

Hualien Tzu Chi Hospital
The Application for In-Hospital Medical Technology Research Project

1. Basic Information

Application Number : _____

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|--|---|-----------------------|---------------------|-------------------------------------|-----------------------------|
| Project Category (Select one) | <input checked="" type="checkbox"/> Individual Research Project: The project leader is a senior staff member of the hospital. | | | | |
| | <input checked="" type="checkbox"/> Experimental Research (Up to 800,000 NTD) | | | | |
| | <input type="checkbox"/> Non-Experimental Research (Up to 400,000 NTD) | | | | |
| | <input type="checkbox"/> Holistic Care Departmental Project (Up to 800,000 NTD) (Only department heads are eligible to apply) | | | | |
| | <input type="checkbox"/> New Staff Research Project (Up to 200,000 NTD) | | | | |
| | <input type="checkbox"/> University-Hospital Collaborative Research Project (Up to 400,000 NTD) | | | | |
| | <input type="checkbox"/> Ministry of Science and Technology Transfer to Hospital Project (Up to 800,000 NTD) | | | | |
| | <input type="checkbox"/> Medical Education Research Project (Up to 400,000 NTD) | | | | |
| Personnel Category (Select one) | <input checked="" type="checkbox"/> Physician <input type="checkbox"/> Non-Physician | | | | |
| Project Title | Esophageal visceral hypersensitivity and hypervigilance in disorders of gut-brain interaction: the roles of cognitive-behavioral therapy | | | | |
| Name of the Project Leader | Wei-Yi Lei | Title/Position | Attending Physician | Applying Department/Division | Gastroenterology Department |
| Project Execution Period | From January 1, 2024 to December 31, 2025 | | | | |
| Research Nature and Classification | <input type="checkbox"/> Basic Research <input checked="" type="checkbox"/> Applied Research <input type="checkbox"/> Technology Development | | | | |
| | (Note: Those who select Applied Research and Technology Development must also select the category of Innovation R&D.) | | | | |
| | Innovation R&D Classification : <input checked="" type="checkbox"/> (1) Clinical Research | | | | |
| | <input type="checkbox"/> (2) Translational Research <input type="checkbox"/> (3) Medical Engineering and Materials | | | | |
| | <input type="checkbox"/> (4) Information <input type="checkbox"/> (5) Medical Assistance Operations <input type="checkbox"/> (6) Others, please specify _____. | | | | |
| Holistic Care (Please refer to the term description, multiple selections are allowed) | Holistic Care Classification : (1) Patient-Centered (<input checked="" type="checkbox"/> Physical, <input type="checkbox"/> Psychological, <input checked="" type="checkbox"/> Environmental, <input type="checkbox"/> Spiritual) (2) Health Education (<input type="checkbox"/> Behavior Change, <input checked="" type="checkbox"/> Health Promotion, <input checked="" type="checkbox"/> Disease Prevention, <input checked="" type="checkbox"/> Early Diagnosis, <input type="checkbox"/> Early Treatment) (3) Others, please specify _____. | | | | |

Has this in-house project applied for the 2023 Ministry of Science and Technology's Special Research

Program?

No Yes.

Has any government agency subsidy for research projects been applied for this year?

No Yes, a total of 1 projects.

A total of 1 in-house research projects have been applied for this year as the principal investigator (jointly hosted projects are not included).

The priority of this project is 1.

Has this project applied for:

No need

Human Experiments / Human Samples (including human embryos/human embryonic stem cells)

Animal Experiments

Biosafety (including recombinant DNA experiments/genetically modified organism field trials/Level 2 or higher infectious biological materials)

【Please check the applicable items】

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| Project Contact Person | Name: Lei Wei-Yi Phone: (Office) (03) 8561825-13224 (Home) 0970-339629 E-Mail: aquarius@seed.net.tw |
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2. Application for Subsidy Funding (The budget allocation will be included in the review and evaluation criteria, please do not inflate the figures.)

Based on the actual needs of the research project, the following items can be applied for subsidy funding:

- For individual research projects:
 - Experimental research: Maximum of 800,000 NTD
 - Non-experimental research: Maximum of 400,000 NTD
- For new personnel research projects: The total research funding is limited to 200,000 NTD.
- For collaborative research projects between schools and institutions: The total research funding is limited to 400,000 NTD.
- For holistic care department projects: The maximum funding is 800,000 NTD.
- For Ministry of Science and Technology transferred in-house projects: The maximum funding is 800,000 NTD.

| Subsidy Items | Requested Amount |
|--------------------------|---|
| Administrative Expenses | 1. Research Personnel Costs 480,000 NTD |
| | 2. Experimental Animal Costs 0 NTD |
| | 3. Consumables, Materials, Books, and Miscellaneous Expenses 160,000 NTD |
| Research Equipment Costs | 0 NTD |
| Total Amount | 640,000 NTD |

3. Equipment Configuration

The names of the main instruments required for this project, their placement locations, and the signature of the responsible person consenting to their use.

| Instrument Name | Installation Location (Department) | Signature and Seal of the Department Head Approving the Use of the Instrument |
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4. Personnel Involved in the Project

(1) Principal Research Personnel

| Category (Principal Investigator, Co-Principal Investigator, Collaborating Principal Investigator, Research Assistant, etc.) | Name | Current Position | Specific Job Role, Tasks, and Scope of Work in this Research Project |
|---|----------------------|--|--|
| Principal Investigator | Lei Wei-Yi | Attending Physician, Gastroenterology | Research project planning and participant recruitment, progress monitoring, data statistical analysis, and report writing. |
| Co-Principal Investigator | Chen Jian- Lin | Director of Gastroenterology Department | Project progress supervision, project planning discussions, participant recruitment, and data analysis. |
| Co-Principal Investigator | Weng Ming- Wen | Attending Physician, Gastroenterology | Research project participant recruitment and actual case handling. |
| Co-Principal Investigator | Yi Zhi-Xun | Attending Physician, Gastroenterology | Research project participant recruitment and actual case handling. |
| Co-Principal Investigator | Liu Zuo-Cai | Director of the Digestive Function Testing Department | Research project participant recruitment and actual case handling. |
| Co-Principal Investigator | Hong Rui- Sheng | Attending Physician, Gastroenterology | Research project participant recruitment and actual case handling. |
| Co-Principal Investigator | Wang Jun- Wei | Attending Physician, Gastroenterology Department, Kaohsiung Medical University Hospital | Research project participant recruitment and actual case handling. |
| Co-Principal Investigator | Liang Shu- Wei | Attending Physician, Gastroenterology Department, Chung Shan Medical University Hospital | Research project participant recruitment and actual case handling. |
| Co-Principal Investigator | Wang Wen- Hui | Director of Gastroenterology Department, E-Da Hospital | Research project participant recruitment and actual case handling. |
| Co-Principal Investigator | Hsieh Ming- Tsung | Attending Physician, Gastroenterology Department, National Cheng Kung University Hospital | Research project participant recruitment and actual case handling. |
| Co-Principal Investigator | Lin Yi-Mei | Professor, Department of Psychology, Kaohsiung Medical University | Cognitive Behavioral Therapy coordination and data analysis. |
| Co-Principal Investigator | Lin Hui-Min | Dietitian, Clinical Nutrition Division, Department of Nutrition | Developing nutrition education materials and arranging the nutrition consultation process. |

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| Research Personnel | Lin Pei-Yun | Psychotherapist, Yuli Hospital | Conducting Cognitive Behavioral Therapy. |
| Research Personnel | Hsu Ssu-Ting | Counseling Psychologist, Secret Garden Counseling Center | Conducting Cognitive Behavioral Therapy. |
| Research Personnel | Su Zhen-Ying | Dietitian, Clinical Nutrition Division, Department of Nutrition | Conducting nutrition counseling and education. |
| Research Assistant | Huang Chun-Hsiang | Research Assistant | Survey administration, data collection, organization and analysis, and handling administrative tasks. |

※If there are insufficient fields, please copy them as needed.

(2) Research projects that the principal investigator, co-principal investigator, and co-researchers have participated in during the past three years.

| Name | Project Name | Role and Responsibilities in the Project | Start and End Date | Funding Agency |
|------------|---|--|-----------------------|---|
| Lei Wei-Yi | Exploring the roles and interrelationships of esophageal hypersensitivity, psychological distress, and functional gastrointestinal disorders in the pathophysiological mechanisms of esophageal symptoms in patients. | Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | Exploring the pathophysiological mechanisms and treatment strategies of gastroesophageal reflux disease (GERD) through the distribution of afferent nerves, esophageal motility, and pharmacological regulation. | Principal Investigator | 2022/8/1~2025/07/31 | Ministry of Science and Technology (MOST) |
| Lei Wei-Yi | Exploring the effects of opioid analgesics on the pathophysiological mechanisms of esophageal contraction and reflux characteristics, as well as their clinical applications. | Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | The efficacy of Jingsi Herbal Concentrate on long COVID symptoms—gut-brain axis dysregulation and related physical and mental symptoms: A randomized double-blind clinical trial. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Tzu Chi Medical Foundation |
| Lei Wei-Yi | Exploring the interaction between upper gastric belching, physical and mental symptoms, and esophageal acid reflux: Clinical applications for optimizing the treatment of gastroesophageal reflux disease (GERD). | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | Using high-resolution pharyngeal function testing to analyze the pharyngeal swallowing physiology and dynamics in patients with ineffective esophageal motility. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | Exploring the efficacy and physiological changes of anti-reflux mucosal ablation in proton pump inhibitor (PPI)-dependent gastroesophageal reflux disease (GERD). | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |

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| Lei Wei-Yi | Exploring the sensitivity to capsaicin, motility sensation function, and the physiological features of reflux in the esophagus: Clinical impact and treatment guidelines for esophageal dysfunction and gastroesophageal reflux disease (GERD). | Co-Principal Investigator | 2023/8/1~2026/07/31 | Ministry of Science and Technology (MOST) |
| Lei Wei-Yi | Exploring the pathophysiological mechanisms of gastroesophageal reflux disease (GERD) through esophageal reflux clearance capacity, mucosal integrity, and psychosocial characteristics, and establishing a basis for precise diagnosis and treatment. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | The application of high-resolution impedance pharyngeal function testing and the Sydney Swallowing Questionnaire in oropharyngeal dysphagia and voice disorders. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | The application of artificial intelligence in high-resolution esophageal function testing: A study on unsupervised computational models based on deep learning. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | Application of supervised learning artificial intelligence in analyzing 24-hour esophageal pH-impedance monitoring: Technological efficacy and clinical applications in diagnosing gastroesophageal reflux disease (GERD). | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | Exploring the clinical characteristics and the impact of gut microbiota in patients with metabolic-associated fatty liver disease under dietary and exercise regulation. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | The efficacy of Jingsi Herbal Drink on the physical and mental symptoms of functional dyspepsia: A randomized double-blind clinical trial. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Tzu Chi Medical Foundation |
| Lei Wei-Yi | Exploring the pathophysiological role of esophageal mucosal afferent nerve distribution in gastroesophageal reflux disease (GERD) with concurrent esophageal motility dysfunction. | Principal Investigator | 2020/8/1~2022/07/31 | Ministry of Science and Technology (MOST) |
| Lei Wei-Yi | Exploring the pathophysiological impact of esophageal contraction, mucosal integrity, and acid sensitivity on gastroesophageal reflux disease (GERD) and the basis for treatment strategies. | Co-Principal Investigator | 2020/8/1~2023/07/31 | Ministry of Science and Technology (MOST) |
| Lei Wei-Yi | Exploring the role of esophageal microbiota in gastroesophageal reflux disease (GERD) through novel impedance parameters, clinical subtypes, and hypersensitivity. | Co-Principal Investigator | 2021/1/1~2021/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | Exploring the interrelationship and pathogenic mechanisms of esophageal acid sensitivity, secondary esophageal contractions, and subtypes of gastroesophageal reflux disease (GERD). | Co-Principal Investigator | 2021/1/1~2021/12/31 | Hualien Tzu Chi Hospital |
| Lei Wei-Yi | Exploring the clinical application of high-resolution impedance pharyngeal function testing in oropharyngeal dysphagia and drug response. | Co-Principal Investigator | 2021/1/1~2021/12/31 | Hualien Tzu Chi Hospital |
| Chen Jian-Lin | The efficacy of Jingsi Herbal Concentrate on long COVID symptoms—gut-brain axis dysregulation | Principal Investigator | 2023/01/01~2023/12/31 | Tzu Chi Medical Foundation |

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| | and related physical and mental symptoms: A randomized double-blind clinical trial. | | | |
| Chen Jian-Lin | Exploring the interaction between upper gastric belching, physical and mental symptoms, and esophageal acid reflux: Clinical applications for optimizing the treatment of gastroesophageal reflux disease (GERD). | Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
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| Chen Jian-Lin | Exploring the pathophysiological mechanisms and interrelationships of esophageal hypersensitivity, psychological distress, and functional gastrointestinal disorders in patients with esophageal symptoms. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Chen Jian-Lin | Exploring the efficacy and physiological changes of anti-reflux mucosal ablation in proton pump inhibitor (PPI)-dependent gastroesophageal reflux disease (GERD). | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Chen Jian-Lin | Using high-resolution pharyngeal function testing to analyze the pharyngeal swallowing physiology and dynamics in patients with ineffective esophageal motility. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Chen Jian-Lin | Exploring the pathophysiological mechanisms of laryngopharyngeal reflux: Clinical applications of artificial intelligence-assisted, precision diagnostics, and personalized treatment strategies. | Co-Principal Investigator | 2022/8/1~2025/07/31 | Ministry of Science and Technology (MOST) |
| Chen Jian-Lin | Exploring the pathophysiological mechanisms and treatment strategies of gastroesophageal reflux disease (GERD) through the distribution of afferent nerves, esophageal motility, and pharmacological regulation. | Co-Principal Investigator | 2022/8/1~2025/07/31 | Ministry of Science and Technology (MOST) |
| Chen Jian-Lin | Exploring the effects of opioid analgesics on the pathophysiological mechanisms of esophageal contraction and reflux characteristics, as well as their clinical applications. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Chen Jian-Lin | Application of supervised learning artificial intelligence in analyzing 24-hour esophageal pH-impedance monitoring: Technological efficacy and clinical applications in diagnosing gastroesophageal reflux disease (GERD). | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |

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| Chen Jian-Lin | Exploring the pathophysiological role of esophageal mucosal afferent nerve distribution in gastroesophageal reflux disease (GERD) with concurrent esophageal motility dysfunction. | Co-Principal Investigator | 2020/8/1~2022/07/31 | Ministry of Science and Technology (MOST) |
| Chen Jian-Lin | Improving the diagnosis of laryngopharyngeal reflux through the proximal esophageal nighttime average baseline mucosal impedance values and establishing the indications for proton pump inhibitor therapy. | Co-Principal Investigator | 2020/8/1~2022/07/31 | Ministry of Science and Technology (MOST) |
| Chen Jian-Lin | Exploring the pathophysiological impacts of esophageal contraction, mucosal integrity, and acid sensitivity on gastroesophageal reflux disease (GERD), and establishing treatment strategies based on these factors. | Principal Investigator | 2020/8/1~2023/07/31 | Ministry of Science and Technology (MOST) |
| Weng Ming-Wen | Exploring the efficacy and physiological changes of anti-reflux mucosal ablation in proton pump inhibitor (PPI)-dependent gastroesophageal reflux disease (GERD). | Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Weng Ming-Wen | Exploring the pathophysiological mechanisms of laryngopharyngeal reflux: Clinical applications of artificial intelligence-assisted precision diagnostics and personalized treatment strategies. | Principal Investigator | 2022/8/1~2025/07/31 | Ministry of Science and Technology (MOST) |
| Weng Ming-Wen | Using supervised learning artificial intelligence to analyze 24-hour esophageal pH-impedance monitoring: Technological efficacy and clinical applications in the diagnosis of gastroesophageal reflux disease (GERD). | Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Weng Ming-Wen | The therapeutic effects of concentrated Jingsu herbal drink on physical and psychological symptoms of long COVID—gut-brain axis | Co-Principal Investigator | 2023/01/01~2023/12/31 | Tzu Chi Medical Foundation |

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| | dysregulation: A randomized double-blind clinical trial. | | | |
| Weng Ming-Wen | Exploring the interplay between belching, psychological symptoms, and esophageal acid reflux: Clinical applications for optimizing the treatment of gastroesophageal reflux disease (GERD). | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Weng Ming-Wen | Exploring the pathophysiological role and interplay of esophageal hypersensitivity, psychological distress, and functional gastrointestinal disorders in patients with esophageal symptoms. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Weng Ming-Wen | Analyzing the pharyngeal swallowing physiology in patients with ineffective esophageal motility using high-resolution pharyngeal function testing. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Weng Ming-Wen | Exploring the relationship between esophageal capsaicin sensitivity, motility sensation, and physiological features of reflux: Clinical impacts and treatment guidelines for esophageal dysfunction and gastroesophageal reflux disease (GERD). | Co-Principal Investigator | 2023/8/1~2026/07/31 | Ministry of Science and Technology (MOST) |
| Weng Ming-Wen | The application of high-resolution impedance pharyngeal function testing and the Sydney Swallowing Questionnaire in the assessment of oropharyngeal swallowing difficulties and voice disorders. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Weng Ming-Wen | The application of artificial intelligence in high-resolution esophageal function testing: A study using an unsupervised deep learning-based algorithm model. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
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| Weng Ming-Wen | The therapeutic effects of Jing Si Herbal Drink on the psychosomatic symptoms of functional dyspepsia: A randomized double-blind clinical trial. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Tzu Chi Medical Foundation |
| Weng Ming-Wen | The use of proximal esophageal nocturnal average baseline mucosal impedance values to improve the diagnosis of laryngopharyngeal reflux disease and establish indications for proton pump inhibitors. | Principal Investigator | 2020/8/1~2022/07/31 | Ministry of Science and Technology (MOST) |
| Weng Ming-Wen | The exploration of the pathophysiological impact of esophageal contraction, mucosal integrity, and acid sensitivity on gastroesophageal reflux disease, along with therapeutic strategies based on these factors. | Co-Principal Investigator | 2020/8/1~2023/07/31 | Ministry of Science and Technology (MOST) |
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| Weng Ming-Wen | Exploring the clinical application of high-resolution impedance pharyngoesophageal function testing in the assessment of pharyngeal dysphagia and drug responses. | Co-Principal Investigator | 2021/1/1~2021/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | The efficacy of Jing's Herbal Decoction Concentrate in treating long COVID symptoms—gut-brain axis dysfunction and associated physical and mental symptoms: A randomized double-blind clinical trial. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Tzu Chi Medical Foundation |
| Yi Zhi-Xun | Exploring the interaction between belching, physical and mental symptoms, and esophageal acid reflux: Clinical applications for optimizing gastroesophageal reflux disease treatment. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | Exploring the pathophysiological mechanisms and interactions of esophageal hypersensitivity, psychological distress, and functional gastrointestinal disorders in patients with esophageal symptoms. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | Exploring the efficacy and physiological changes of anti-reflux mucosal ablation therapy in proton pump inhibitor-dependent gastroesophageal reflux disease. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | Analyzing the pharyngeal swallowing physiology and dynamics in patients with ineffective esophageal motility using high-resolution pharyngoesophageal function testing. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | Exploring the relationship between esophageal capsaicin sensitivity, motility sensory function, and the reflux characteristics of physical and psychological physiology: Clinical impact and treatment guidelines for esophageal dysfunction and gastroesophageal reflux disease. | Co-Principal Investigator | 2023/8/1~2026/07/31 | Ministry of Science and Technology (MOST) |
| Yi Zhi-Xun | Exploring the pathophysiological mechanisms of gastroesophageal reflux disease through esophageal clearance ability, mucosal integrity, and psychological characteristics, and establishing the basis for precise diagnosis and treatment. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | Exploring the impact of opioid analgesics on the pathophysiological mechanisms of esophageal contraction and reflux characteristics, and their clinical applications. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | The application of high-resolution impedance pharyngoesophageal function testing and the Sydney Swallow Questionnaire in oropharyngeal dysphagia and voice disorders. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | The Application of Artificial Intelligence in High-Resolution Esophageal Function Testing: A Study on Unsupervised Computational Models Based on Deep Learning. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | Artificial Intelligence Analysis of 24-Hour Esophageal pH Impedance Testing Using Supervised Learning: Technical Performance and Clinical Applications in the Diagnosis of Gastroesophageal Reflux Disease. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |

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| Yi Zhi-Xun | Exploring the Impact of Diet and Exercise Regulation on Clinical Features and Gut Microbiota in Patients with Metabolism-Related Fatty Liver Disease. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | The Therapeutic Effect of Jinseng Herbal Drink on Psychosomatic Symptoms in Functional Dyspepsia: A Randomized Double-Blind Clinical Trial. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Tzu Chi Medical Foundation |
| Yi Zhi-Xun | Exploring the Interrelationship and Pathogenic Mechanisms Between Esophageal Acid Sensitivity, Esophageal Secondary Contractions, and Subtypes of Gastroesophageal Reflux Disease. | Principal Investigator | 2021/1/1~2021/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | Exploring the Role of Esophageal Microbiota in Gastroesophageal Reflux Disease: Its Impact on Novel Impedance Parameters, Clinical Classification, and Hypersensitivity. | Co-Principal Investigator | 2021/1/1~2021/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | Clinical Application of High-Resolution Impedance Pharyngeal Function Testing in the Assessment of Pharyngeal Dysphagia and Drug Response. | Co-Principal Investigator | 2021/1/1~2021/12/31 | Hualien Tzu Chi Hospital |
| Yi Zhi-Xun | Exploring the Pathophysiological Impact of Esophageal Contractions, Mucosal Integrity, and Acid Sensitivity on Gastroesophageal Reflux Disease and the Basis for Therapeutic Strategies. | Co-Principal Investigator | 2020/8/1~2023/07/31 | Ministry of Science and Technology (MOST) |
| Liu Zuo-Cai | Exploring the Impact of Diet and Exercise Regulation on Clinical Features and Gut Microbiota in Patients with Metabolism-Related Fatty Liver Disease. | Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Liu Zuo-Cai | The Therapeutic Effect of Jinseng Herbal Extract on Long COVID Symptoms: Psychosomatic Symptoms Related to Gut-Brain Axis Dysregulation – A Randomized Double-Blind Clinical Trial. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Tzu Chi Medical Foundation |
| Liu Zuo-Cai | Exploring the Interrelationship Between Belching, Psychosomatic Symptoms, and Esophageal Acid Reflux: Clinical Applications for Optimizing Gastroesophageal Reflux Disease Treatment. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Liu Zuo-Cai | Exploring the Pathophysiological Mechanisms and Interrelationship Between Esophageal Hypersensitivity, Psychological Distress, and Functional Gastrointestinal Disorders in Patients with Esophageal Symptoms. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Liu Zuo-Cai | Analyzing the Pharyngeal Physiology and Dynamics of Swallowing in Esophageal Ineffective Peristalsis Patients Using High-Resolution Pharyngeal Function Testing. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Liu Zuo-Cai | Exploring the Efficacy and Physiological Changes of Anti-Reflux Mucosal Ablation in Proton Pump Inhibitor-Dependent Gastroesophageal Reflux Disease. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Liu Zuo-Cai | Exploring Esophageal Capsaicin Sensitivity, Peristaltic Sensory Function, and Psychophysiological Reflux Characteristics: Clinical Impact and Treatment Guidelines for | Co-Principal Investigator | 2023/8/1~2026/07/31 | Ministry of Science and Technology (MOST) |

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| | Esophageal Dysfunction and Gastroesophageal Reflux Disease. | | | |
| Liu Zuo-Cai | Exploring the Pathophysiological Mechanisms of Gastroesophageal Reflux Disease Through Esophageal Reflux Clearance Ability, Mucosal Integrity, and Psychosocial Traits: Establishing the Basis for Precise Diagnosis and Treatment. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Liu Zuo-Cai | Exploring the Impact of Opioid Analgesics on Esophageal Contraction and Reflux Characteristics: Pathophysiological Mechanisms and Clinical Applications. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
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| Liu Zuo-Cai | Artificial Intelligence Analysis of 24-Hour Esophageal pH-Impedance Monitoring Using Supervised Learning: Technical Performance and Clinical Applications in the Diagnosis of Gastroesophageal Reflux Disease. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
| Liu Zuo-Cai | The Application of Artificial Intelligence in High-Resolution Esophageal Function Testing: A Study on Unsupervised Computational Models Based on Deep Learning. | Co-Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |
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| Liu Zuo-Cai | Clinical Application of High-Resolution Impedance Pharyngeal Function Testing in the Assessment of Pharyngeal Dysphagia and Drug Response. | Co-Principal Investigator | 2021/1/1~2021/12/31 | Hualien Tzu Chi Hospital |
| Liu Zuo-Cai | Exploring the Pathophysiological Impact of Esophageal Contractions, Mucosal Integrity, and Acid Sensitivity on Gastroesophageal Reflux Disease and the Basis for Therapeutic Strategies. | Co-Principal Investigator | 2020/8/1~2023/07/31 | Ministry of Science and Technology (MOST) |
| Hong Rui-Sheng | Analyzing the Pharyngeal Physiology and Dynamics of Swallowing in Esophageal Ineffective Peristalsis Patients Using High-Resolution Pharyngeal Function Testing. | Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Hong Rui-Sheng | The Application of High-Resolution Impedance Pharyngeal Function Testing and the Sydney Swallowing Questionnaire in Oropharyngeal Dysphagia and Voice Disorders. | Principal Investigator | 2022/1/1~2022/12/31 | Hualien Tzu Chi Hospital |

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| Hong Rui-Sheng | The Therapeutic Effect of Jinseng Herbal Extract on Long COVID Symptoms: Psychosomatic Symptoms Related to Gut-Brain Axis Dysregulation – A Randomized Double-Blind Clinical Trial. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Tzu Chi Medical Foundation |
| Hong Rui-Sheng | Exploring the Interrelationship Between Belching, Psychosomatic Symptoms, and Esophageal Acid Reflux: Clinical Applications for Optimizing Gastroesophageal Reflux Disease Treatment. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Hong Rui-Sheng | Exploring the Pathophysiological Mechanisms and Interrelationship Between Esophageal Hypersensitivity, Psychological Distress, and Functional Gastrointestinal Disorders in Patients with Esophageal Symptoms. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Hong Rui-Sheng | Exploring the Efficacy and Physiological Changes of Anti-Reflux Mucosal Ablation in Proton Pump Inhibitor-Dependent Gastroesophageal Reflux Disease. | Co-Principal Investigator | 2023/01/01~2023/12/31 | Hualien Tzu Chi Hospital |
| Hong Rui-Sheng | Exploring Esophageal Capsaicin Sensitivity, Peristaltic Sensory Function, and Psychophysiological Reflux Characteristics: Clinical Impact and Treatment Guidelines for Esophageal Dysfunction and Gastroesophageal Reflux Disease. | Co-Principal Investigator | 2023/8/1~2026/07/31 | Ministry of Science and Technology (MOST) |
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※If there are insufficient fields, please copy them as needed.

5. Research Related to Costs

| Project Name | Description | Unit Price (NTW) | Quantity | Total Price (NTW) | Remarks |
|--|--|--------------------------------|------------------------|-------------------------------------|---------|
| 1.Research Personnel Costs (For related insurance premiums, please consult the Human Resources Department) | <p>(1) Full-time Personnel (for individual project applications only):</p> <ul style="list-style-type: none"> • Work remuneration (including year-end bonus reserve) • Employer contribution to labor and health insurance • Employer contribution to labor pension (6% of insured salary) <p>(2) Part-time Personnel (must be enrolled students):</p> <ul style="list-style-type: none"> • Work remuneration <ul style="list-style-type: none"> <input type="checkbox"/> Undergraduate student <input type="checkbox"/> Master's student <input type="checkbox"/> Other: • Employer contribution to labor and health insurance • Employer contribution to labor pension (6% of insured salary) <p>(3) Temporary Workers:</p> <ul style="list-style-type: none"> • Work remuneration • Employer contribution to labor and health insurance • Employer contribution to labor pension (6% of insured salary) | | | | |
| 1. Operational Expenses | (4) Professional Assistance Fees | 12,000 | 40 | 480,000 | |
| | | | Subtotal: | 480,000 | |
| 2.Animal Experimentation Fees | | | Subtotal: | | |
| 3.Consumables, Equipment, Books, and Miscellaneous Expenses | Participant Stipends Miscellaneous: Postage and Telecommunications, Printing Costs, Copy Paper, Copying | 500 1,000 15,000 | 210 40 1 | 105,000 40,000 15,000 | |

| | | | | | |
|---|--|--|-----------|----------------|--|
| | Fees, Binding Fees, Stationery Costs, Poster Production Fees, Computer Data Statistics Fees, Computer Data Analysis Fees, Paper Submission Fees, Paper Publication Fees, Sectioning, Embedding, and Staining Immunology Costs. | | | | |
| | | | Subtotal: | 160,000 | |
| 2. Research Equipment Costs (According to regulations, books, computers, and peripheral equipment are not included in the subsidy. Medium and large instruments will be applied for collectively by the research department, based on necessity, for shared use.) | | | Subtotal: | 0 | |
| | Total | | | 640,000 | |

6. Project Abstract

(Please provide a summary of the key points of this project within 500 words, and create customized keywords based on the nature of the project.)

Gastroesophageal reflux disease (GERD) poses a challenging medical condition to manage, with up to 40% of patients showing refractory to standard medical intervention, which usually begins with a proton pump inhibitor (PPI). Among these cases, esophageal disorders of gut-brain interaction (DGBI), such as reflux hypersensitivity and functional heartburn, or GERD patients with concurrent occurrences of these conditions, constitute more than 90% of the patients who did not respond to twice-daily PPI treatment. Esophageal visceral hypersensitivity and hypervigilance are the two pathways that drive esophageal DGBI and symptoms. The Rome IV esophageal disorders, encompassing functional chest pain, functional heartburn, globus, functional dysphagia, and reflux hypersensitivity, are defined by present with symptoms originating from the esophagus without detectable evidence of structural, inflammatory, or motor disorders. Diagnosing esophageal DGBI necessitates testing involving endoscopy, pH-impedance monitoring, and high-resolution manometry. Neuromodulators form the basis of the pharmacological strategy for managing various esophageal DGBI and symptoms, modulating both peripheral and central hyperalgesia. Increasing evidence supports the use of brain-gut behavioral therapies, such as gut-directed hypnotherapy and cognitive behavior therapy, as effective treatments for a variety of DGBIs. However, the efficacy of neuromodulators or cognitive behavior therapy in treating esophageal DGBI and related symptoms remains largely unexplored. The primary objective of this study is to examine the efficacy of cognitive behavior therapy in managing esophageal DGBI. Additionally. The findings from this study will contribute to a better understanding of the pathophysiology of esophageal DGBI and GERD with refractory symptoms. These clinical insights may then offer valuable guidance for future therapeutic approaches in DGBI patients who experience esophageal symptoms and do not respond to PPI treatment.

Key words: gastroesophageal reflux disease, disorders of gut-brain interaction, neuromodulators, cognitive behavior therapy

7. Background and Objectives of the Research Project

(Please provide a detailed description of the background, objectives, significance of this research project, as well as the research status both domestically and internationally related to this project. Also, include a review of important references and literature.)

Research Background

◆ Pathophysiological Mechanisms and Importance of Gastroesophageal Reflux Disease (GERD)

Gastroesophageal reflux disease (GERD) is defined as a condition where stomach contents flow back into the esophagus, resulting in symptoms or mucosal injury. Common typical symptoms include heartburn or acid reflux, while atypical symptoms may include chest tightness, a sensation of a foreign body in the throat, hoarseness, or chronic cough. Clinically, GERD is a common chronic disease. In the United States, where symptoms occur at least once a week, up to 30% of adults are affected by GERD; in East Asia, the prevalence is 5-10%, but there is a growing trend in its incidence.

There are many possible pathogenic mechanisms for GERD, including lower esophageal sphincter (LES) dysfunction or structural abnormalities, ineffective esophageal motility, esophageal mucosal integrity defects, esophageal hypersensitivity, the formation of acid pockets after meals, the composition of gastric refluxate, and delayed gastric emptying. Currently, the most common diagnostic method involves observing damage to the distal esophageal mucosa through endoscopy or confirming abnormal gastric acid exposure via a 24-hour pH monitoring test. Based on the results of endoscopy and esophageal pH monitoring, GERD patients can be classified into two categories: erosive esophagitis (EE) and non-erosive reflux disease (NERD).

Repeated gastric acid exposure to the distal esophagus not only causes mucosal damage but may also lead to severe complications such as esophageal stricture, Barrett's esophagus, and esophageal adenocarcinoma. Statistics show that in the United States, medical and non-medical losses due to GERD exceed \$930 million annually. Therefore, GERD has become an important issue both clinically and in national public health policies in recent years.

◆ Disorders of gut-brain axis interaction in esophagus

Disorders of gut-brain axis interaction (DGBI) refer to gastrointestinal diseases that present with symptoms but no organic abnormalities, which were previously referred to as functional gastrointestinal disorders. In the recent Rome IV criteria , ¹¹ In the esophageal context, the Rome IV criteria define five conditions: functional chest pain, reflux hypersensitivity (RH), functional heartburn (FH), globus, and functional dysphagia. Epidemiologically, the prevalence of esophageal disorders related to gut-brain axis interaction is still not well understood. Past population-based

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studies have shown that the prevalence of non-cardiac chest pain is approximately 19-33% , ^{12,13}

Further generation-based analysis of the population with psychogenic chest pain revealed that approximately 32-35% of them were diagnosed with functional chest pain.¹⁴ In terms of reflux hypersensitivity, among patients with non-erosive mucosal damage in the esophagus, approximately 10-36% are diagnosed with esophageal hypersensitivity.^{15,16} Functional heartburn has an unknown prevalence due to the limitations of current diagnostic tools and receiver operating characteristic (ROC) curves. Globus, on the other hand, is a commonly encountered disorder of gut-brain axis interaction in clinical practice. Research reports indicate that 46% of healthy adults have experienced globus at some point.¹⁷ Functional dysphagia is the least common, and its prevalence remains unclear to this day.

In terms of definition, patients must have chronic esophageal symptoms lasting at least three months, with the first occurrence of symptoms being more than six months before the diagnosis of the disease. Additionally, structural, inflammatory, motility, and metabolic abnormalities in the esophagus must be excluded.¹ Therefore, to diagnose esophageal disorders related to gut-brain axis interaction, upper gastrointestinal endoscopy, esophageal pH-impedance testing, and high-resolution esophageal manometry are required to exclude other esophageal diseases that may cause similar symptoms. Regarding the pathophysiological mechanisms, it is currently believed that they may be related to esophageal visceral hypersensitivity and hypervigilance, but the exact mechanisms still require further research for confirmation. In terms of diagnostic criteria, according to the Rome IV criteria, the definition is as follows:¹¹

➤ **Functional Chest Pain:**

- (1) Occurs ≥ 1 time per week with non-cardiac chest pain or chest tightness;
- (2) No associated heartburn or dysphagia;
- (3) Symptoms are not related to gastroesophageal reflux disease (GERD) or eosinophilic esophagitis;
- (4) No significant esophageal motility disorders.

➤ **Functional Heartburn:**

- (1) Occurs ≥ 2 times per week with substernal symptoms such as heartburn or chest pain;
- (2) Symptoms do not improve with antisecretory therapy;
- (3) Symptoms are not related to gastroesophageal reflux disease (GERD) or eosinophilic esophagitis;
- (4) No significant esophageal motility disorders.

➤ **Reflux Hypersensitivity (Esophageal Hypersensitivity):**

- (1) Occurs ≥ 2 times per week with substernal symptoms such as heartburn or chest pain;
- (2) Endoscopy is normal, and eosinophilic esophagitis must be excluded;
- (3) No significant esophageal motility disorders;

(4) Esophageal pH or pH-impedance testing shows normal acid exposure levels, but reflux is associated with symptoms.

➤ **Globus:**

- (1) Occurs ≥ 1 time per week with persistent or intermittent, non-painful sensation of a lump in the throat, with no organic lesions confirmed through clinical examination, laryngoscopy, or endoscopy;
- (2) Symptoms occur between meals, with no dysphagia or odynophagia, and no gastric metaplasia in the proximal esophagus (gastric inlet patch);
- (3) Symptoms are not related to gastroesophageal reflux disease (GERD) or eosinophilic esophagitis;
- (4) No significant esophageal motility disorders.

➤ **Functional Dysphagia:**

- (1) Occurs ≥ 1 time per week with a sensation of obstruction or abnormal feeling when solids or liquids pass through the esophagus;
- (2) Symptoms are not related to esophageal mucosal or structural abnormalities;
- (3) Symptoms are not related to gastroesophageal reflux disease (GERD) or eosinophilic esophagitis;
- (4) No significant esophageal motility disorders.

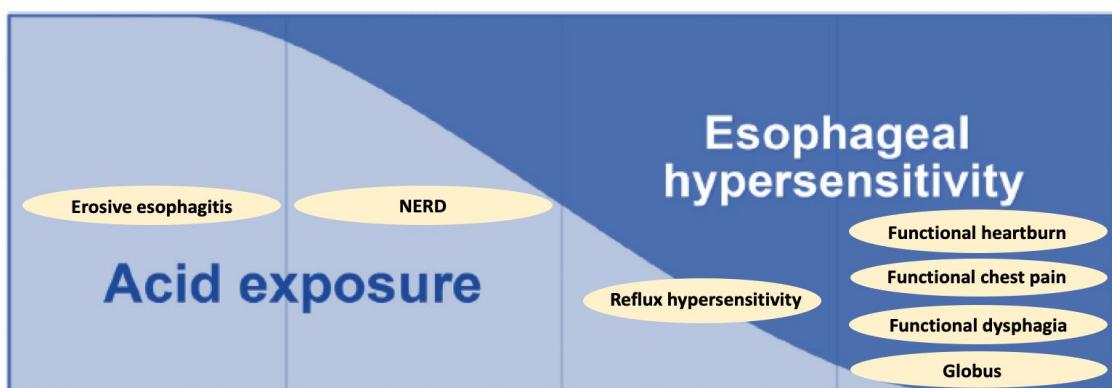


Figure 1: Diagnostic Spectrum Classification of Gastroesophageal Reflux Disease (GERD) and Disorders of Gut-Brain Axis Interaction (DGBI).

◆ **Physiological Tests for Diagnosing Gastroesophageal Reflux Disease (GERD) and Disorders of Gut-Brain Axis Interaction (DGBI)**

The current diagnosis of gastroesophageal reflux disease (GERD) spectrum disorders is based on endoscopic examination, esophageal pH (or pH-impedance) testing results, and the association between reflux and symptoms. Among these, esophageal pH testing, specifically the acid exposure time (AET), is the most important pathophysiological parameter used to differentiate GERD from disorders of gut-brain axis interaction (DGBI).¹⁸ The measurement method involves calculating the percentage of time during a 24-hour monitoring period in which the distal esophageal pH value is less

than 4. The Lyon Consensus on the diagnosis of gastroesophageal reflux disease (GERD) states that an acid exposure time (AET) of less than 4% is considered physiological reflux, while an AET greater than 6% is considered pathological reflux. Additionally, if the total number of reflux episodes in 24 hours is less than 40, it is considered normal, while more than 80 episodes is considered abnormal.⁸ The combination of parameters such as acid exposure time (AET), number of acid reflux episodes, number of acid reflux episodes lasting more than five minutes, and the longest reflux episode duration can be used to assess the severity of reflux.¹⁹ By combining esophageal pH testing with impedance values, it is possible to detect the direction of reflux, as well as the reflux of weakly acidic, alkaline fluids, or gases.²⁰ During the detection period, patients are required to record all esophageal symptoms occurring during the esophageal pH-impedance testing. The physician will then compare these recorded symptoms with the reflux events documented by the pH-impedance monitor to calculate the association between reflux and symptoms (Symptom Association Probability, SAP, and Symptom Index, SI).²¹

Based on the above criteria for esophageal pH testing and endoscopic examination results, patients with esophageal reflux symptoms can be classified into erosive esophagitis, non-erosive reflux disease, esophageal hypersensitivity, and functional heartburn. Erosive esophagitis is characterized by visible mucosal damage at the distal esophagus during endoscopy; non-erosive reflux disease is identified by normal mucosa on endoscopy and pathological prolongation of the acid exposure time (AET) at the distal esophagus on esophageal pH testing; esophageal hypersensitivity presents with a normal AET, but the symptoms are associated with reflux events (refluxate may be acidic, weakly acidic, or weakly alkaline) as seen on pH-impedance testing; functional heartburn occurs when there are symptoms of gastroesophageal reflux disease, but both endoscopic examination and AET are normal. For disorders of gut-brain axis interaction, including functional chest pain, globus, and functional dysphagia, in addition to normal endoscopic and AET results, patients must not have significant esophageal motility disorders and must meet the diagnostic criteria related to esophageal symptoms, as well as the onset and duration of symptoms.

Current diagnostic tools, such as questionnaires, proton-pump inhibitor trials, and endoscopic examination, have low sensitivity and specificity for diagnosing gastroesophageal reflux disease (GERD). While esophageal pH (or pH-impedance) testing is considered the gold standard for diagnosing GERD, it can only detect and diagnose reflux events that occur during the test period. Among these, catheter-based esophageal pH testing is limited because it can only detect reflux activity during the 24-hour test period. Additionally, patients may experience discomfort from the catheter, which could lead to changes in their daily activities, thereby potentially affecting the diagnostic results to varying degrees. ²²⁻²³ The 96-hour wireless capsule-based esophageal pH monitoring, compared to the 24-hour esophageal pH-impedance testing, not only avoids the discomfort caused by the catheter but also extends the monitoring period to 96 hours. Previous studies

have indicated that up to one-third of patients diagnosed with functional heartburn based on 24-hour esophageal pH-impedance testing had their diagnosis corrected to non-erosive reflux disease after undergoing 96-hour wireless capsule-based esophageal pH monitoring.²⁴ However, the 24-hour esophageal pH-impedance testing can improve the probability of diagnosing or excluding gastroesophageal reflux disease (GERD) by calculating the mean nocturnal baseline impedance (MNBI). The mean nocturnal baseline impedance is derived by recording the 10-minute average impedance values during the patient's sleep at three one-hour intervals (1:00, 2:00, 3:00). Recent studies have indicated that the mean nocturnal baseline impedance is associated with mucosal integrity, acid exposure time, and reflux symptoms.^{25, 26}

◆The Treatment Dilemma of Refractory Gastroesophageal Reflux Disease and Esophageal Brain-Gut Axis Communication Disorders

Proton pump inhibitors (PPIs) are the primary medications used to treat gastroesophageal reflux disease. Although they are highly effective in improving typical heartburn symptoms in patients with erosive esophagitis,²⁷⁻²⁹ However, their effectiveness in treating non-erosive gastroesophageal reflux disease (NERD) is less than ideal. According to statistics, up to 50% of patients treated with proton pump inhibitors (PPIs) for suspected reflux symptoms still experience persistent symptoms.^{1,30} Studies have indicated that most gastroesophageal reflux disease (GERD) patients who are unresponsive to proton pump inhibitor (PPI) treatment have a normal acid exposure time (AET).³² In patients with heartburn who remain unresponsive to high-dose proton pump inhibitor (PPI) treatment, more than 90% are diagnosed with esophageal hypersensitivity or functional heartburn.^{31,32} In addition, patients with pathological reflux may also have concurrent esophageal brain-gut axis communication disorders. The complex pathophysiological mechanisms of gastroesophageal reflux disease (GERD) and the limited understanding of brain-gut interaction contribute to the poor treatment outcomes in such patients. Recent consensus suggests that non-reflux factors, such as altered perception or visceral hypersensitivity, may be associated with the refractory symptoms of the esophagus.³³

◆Treatment Strategies for Refractory Gastroesophageal Reflux Disease and Esophageal Brain-Gut Axis Communication Disorders

The treatment strategies for refractory gastroesophageal reflux disease (GERD) and esophageal brain-gut axis communication disorders remain unclear. Currently, it is believed that esophageal hypervigilance, anxiety, and autonomic arousal are the primary factors influencing the severity of symptoms and the response to reflux burden. The Esophageal Hypervigilance and Anxiety Scale (EHAS) has been recently validated in studies as an effective tool for assessing esophageal hypersensitivity.³⁴ Therefore, it is considered a helpful tool in diagnosing esophageal brain-gut axis communication disorders. Neuromodulators are medications used clinically to treat these disorders.

Previous research has shown that neuromodulators can effectively reduce symptoms in patients with irritable bowel syndrome (IBS) or functional dyspepsia by modulating visceral hypersensitivity through central and peripheral mechanisms.^{35,36} Therefore, using neuromodulators to regulate visceral hypersensitivity and esophageal hypervigilance in esophageal brain-gut axis communication disorders is considered a feasible strategy. However, a systematic review of the literature shows that among the few available randomized controlled trials, the efficacy of neuromodulators in the various subtypes of esophageal brain-gut axis communication disorders is inconsistent.³⁷ Therefore, whether neuromodulators can be widely used in the treatment of these disorders still requires more supporting evidence.

Cognitive Behavioral Therapy (CBT) is a form of psychological treatment that functions as a brain-gut axis intervention. It can modify the pain perception pathways of the brain-gut axis, reduce hypervigilance and symptom-specific anxiety, and is considered effective in improving chronic esophageal symptoms associated with disorders of brain-gut axis communication.

This approach includes the measurement of Heart Rate Variability (HRV), which involves collecting raw electrocardiogram signals through a biofeedback system or using photoplethysmography (PPG) sensors to detect pulse wave signals. These signals are then converted into HRV indicators, which serve as markers of autonomic nervous system activity.

Heart Rate Variability Biofeedback (HRVB) can enhance HRV indices and has been shown to be effective in individuals with physical illnesses, psychological disorders, and even in healthy populations.^{38, 39}

Recent studies have shown that Cognitive Behavioral Therapy (CBT) can improve esophageal symptoms and quality of life in individuals with supragastric belching and non-erosive reflux disease (NERD).⁴⁰⁻⁴² Currently, Cognitive Behavioral Therapy (CBT) for gastrointestinal disorders typically involves 6 to 8 therapy sessions. In this study, participants will undergo either six weeks of CBT or lifestyle management, administered by psychologists trained in CBT and conducted in accordance with the clinical guidelines of the American Gastroenterological Association (AGA).⁴³

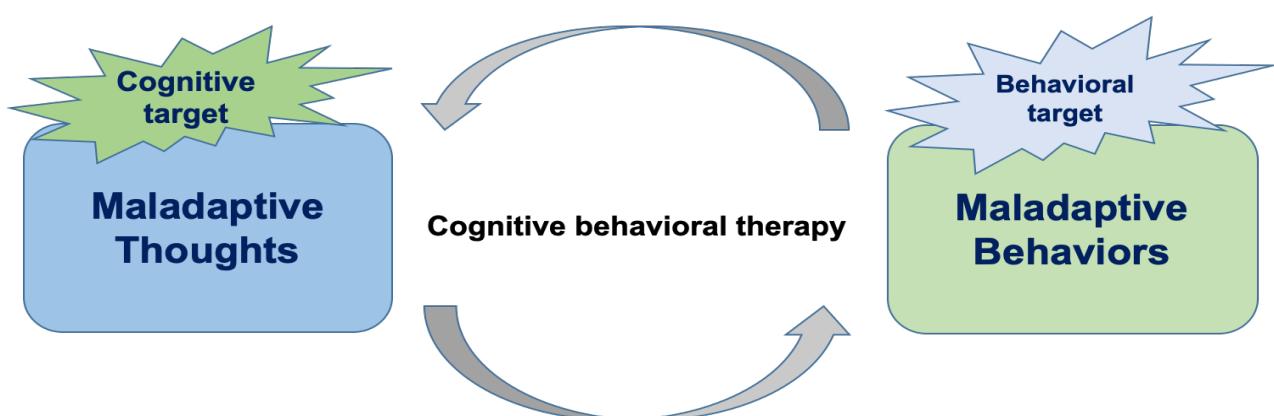


Figure 2. The primary goal of Cognitive Behavioral Therapy (CBT) is to modify maladaptive thoughts and behaviors in order to reduce esophageal hypervigilance.

Research Objectives

The objectives of this study :

Exploring the Effects of Cognitive Behavioral Therapy on Disorders of Esophageal Brain-Gut Axis Dysregulation.

Hypothesis:

- (1) Patients with disorders of esophageal brain-gut axis dysregulation often experience esophageal symptoms due to visceral hypersensitivity and esophageal hypervigilance, which can negatively affect their physical and mental health, sleep, and quality of life. Cognitive Behavioral Therapy (CBT) can help alleviate these symptoms and reduce their impact.
- (2) CBT has been shown to improve symptoms across different subtypes of disorders involving esophageal brain-gut axis dysregulation.

8. Research Methods, Procedures, and Execution Progress

1. Please describe in detail the research methods adopted in this project and the reasons for choosing them.
2. Potential challenges and solutions expected during the project.
3. If this is a continuous project, please also attach the progress report from the previous year or primary data.

Research Method

Participant

This project is a multi -center study. we will recruit cases from three medical centers in Taiwan, We plan to enroll a total of 120 participants, including 40 from our hospital, 40 from Kaohsiung Medical University Hospital, and 40 from E-Da Hospital.

This study is expected to last for 2 years, with the study period ending on December 31, 2025. We intend to recruit participants with esophageal symptoms related to disorders of the gut-brain axis communication from the Gastroenterology outpatient clinics.

Inclusion criteria for participants :

1. Age between 18 and 75 years, with clear consciousness and willingness to sign the informed consent form.

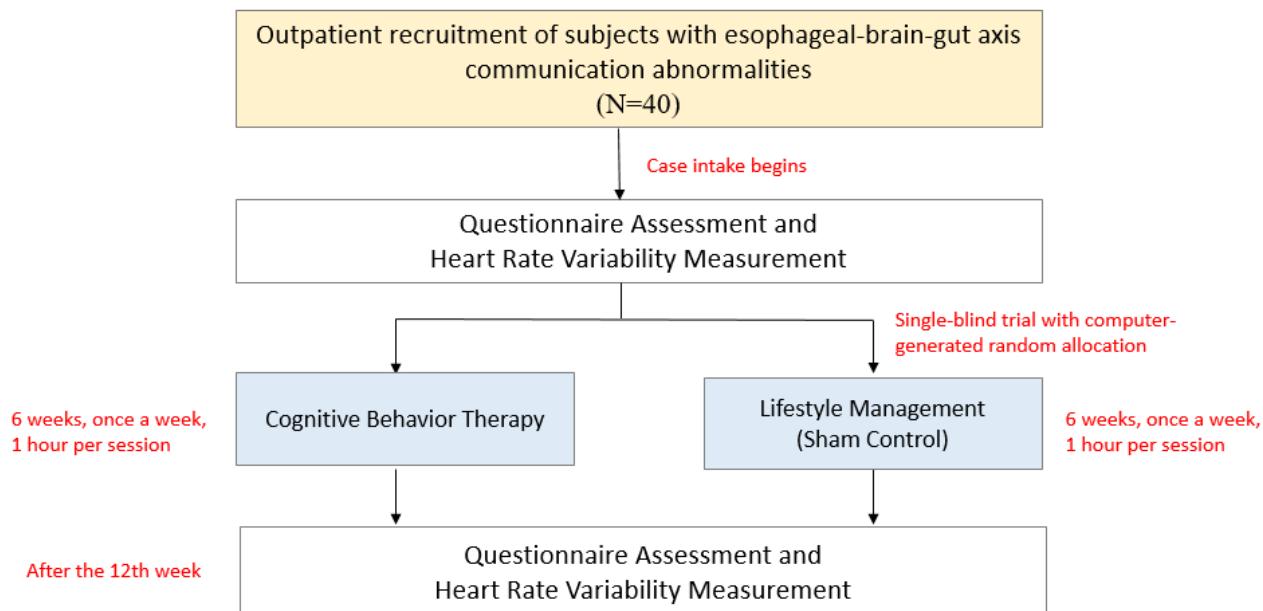
Version Date : (Version 8, 11/19/2024)

2. Participants with chronic esophageal symptoms related to esophageal-brain-gut axis communication disorders (such as heartburn, acid reflux, sensation of a foreign body in the throat, difficulty swallowing, chest pain, and chest tightness).

Exclusion criteria for participants :

1. Esophageal stricture, or a history of esophageal, gastrointestinal, or throat surgery.
2. Structural esophageal diseases (e.g., diverticula, esophageal rings), infectious esophagitis, erosive esophagitis, eosinophilic esophagitis.
3. Non-erosive gastroesophageal reflux disease or significant esophageal motility disorders.
4. A history or current diagnosis of esophageal, gastrointestinal, or other organ malignancies.
5. Significant endocrine or rheumatic autoimmune diseases that may affect gastrointestinal motility.
6. Continuous use of medications that may affect esophageal motility (e.g., anticholinergics, morphine-like drugs, nitrates, calcium channel blockers) within the past month.
7. Use of antidepressants, selective serotonin reuptake inhibitors, or other psychiatric medications within the past three months.
8. Pregnant or breastfeeding women.
9. Individuals with mental disorders or those unable to cooperate.
10. Known allergy to tricyclic antidepressants.
11. Known allergy to selective serotonin reuptake inhibitors.
12. Known allergy to any component of proton pump inhibitors.

Research Design Flowchart



Steps to Follow

In this study, All participants will undergo questionnaire assessments and heart rate variability measurements before treatment. The questionnaires include the Gastroesophageal Reflux Disease Questionnaire (GERDQ), PROMIS GERD, DSI & GSS, RSI, Brief Esophageal Dysphagia Questionnaire (BEDQ), Esophageal Hypervigilance and Anxiety Scale (EHAS), Visceral Sensitivity Index (VSI), Sleep and Mental Health Questionnaires (Sleep Habits Questionnaire PSQI, Taiwanese Depression Questionnaire TDQ, State-Trait Anxiety Inventory STAI, Functional Dyspepsia (FD) Questionnaire, Irritable Bowel Syndrome (IBS) Questionnaire, Quality of Life Questionnaire SF-12, and Northwest Esophageal Quality of Life Scale (NEQOL). Heart rate variability will be measured using the non-invasive "Mind Technology" biofeedback system (Taiwan FDA Medical Device Certification No. 011374).

Following this, a single-blind trial will be conducted with computer-generated random allocation. Participants will receive either 6 weeks of Cognitive Behavioral Therapy (CBT) or 6 weeks of lifestyle management (sham control), with one 1-hour session per week. After 6 weeks of counseling, participants will undergo a final questionnaire assessment and heart rate variability measurement after the 12th week of enrollment. The questionnaires and measurements will take approximately 20 to 30 minutes to complete, marking the end of the trial.

Cognitive Behavioral Therapy (CBT) will be carried out according to the following steps :

(1) Education and Initial Follow-up

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- (2) Heart Rate Variability and Breathing Introduction
- (3) Cognitive Restructuring and Breathing Application
- (4) Cognitive Diffusion and Behavioral Experiments
- (5) Problem-Solving and Emotion-Focused Coping Strategies
- (6) End of Treatment and Relapse Prevention

Lifestyle Management (Sham Control) will be carried out according to the following steps :

- (1) Education and Initial Follow-up
- (2) Dietary Habits: What, When, Where, Why
- (3) Changing My Diet: Strategies and Barriers
- (4) Lifestyle Factors: Alcohol, Smoking, and Sugar
- (5) Lifestyle Factors: Sleep and Exercise
- (6) End of Treatment and Relapse Prevention

In this study, we will use non-invasive physiological signal sensors connected to a biofeedback system to measure the participants' physiological signals, including electrocardiogram (ECG) and breathing. Before measurement, participants will first apply ECG electrodes for a two-lead ECG measurement, which will then be converted into heart rate variability (HRV) indicators. Simultaneously, a non-invasive breathing sensor will be used to measure the respiratory rate per minute. Except for a very small number of participants who may experience allergic reactions to the ECG electrodes, the likelihood of side effects is less than 1%.

Multicenter Communication and Coordination Method

The hospital directors of the participating institutions and the principal investigator, Dr. Lei Wei-Yi, will communicate and coordinate via email and a Line group established for the project. The research data collected by each center will be managed and stored by the respective center's director. The hospital directors will assist in consolidating the research data from their institution, and the electronic data will be coded for identification. After the data is compiled, it will be sent back to the principal investigator. Additionally, the research physicians and staff at each participating center will have regular video conferences (every 2 months) to discuss and report on the progress of the study.

Statistical Analysis

All data will undergo normality testing using the Kolmogorov-Smirnov test. If continuous variables follow a normal distribution, they will be expressed as means and standard deviations; if not, they will be presented as medians and interquartile ranges.

For categorical variables, the Chi-square test or Fisher's exact test will be used for analysis. Continuous variables that are normally distributed will be analyzed using the unpaired t-test, while non-normally distributed continuous variables will be analyzed using the Mann-Whitney U test.

For comparisons involving more than three groups, if the data are normally distributed, an ANOVA with post hoc tests will be conducted. If the data are non-normally distributed, the Kruskal-Wallis test will be applied. A p-value of less than 0.05 will be considered statistically significant.

Statistical analyses will be performed using SPSS 19 for Windows (SPSS, Inc., Chicago, IL, USA).

Clinical Significance and Originality of This Study

1. The originality of this study lies in its use of visceral sensitivity, mind-body connection, esophageal hypersensitivity, anxiety questionnaires, and functional gastrointestinal questionnaires to explore the effects of neuromodulators on diseases related to esophageal-brain-gut axis communication abnormalities. Patients with such conditions often experience more severe esophageal symptoms due to excessive visceral sensitivity and esophageal hypersensitivity.
2. This study aims to establish a model for Cognitive Behavioral Therapy (CBT) in disorders of esophageal brain-gut axis dysregulation. Our research examines the role of CBT in esophageal brain-gut axis dysregulation and refractory gastroesophageal reflux disease (GERD). The results obtained from this study will deepen our understanding of the pathophysiological mechanisms of esophageal brain-gut axis dysregulation and refractory GERD. The findings will help elucidate the etiology of refractory GERD, particularly when patients with GERD also present with esophageal brain-gut axis dysregulation, which leads to a lowered threshold for esophageal symptom perception. This condition can be reversed and improved through the aforementioned treatments. Furthermore, it will assist in early clinical intervention for patients with brain-gut axis communication disorders, enabling the establishment of personalized treatment strategies and the achievement of precision medicine for such patients.

9.Expected Work Items and Specific Outcomes

- (1) Please list the expected tasks to be completed within the execution period.
- (2) Expected contributions to academic research and other applied areas.
- (3) Expected training that participants will receive.

(1) Work items expected to be completed.

In this study, we will also explore the effects of Cognitive Behavioral Therapy (CBT) on disorders of esophageal brain-gut axis dysregulation, as well as its impact on physical and mental health and quality of life.

(2) The anticipated contributions to academic research, national development, and other applications.

1. The data obtained from this study will allow us to understand the role of visceral sensitivity and esophageal awareness in esophageal-brain-gut axis communication abnormalities and refractory gastroesophageal reflux disease. It will also help us establish the role of Cognitive Behavioral Therapy (CBT) in esophageal-brain-gut axis communication abnormalities and their impact on the regulation of brain-gut axis communication.
2. Clinically, patients with esophageal-brain-gut axis communication abnormalities often experience delayed diagnoses and poor treatment outcomes. The results of this study will enable us to intervene early and accurately in such brain-gut axis communication abnormality cases, helping clinical healthcare providers develop precise and effective treatment strategies.

(3) The expected training for the participating staff.

In addition to receiving general research training (such as experimental design and execution, questionnaire creation and completion, result analysis and statistics, chart creation, oral presentations, writing papers, and the submission process), participants will also have the opportunity to learn more specialized research design and numerical analysis techniques.

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