

Progress in the Application of Acupuncture Intervention in Common Childhood Diseases: From Clinical Efficacy to Mechanism Exploration

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Abstract: *Acupuncture, a key component of Traditional Chinese Medicine, has gained increasing attention in recent years for the treatment of common pediatric illnesses. This article reviews the progress in the clinical application of acupuncture for respiratory, digestive, and nervous system diseases, as well as other common pediatric conditions, and summarizes its effectiveness in improving symptoms and enhancing quality of life. Analysis of relevant studies revealed that acupuncture has significant effects in regulating lung qi, promoting gastrointestinal motility, improving neurobehavioral function, and enhancing immunity. The biological mechanisms underlying acupuncture interventions were further explored, including neuromodulation, immunomodulation, endocrine and metabolic regulation, and microecological and brain-gut axis regulation. Although current research has achieved some results, deficiencies remain in clinical study design, in-depth mechanism exploration, and the development of treatment protocols. Future efforts should strengthen high-quality clinical trials and multidimensional mechanism research to promote the standardization and modernization of acupuncture in pediatrics and provide safe and effective treatment options for children's health.*

Keywords: Acupuncture, Common pediatric diseases, Clinical efficacy, Mechanism of action, Brain-gut axis, Immunomodulation.

1. Introduction

In recent years, the incidence of common pediatric diseases such as respiratory infections, gastrointestinal diseases, neurodevelopmental disorders, and allergic reactions has been increasing worldwide [1]. These diseases not only affect children's physical health and quality of life, but also place a heavy burden on families and healthcare systems. Although traditional treatments are often effective, they may be accompanied by side effects, limited long-term efficacy, or poor compliance in the pediatric population. Therefore, complementary and alternative therapies, especially acupuncture, have received increasing attention due to their potential to provide safe, non-drug interventions in children [2].

Acupuncture is a core therapy in Traditional Chinese Medicine (TCM) that has been practiced for thousands of years and is widely recognized for its regulatory effects on the nervous, immune, and endocrine systems [3]. In pediatric care, acupuncture is highly regarded for its gentle treatment, minimal invasiveness, and holistic approach. Acupuncture has been used in a variety of pediatric diseases, from asthma and allergic rhinitis to functional gastrointestinal disorders, sleep disorders, and behavioral problems [4]. Clinical studies have shown that acupuncture is effective in relieving symptoms, regulating immunity, and improving quality of life, making it a viable adjunctive therapy or alternative to traditional therapies [5].

Despite the increasing clinical application of acupuncture, the mechanisms by which it exerts its therapeutic effects in children remain incompletely elucidated. Recent advances in biomedical research have begun to elucidate its potential pathways, including neuroimmune regulation, regulation of inflammatory cytokines, and interactions with the gut microbiota and the brain-gut axis [6, 7]. These findings

provide a scientific basis for integrating acupuncture into evidence-based pediatric practice [8]. This review aims to summarize the progress in the application of acupuncture in the treatment of common pediatric diseases, focusing on clinical efficacy and mechanistic insights. By combining traditional wisdom with modern science, we strive to highlight the value of acupuncture in pediatric healthcare and identify future research and clinical integration directions [9, 10].

2. Clinical Application of Acupuncture in Common Childhood Diseases

Childhood is a critical stage of growth and development. The immune system is not yet mature and organ function is still being improved. Therefore, it is more susceptible to the influence of external factors such as environment, diet, and emotions, which may induce diseases. Acupuncture, as a non-drug intervention, has unique advantages in regulating body functions and promoting recovery, especially in the treatment of common childhood diseases.

2.1 Respiratory Diseases

Respiratory diseases are one of the most common types of diseases in children, especially in environments with changing seasons or poor air quality. Common diseases include pediatric cough, bronchial asthma, allergic rhinitis, etc. There have been many studies on the application of acupuncture in such diseases. Commonly used acupoints in clinical practice include Yingxiang, Feishu, Lieque, Tiantu, etc., which have the functions of clearing the lungs and relieving coughs, opening the nose and opening the orifices, and regulating qi [11]. Studies have shown that acupuncture can improve the function of respiratory mucosa by regulating lung qi, dredging meridians, enhancing immunity, and reducing the frequency of use of hormone drugs. A

randomized controlled trial showed that acupuncture combined with conventional treatment can significantly improve the lung function indicators of children with asthma, improve the frequency of nighttime coughing, and improve the quality of life [12]. In addition, acupuncture can reduce the recurrence rate of respiratory infections, improve the physical fitness of children, and have a good preventive effect [13].

2.2 Digestive System Diseases

Digestive system diseases such as pediatric diarrhea, constipation, anorexia, and functional gastrointestinal diseases have a high incidence in children, especially in infants and young children. Acupuncture can stimulate acupuncture points such as Zhongwan, Tianshu, Zusanli, and Qihai to promote gastrointestinal motility, regulate intestinal flora, and improve digestive function [14]. Studies have found that acupuncture has a good alleviating effect on diseases such as functional abdominal pain and irritable bowel syndrome, with few side effects and high compliance among children [15]. Some studies also point out that acupuncture can improve gastrointestinal motility disorders, regulate gastric acid secretion, and relieve symptoms such as abdominal distension and abdominal pain. In children with anorexia, acupuncture can regulate spleen and stomach function, enhance appetite, improve nutrient absorption, and promote growth and development [16].

2.3 Nervous System and Mental and Behavioral Disorders

As the pace of society accelerates, the incidence of children's nervous system and mental and behavioral disorders has increased year by year, including tics, attention deficit hyperactivity disorder (ADHD), sleep disorders, autism spectrum disorder (ASD), etc. The application of acupuncture in such diseases has gradually increased. Commonly used acupuncture points such as Baihui, Shenmen, Yintang, and Sishencong have the effect of calming the mind and harmonizing the brain [17]. Studies have shown that acupuncture can significantly improve attention, emotional stability, and sleep quality by regulating brain electrical activity and improving the levels of neurotransmitters such as dopamine and serotonin [18]. Some clinical studies have shown that acupuncture combined with behavioral intervention can improve treatment efficacy, shorten the recovery period, and improve social skills and language expression [19]. In addition, acupuncture also has a positive effect on improving children's anxiety, depression, and other emotional disorders.

2.4 Other Common Diseases

In addition to the above-mentioned diseases, the application of acupuncture in children with enuresis, low immune function, obesity, and physical weakness has also gradually attracted attention. Acupuncture at Guanyuan, Shenshu, Sanyinjiao and other acupoints can enhance physical fitness, regulate endocrine function, and improve metabolic function. In the intervention of childhood obesity, acupuncture combined with diet and exercise therapy can promote weight control, improve insulin resistance, and reduce the risk of metabolic syndrome [20]. For children with enuresis, acupuncture can improve nighttime urination control by

regulating bladder function and strengthening kidney qi [21]. In addition, acupuncture can also be used to improve children's resistance to disease, reduce the incidence of common infectious diseases such as colds and fever, and has a good preventive and health-care effect.

3. Exploration of the Mechanism of Action of Acupuncture Intervention

The therapeutic effect of acupuncture is not only reflected in the improvement of symptoms, but the biological mechanism behind it has also been gradually revealed by modern medical research. Through multi-system and multi-level regulatory effects, acupuncture has shown systemic and holistic advantages in the treatment of children's diseases. The following discussion will focus on neuroregulation, immune regulation, endocrine metabolism, microecological regulation, etc.

3.1 Neuroregulatory Mechanism

Acupuncture activates skin receptors by stimulating specific acupoints, transmits to the central nervous system, and regulates autonomic nervous function. Studies have shown that acupuncture can affect the functional activities of brain regions and improve the secretion of neurotransmitters such as dopamine and serotonin, thereby playing a role in regulating emotions, behavior, sleep, etc. [22]. In diseases such as tics and ADHD, acupuncture can improve the functional imbalance of the nervous system by regulating the excitatory and inhibitory functions of the cerebral cortex. Functional magnetic resonance imaging (fMRI) studies have shown that acupuncture can activate brain regions such as the prefrontal cortex and hippocampus, improving cognitive function and emotional regulation [23]. In addition, acupuncture can also regulate vagus nerve activity, affect heart rate variability, and enhance the self-regulation ability of the nervous system [6].

3.2 Immune Regulation and Inflammatory Response

Children's immune system is not yet fully mature and is vulnerable to invasion by external pathogens. Acupuncture can improve chronic inflammatory conditions by regulating immune cell activity and reducing the levels of inflammatory factors such as IL-6 and TNF- α [24]. In diseases such as asthma and allergic rhinitis, acupuncture can reduce IgE levels, regulate Th1/Th2 immune balance, and enhance the body's immune defense capabilities [25]. Studies have also found that acupuncture can promote T cell differentiation, enhance mucosal immune function, and help reduce the occurrence of respiratory infections [13]. In functional gastrointestinal diseases, acupuncture can reduce intestinal mucosal inflammatory response, improve intestinal barrier function, and relieve symptoms such as abdominal pain and diarrhea [7].

3.3 Endocrine and Metabolic Regulation

Acupuncture intervention can affect the function of the hypothalamic-pituitary-adrenal axis (HPA axis), regulate hormone secretion, and improve insulin sensitivity and lipid metabolism. In diseases such as childhood obesity and

endocrine disorders, acupuncture can help restore metabolic homeostasis and alleviate related symptoms. Studies have shown that acupuncture can reduce serum insulin levels, improve insulin resistance, and has positive significance for preventing childhood metabolic syndrome [20]. In addition, acupuncture can also regulate thyroid function and sex hormone levels, and has potential application value in diseases such as puberty developmental abnormalities and precocious puberty.

3.4 Microecology and Brain-gut Axis Regulation

Recent studies have found that intestinal flora plays an important role in children's health, especially in diseases such as functional gastrointestinal diseases and autism spectrum disorders. Acupuncture can affect the production of short-chain fatty acids, intestinal barrier function, and brain-gut axis signal transduction by regulating the structure of intestinal flora [26]. Some animal experiments have shown that acupuncture can increase the number of beneficial intestinal bacteria, reduce the colonization of pathogenic bacteria, improve intestinal permeability, and promote nutrient absorption and immune regulation [27]. As a key pathway connecting the central nervous system and intestinal function, the brain-gut axis plays an important role in emotional regulation and behavior control. Acupuncture can improve the social behavior, language expression and emotional stability of children with autism by regulating the signal transmission of the brain-gut axis, providing a new direction for mechanism research [28].

4. Research Status and Existing Problems

In recent years, the application of acupuncture in common childhood diseases has gradually received attention in the clinical and scientific research fields, and the number of related studies has continued to increase, covering multiple system diseases such as respiratory, digestive, nervous, and immune. A large number of clinical observations and some randomized controlled trials (RCTs) have shown that acupuncture has a positive effect on improving children's symptoms and improving their quality of life. However, there are still many deficiencies in the current research, which urgently needs further standardization and improvement.

First, the quality of clinical research varies. Some studies have small sample sizes and lack multi-center, large sample, and long-term follow-up designs, which affects the generalizability and credibility of the research results. Second, there is a lack of unified standards for acupuncture treatment plans. Different studies have large differences in acupoint selection, stimulation methods, treatment frequency, etc., making it difficult to form a replicable clinical pathway. Furthermore, the unique characteristics of children determine their sensitivity and compliance to acupuncture stimulation. Some studies have failed to fully consider the impact of factors such as age, physical constitution, and psychological state on therapeutic efficacy. Regarding mechanistic research, although some experimental studies have revealed the effects of acupuncture in neuromodulation, immunomodulation, and endocrine regulation, this research remains in its early stages. Most studies have focused on adult models, while research specifically addressing the physiological characteristics of

children is limited, lacking systematicity and depth. In particular, in emerging areas such as the brain-gut axis, gut microbiota, and metabolic pathways, acupuncture's mechanisms of action have yet to be fully established. Furthermore, ethical and safety issues are significant limitations to the widespread use of acupuncture in children. Although acupuncture is clinically considered relatively safe, children are more sensitive to pain and unfamiliar treatments, leading some parents to adopt a hesitant attitude, hindering its widespread adoption. Currently, there is a lack of a safety assessment system and operational protocols for acupuncture in children, and standardized guidelines are urgently needed to ensure safe treatment. While initial progress has been made in the application of acupuncture for common pediatric conditions, numerous challenges remain in study design, mechanism exploration, standardization, and safety assessment, requiring multidisciplinary collaboration.

5. Future Research Directions and Outlook

Acupuncture, as an important component of traditional medicine, holds broad application prospects in the treatment of pediatric illnesses. Future research should build on existing research, further expanding its depth and breadth to promote the standardized and scientific development of acupuncture in pediatrics. First, high-quality clinical research should be strengthened. It is recommended to adopt a multicenter, randomized, double-blind, controlled study design, increase the sample size, and extend the follow-up period to enhance the scientific and reliable nature of the research. Furthermore, a pediatric acupuncture database should be established to collect treatment data across age groups, constitutions, and disease types to provide a basis for personalized treatment. Second, mechanistic research needs to be expanded to a multidimensional and multisystemic approach. Integrating modern medical technologies, such as functional magnetic resonance imaging (fMRI), electroencephalography (EEG), metabolomics, and microbiome analysis, will allow for in-depth exploration of the mechanisms of action of acupuncture in neuromodulation, immunomodulation, endocrine regulation, and gut microbiota regulation. In particular, the potential regulatory effects of acupuncture in areas such as the brain-gut axis and neuroimmune networks deserve special attention. Specific acupuncture treatment protocols for children should also be developed. Based on the physiological characteristics of children of different age groups, appropriate operational standards should be established for acupoint selection, needling depth, stimulation intensity, and treatment frequency to enhance treatment safety and compliance. Furthermore, professional training for medical staff should be strengthened to improve their proficiency and communication skills in pediatric acupuncture, thereby promoting the integration of acupuncture with modern medicine. In the comprehensive treatment of childhood illnesses, acupuncture can be used in conjunction with medication, rehabilitation training, and psychological intervention to form a diversified, individualized treatment model. Through interdisciplinary collaboration, a child health management system integrating Traditional Chinese and Western medicine should be established to improve overall treatment outcomes and strengthen awareness and education among parents and the public. Through popular science education, clinical

demonstrations, and health lectures, public awareness and acceptance of acupuncture for the treatment of childhood illnesses should be increased, fostering a supportive social environment. In summary, the application of acupuncture for common childhood illnesses has broad potential for development. Future efforts should be made in clinical research, mechanism exploration, standard setting, and scientific outreach to promote the scientific, standardized, and international development of acupuncture in pediatrics, providing safer, more effective, and sustainable treatment options for children's health.

6. Conclusion

Acupuncture, as an important component of Traditional Chinese Medicine, demonstrates broad application value and promising clinical prospects in the prevention and treatment of common childhood illnesses. By regulating multiple mechanisms, including the nervous system, immune function, endocrine metabolism, and the intestinal microbiome, it achieves comprehensive intervention for multisystem diseases, including respiratory, digestive, and neurobehavioral disorders. This embodies the core principles of Traditional Chinese Medicine (TCM) of "holistic approach" and "differential diagnosis and treatment." While current research has achieved some results, significant deficiencies remain in clinical study design, in-depth mechanism exploration, and the development of treatment protocols. Future efforts should strengthen high-quality multicenter clinical trials, promote multidisciplinary cross-disciplinary mechanism research, establish a specialized acupuncture treatment system for children, and enhance public awareness and acceptance. Through the integration of Chinese and Western medicine, acupuncture is expected to play a greater role in child health management and provide solid support for the development of safe, effective, and personalized pediatric treatment models.

In summary, acupuncture intervention is not only a beneficial supplement to the treatment of common childhood illnesses but also a model for the integrated development of traditional and modern medicine. Driven by both scientific research and clinical practice, acupuncture will play an even more important role in pediatric medicine, safeguarding the healthy growth of children.

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