic laxatives (e.g., polyethylene glycol, lactulose, mannitol) form a hyperosmotic environment in the intestinal tract to absorb water, soften stools and promote defecation. With mild efficacy and few adverse reactions, they have become the preferred drugs for FC [22]. Stimulant laxatives (e.g., senna, rhubarb, bisacodyl) stimulate the intestinal mucosal nerves to accelerate intestinal peristalsis and take effect rapidly. However, long-term use easily causes drug dependence, electrolyte disorders and melanosis coli, so they are only suitable for short-term relief of severe constipation. Bulk-forming laxatives (e.g., polycarbophil calcium, bran) increase stool volume by absorbing water to stimulate peristalsis. Sufficient water intake is required during medication, otherwise intestinal obstruction may be aggravated; this type of drug is suitable for patients with insufficient dietary fiber intake. Gastrointestinal prokinetic agents (e.g., mosapride, itopride) enhance the contraction of gastrointestinal smooth muscles to accelerate gastric emptying and colonic transit, and are applicable to patients with slow transit constipation. Some patients may experience adverse reactions such as abdominal pain and diarrhea.

2.4.2 Non-pharmacological Treatment

For patients with poor response to drugs or intolerance to medication, biofeedback therapy is the preferred non-pharmacological therapy for defecation disorder constipation. With real-time feedback of the contraction and relaxation state of pelvic floor muscles via instruments, patients can learn to coordinate pelvic floor muscle movement and relieve difficult defecation. Clinical studies show that the effective rate of biofeedback therapy for defecation disorder constipation reaches 70%–80% [23]. In addition, dietary adjustment (increasing dietary fiber and water intake), lifestyle intervention (regular exercise and developing good defecation habits) and psychological intervention (cognitive behavioral therapy, anti-anxiety and anti-depression treatment) can be used as adjuvant therapies for FC. Combined use with drugs can improve the overall therapeutic effect [24].

2.4.3 Surgical Treatment

Surgical treatment is only applied to a small number of severe FC patients, specifically those with slow transit constipation who fail to respond to standardized conservative treatment. Detailed preoperative assessments including colonic transit test, pelvic floor electromyography and defecography are mandatory before surgery. Common surgical procedures include subtotal colectomy, total colectomy and ileorectal anastomosis [25]. Surgery yields satisfactory short-term

outcomes, but carries risks of postoperative complications (e.g., diarrhea, intestinal obstruction, pelvic adhesion) and long-term recurrence. Hence, surgical indications must be strictly controlled.

In general, although modern medicine has various treatments for FC, all have certain limitations and fail to solve the problem fundamentally with unsatisfactory long-term efficacy. Therefore, exploring safer and more effective therapies as well as establishing standardized diagnostic criteria have become important directions for clinical research on FC.

3. TCM Understanding and Research Status of Functional Constipation

3.1 Understanding of Etiology and Pathogenesis

TCM has a long history of understanding constipation, which can be traced back to Huangdi Neijing (Yellow Emperor's Internal Classic). Suwen·Lilan Midian Lun records that "The large intestine is the organ of conduction, transforming and excreting waste". TCM holds that the core pathogenesis of constipation is dysfunction of large intestine conduction. The normal conduction function of the large intestine relies on the coordinated function of the lung, spleen, liver, kidney and other zang-fu organs, so the onset of constipation is closely related to the dysfunction of these organs.

3.1.1 Disorder of Lung Diffusion and Descending

The lung and large intestine are interior-exterior related. The dispersing and descending functions of lung qi regulate the conduction of the large intestine. Normal lung diffusion ensures unobstructed intestinal qi; proper lung descending promotes the downward movement of intestinal waste. External contraction of wind-cold or wind-heat pathogens, or chronic cough and asthma leading to lung qi consumption will cause disorder of lung diffusion and descending, resulting in stagnated intestinal qi, impaired conduction and subsequent constipation [26]. As stated in Yizong Bidu·Intestinal Obstruction: "The lung governs descending; if the lung fails to descend, the large intestine loses its conduction function."

3.1.2 Dysfunction of Spleen Transportation and Transformation

The spleen dominates transportation and transformation, converting ingested food and water into nutrient substances and transporting waste to the large intestine. Improper diet, overstrain or chronic illness may impair spleen function. Consequently, the transportation and transformation of nutrients are disturbed and waste accumulates in the intestine. Meanwhile, dysfunction of the spleen leads to insufficient qi and blood generation, resulting in malnutrition of the intestinal tract and constipation.

3.1.3 Disorder of Liver Qi Stagnation

The liver governs qi movement, regulating qi activity of the whole body and promoting the transportation function of the spleen, stomach and large intestine. Emotional disturbance causes liver qi stagnation, which blocks intestinal qi

movement and waste excretion, namely qi constipation. As recorded in Jinkui Yi-Constipation: “Qi constipation refers to internal qi stagnation leading to retention of waste.” In addition, liver qi stagnation disturbs qi and blood circulation, causes intestinal malnutrition and further aggravates constipation [27].

3.1.4 Deficiency of Kidney Yin and Kidney Yang

The kidney regulates body fluid metabolism. Kidney yin nourishes and moistens the intestinal tract, while kidney yang warms the intestine and promotes intestinal peristalsis. Senility, chronic illness or excessive sexual activity consuming kidney yin leads to insufficient intestinal moistening and dry hard stools, namely yin deficiency constipation. Deficiency of kidney yang fails to warm the intestine, slows intestinal peristalsis and causes retention of waste, namely yang deficiency constipation. Jingyue Quanshu mentions: “Deficiency of lower-jiao yang results in inhibited yang movement, which fails to transport waste and leads to yin stagnation in the lower jiao, i.e., constipation due to yang deficiency.”

Furthermore, improper diet, external contraction of heat pathogens or chronic illness consuming body fluid may cause intestinal heat accumulation and fluid depletion, resulting in heat constipation. Chronic illness or postpartum blood loss leads to deficiency of qi and blood, malnutrition of the intestine and weakened peristalsis, triggering deficiency constipation. In conclusion, the etiology and pathogenesis of FC in TCM are complex, mostly manifested as deficiency syndrome or deficiency-excess mixed syndrome with multiple involved zang-fu organs, and the core pathogenesis is dysfunction of large intestine conduction.

3.2 Research on TCM Syndrome Differentiation

3.2.1 Research on Syndrome Elements

Syndrome elements are the basic components of TCM syndromes, including disease location elements and disease nature elements. Based on an analysis of syndrome elements from 1994 FC patients involved in 14 literatures, Ma Xinwen et al. [28] found that the predominant disease nature elements of FC were qi deficiency (22.37%), blood deficiency (21.36%), yin deficiency (16.65%) and dry-heat (16.45%), followed by qi stagnation (12.32%), yang deficiency (8.75%) and phlegm-dampness (2.10%). The main disease location elements included the large intestine (35.62%), kidney (24.31%), spleen (20.15%), liver (12.87%) and lung (7.05%). This study indicates that FC is mainly manifested as deficiency syndrome in TCM, with the primary lesion located in the large intestine, and closely associated with the kidney, spleen, liver and lung.

3.2.2 Distribution of TCM Syndromes

Due to different combinations of syndrome elements, the classification of TCM syndromes varies across studies. Based on data mining of 313 FC patients, Cai Shuyu et al. [29] identified four major syndromes: qi-yin deficiency syndrome (32.27%), spleen deficiency and qi stagnation syndrome (25.56%), liver depression and spleen deficiency syndrome

(21.72%), and spleen-kidney yang deficiency syndrome (20.45%). The study held that deficiency-excess mixed syndromes were dominant in FC, and qi-yin deficiency syndrome was the most common type.

A clinical survey of 188 FC patients conducted by Wang Ce et al. [30] showed the syndrome distribution as follows: intestinal excess-heat syndrome (29.79%), liver-kidney yin deficiency syndrome (20.74%), liver-stomach disharmony syndrome (18.62%), spleen deficiency and qi weakness syndrome (15.96%), and spleen-kidney yang deficiency syndrome (14.89%). The results are basically consistent with the above research, further proving that qi deficiency, yin deficiency, qi stagnation and dry-heat are the main disease nature elements, while the large intestine, spleen, kidney and liver are the main disease locations.

A study of 170 FC patients by Liu Yamei et al. [31] reported that intestinal qi stagnation syndrome (27.65%) ranked first, followed by qi deficiency constipation syndrome (22.35%), yin deficiency constipation syndrome (18.82%), intestinal excess-heat syndrome (15.29%), yang deficiency constipation syndrome (10.59%) and blood deficiency constipation syndrome (5.29%). This study emphasized the important role of qi stagnation in FC, showing discrepancies with other researches.

The Guiding Principles for Clinical Research of New Chinese Medicines divides FC into five syndromes: intestinal excess-heat syndrome, intestinal qi stagnation syndrome, spleen deficiency and qi weakness syndrome, spleen-kidney yang deficiency syndrome, and intestinal dryness due to yin deficiency syndrome, which is the most widely adopted classification standard in current TCM clinical research [8]. Nevertheless, many scholars adjust the classification according to personal clinical experience in practical application.

3.2.3 Analysis on Causes of Differences in Syndrome Classification

The significant differences in syndrome classification among various studies are mainly attributed to the following factors:

Inconsistent diagnostic criteria: There is no unified national standard for TCM syndrome diagnosis of FC. Different studies adopt criteria from Internal Medicine of Traditional Chinese Medicine, Guiding Principles for Clinical Research of New Chinese Medicines or self-formulated standards, leading to lack of unified basis for syndrome differentiation.

Diverse research methods: Some studies adopt traditional descriptive statistics, while others apply data mining, factor analysis and other multivariate statistical methods, resulting in divergent research outcomes.

Differences in samples and research populations: Sample size, age, gender, region and living habits of research subjects vary across studies, and these factors greatly affect the distribution of TCM syndromes of FC.

Subjectivity in syndrome judgment: TCM syndrome differentiation mainly relies on the four diagnostic methods

(inspection, listening and smelling, inquiry, palpation), lacking objective and quantitative indicators. Differences in clinicians' differentiation experience and proficiency also lead to inconsistent syndrome judgment.

3.3 Current Status of TCM Treatment

3.3.1 Oral Chinese Herbal Medicine

Oral herbal medicine is the core therapy of TCM for FC, which follows the principle of treatment based on syndrome differentiation. Corresponding prescriptions are selected according to different syndromes:

Intestinal excess-heat syndrome: The therapeutic principle is to clear heat, moisten the intestine and relax the bowels. Representative prescriptions include Maziren Pill and Runchang Pill.

Intestinal qi stagnation syndrome: The therapeutic principle is to regulate qi, relieve stagnation and relax the bowels. Representative prescriptions include Liumo Decoction and Sini Powder.

Spleen deficiency and qi weakness syndrome: The therapeutic principle is to tonify the spleen, replenish qi and relax the bowels. Representative prescriptions include Buzhong Yiqi Decoction and Shenling Baizhu Powder.

Spleen-kidney yang deficiency syndrome: The therapeutic principle is to warm yang, invigorate the spleen and relax the bowels. Representative prescriptions include Jichuan Decoction and Fuzi Lizhong Pill.

Intestinal dryness due to yin deficiency syndrome: The therapeutic principle is to nourish yin, moisten dryness and relax the bowels. Representative prescriptions include Zengye Decoction and Liuwei Dihuang Pill [32].

In recent years, many scholars have modified classical prescriptions and achieved favorable clinical efficacy. For instance, Shi Chong et al. [33] treated FC patients with qi-yin deficiency syndrome using a self-formulated qi-replenishing, yin-nourishing and intestine-moistening formula (containing Astragali Radix, Pseudostellariae Radix, Ophiopogonis Radix, Rehmanniae Radix, Scrophulariae Radix, Angelicae Sinensis Radix, Cannabis Fructus and Pruni Semen). The total effective rate reached 92.5%, significantly higher than 75.0% of the control group treated with polyethylene glycol. Chen Zhuonan et al. [34] applied a spleen-invigorating, liver-soothing and intestine-moistening formula (containing Atractylodis Macrocephalae Rhizoma, Poria, Bupleuri Radix, Aurantii Fructus Immaturus, Angelicae Sinensis Radix, Paeoniae Radix Alba, Cannabis Fructus and Armeniacae Semen) for FC patients with spleen deficiency and qi stagnation syndrome, with a total effective rate of 89.3%. This formula can obviously improve defecation frequency, stool property and defecation difficulty.

3.3.2 Acupuncture Therapy

Acupuncture regulates zang-fu organ functions and unblocks meridian qi by stimulating acupoints, so as to improve

intestinal conduction dysfunction. Commonly used acupoints include Tianshu (ST25), Zusanli (ST36), Shangjuxu (ST37), Xiajuxu (ST39), Zhigou (TE6), Taichong (LR3) and Dachangshu (BL25).

A Meta-analysis conducted by Li Hongxia et al. [35] proved that the total effective rate of acupuncture for FC was significantly higher than that of non-acupuncture therapies, and acupuncture could markedly improve defecation frequency, stool property and defecation difficulty. Lou Jing et al. [36] treated FC patients with spleen-kidney yang deficiency syndrome by combining Jichuan Decoction with warm acupuncture at Guanyuan (CV4), Qihai (CV6), Zusanli (ST36) and Dachangshu (BL25), three times a week for 4 consecutive weeks. The total effective rate was 86.7%, and the colonic transit time of patients was obviously shortened.

3.4 Progress and Problems in Standardization Research of TCM Syndromes

3.4.1 Research Progress

Current research on the standardization of TCM syndromes of FC mainly focuses on three aspects:

Formulation of syndrome diagnostic criteria: Based on literature research, clinical investigation and expert consultation, some scholars have drafted preliminary TCM syndrome diagnostic criteria for FC and clarified the diagnostic key points of each syndrome.

Development of TCM syndrome scales: To improve the objectivity and quantification of syndrome diagnosis, researchers have developed a series of TCM syndrome scales for FC, such as the TCM Syndrome Rating Scale for Functional Constipation and TCM Differentiation Scale for Constipation. These scales grade and score symptoms and physical signs, providing quantitative evidence for syndrome diagnosis.

Application of data mining technology: With the development of information technology, data mining, factor analysis, cluster analysis and other methods have been gradually applied to TCM syndrome research of FC, offering new technical means for exploring syndrome rules and promoting standardization.

3.4.2 Existing Problems

Despite certain achievements, the standardization research of TCM syndromes of FC still faces prominent problems:

Unified national diagnostic criteria are absent: No universally recognized national standard for TCM syndrome diagnosis of FC has been established. Divergent criteria adopted in different studies make it difficult to compare and integrate the results of syndrome distribution.

Strong subjectivity in syndrome judgment: TCM syndrome differentiation relies mainly on clinicians' four diagnostic methods without objective quantitative indicators, leading to inconsistent differentiation results among different physicians.

Single research methods: Most studies adopt traditional descriptive statistics, which fail to deeply explore the internal structural relationship of syndromes and reveal the essential characteristics of TCM syndromes.

Small sample size and single-center research: Most existing studies are carried out in a single center with a small sample size, lacking large-sample and multi-center clinical verification. The research results are insufficient in representativeness and reliability.

Insufficient research on the correlation between TCM syndromes and modern medical indicators: Current studies mostly focus on the distribution rules of TCM syndromes of FC, while in-depth research on the correlation between TCM syndromes and modern medical indicators is scarce, making it hard to explore the pathophysiological basis of TCM syndromes.

4. Application of Factor Analysis in TCM Syndrome Research

4.1 Principle and Advantages of Factor Analysis

Factor analysis is a multivariate statistical method designed to extract a small number of potential and unobservable common factors from numerous correlated observed variables. These common factors reflect the internal structure and essential characteristics of observed variables and realize data dimensionality reduction and simplification. The core hypothesis of factor analysis is that all observed variables can be expressed as a linear combination of common factors and unique factors. Common factors affect multiple observed variables, while unique factors only act on a single variable.

The main procedures of factor analysis are as follows:

Data preparation and suitability test: The Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity are used to judge whether the data is suitable for factor analysis. Generally, data with $KMO > 0.7$ and $P < 0.05$ in Bartlett's test is eligible.

Extraction of common factors: Principal component analysis and principal axis factoring are commonly used to extract common factors. The number of common factors is determined according to the standard of eigenvalue greater than 1 or the inflection point of the scree plot.

Factor rotation: Varimax rotation and oblique rotation are applied to rotate the extracted common factors for clearer interpretation.

Interpretation and naming of factors: Combined with professional knowledge, each common factor is interpreted and named based on the factor loading matrix (the loading coefficient threshold is usually set at 0.4).

Calculation of factor scores: Regression method or Bartlett method is adopted to calculate factor scores for subsequent statistical analysis.

The advantages of factor analysis are summarized as follows:

It can reveal the internal structure of complex systems. TCM syndromes are complex systems composed of numerous interrelated symptoms and physical signs, and factor analysis can extract core common factors reflecting the essence of syndromes.

It realizes dimensionality reduction and simplification of syndrome research, making it easier to analyze complex symptom combinations.

It improves the objectivity and quantification of TCM syndrome diagnosis by calculating factor scores to quantitatively evaluate the syndrome characteristics of each subject and reduce subjectivity.

It provides a scientific basis for the standardization of TCM syndromes, as the extracted common factors reflect the core characteristics of syndromes and support the formulation of unified diagnostic criteria.

4.2 Application Status of Factor Analysis in TCM Syndrome Research

4.2.1 Application in TCM Syndrome Research of Rheumatoid Arthritis

Rheumatoid arthritis is a common autoimmune disease, categorized as "bi syndrome" in TCM with complicated syndromes. Li Zengbian [37] conducted factor analysis on 300 patients with rheumatoid arthritis. Six common factors were extracted from symptoms and physical signs, namely cold-dampness obstruction factor, damp-heat obstruction factor, phlegm-stasis accumulation factor, qi deficiency factor, yin deficiency factor and yang deficiency factor, which were basically consistent with traditional TCM syndrome classification. The study verified that factor analysis can effectively reveal the internal structure of TCM syndromes of rheumatoid arthritis and provide a basis for the standardization of syndrome diagnosis.

5. Existing Problems and Future Prospects of Current Research

5.1 Existing Problems

Lack of unified TCM syndrome diagnostic criteria for FC: As mentioned above, the absence of nationally unified diagnostic criteria leads to inconsistent syndrome distribution results across studies, hindering efficacy evaluation and academic communication of TCM for FC.

Single and outdated research methods: Most studies adopt traditional descriptive statistics and fail to deeply explore the essential characteristics of TCM syndromes. Although multivariate statistical methods such as factor analysis have been applied, relevant studies are limited, mostly small-sample and single-center researches without systematic standardization.

Insufficient representativeness of research samples: Most existing studies have a sample size of 100–200 cases in a single region, failing to cover populations of different ages,

genders and regions. The research results are poor in representativeness and difficult to be popularized.

Inadequate research on the correlation between TCM syndromes and modern medical indicators: Few studies explore the correlation between TCM syndromes and indicators such as colonic transit time, pelvic floor electromyography, defecography and psychological assessment scales. The pathophysiological mechanism of TCM syndromes remains unclear, restricting the development of integrated traditional and Western medicine diagnosis and treatment.

5.2 Future Research Prospects

Carry out large-sample and multi-center clinical studies: Large-sample and multi-center researches with stratified sampling should be implemented to ensure the balanced distribution of samples in terms of age, gender, region and living habits. Sufficient clinical data will support the exploration of TCM syndrome rules and the formulation of standardized criteria.

Apply multivariate statistical methods to deepen syndrome research: Further promote the application of factor analysis, cluster analysis, structural equation model and other multivariate statistical methods in TCM syndrome research of FC, to deeply explore the internal structure and essential characteristics of syndromes.

Strengthen research on the correlation between TCM syndromes and modern medical indicators: Explore the correlation between different TCM syndromes and colonic transit function, pelvic floor muscle function, nerve regulation, mental state and intestinal flora. Such research can reveal the pathophysiological basis of TCM syndromes, realize the objectification of syndrome diagnosis and promote the integration of traditional and Western medicine.

Establish a quantitative diagnosis model for TCM syndromes of FC: Based on large-sample multi-center clinical data and multivariate statistical methods such as factor analysis, build a quantitative diagnosis model and unified quantitative diagnostic criteria for TCM syndromes of FC, so as to reduce subjectivity and improve the consistency and repeatability of syndrome differentiation.

Promote the integrated diagnosis and treatment mode of traditional and Western medicine: Combine TCM syndrome classification and modern medical subtype classification of FC to formulate individualized integrated treatment regimens, give full play to the advantages of both disciplines and improve clinical efficacy.

6. Conclusion

Functional Constipation is a prevalent functional intestinal disorder that severely impairs patients' quality of life. Modern medicine has limited long-term therapeutic effects on FC. TCM has unique advantages of holistic regulation and treatment based on syndrome differentiation, but the development of TCM is restricted by non-standardized syndrome diagnosis, strong subjectivity and lack of

quantitative indicators. As a multivariate statistical method, factor analysis can effectively analyze complex systems and shows promising application value in the standardization and objectification of TCM syndromes. Though its application in TCM syndrome research of FC is still in the exploratory stage, existing studies have verified its effectiveness.

In the future, large-sample and multi-center clinical studies should be carried out. Combined with multivariate statistical methods including factor analysis, researchers need to further explore the distribution rules and internal structure of TCM syndromes of FC, establish quantitative diagnosis models, and strengthen the correlation research between TCM syndromes and modern medical indicators. These efforts will accelerate the standardization and objectification of TCM syndromes of FC, promote the establishment of integrated traditional and Western medicine diagnosis and treatment modes, and ultimately improve the clinical efficacy for FC and patients' quality of life.

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