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Quantitative Data Mining and Analysis of the Efficacy and Quality of Life of Children with Dystonia in Herbal Medicine

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Abstract: This study investigates the efficacy of combined traditional Chinese medicine fumigation therapy with conventional rehabilitation treatment for pediatric dystonia and its impact on quality of life. Data from 80 pediatric dystonia patients treated at our hospital between August 2023 and March 2024 were analyzed using a randomized digital list method, with 40 patients assigned to each group (conventional therapy and fumigation therapy). The conventional group received standard rehabilitation treatment, while the fumigation group received additional traditional Chinese medicine fumigation therapy for 4 weeks. Muscle tone (MAS scores), motor function (GMFM scores), daily living skills (WeeFIM scores), and quality of life (PedsQL scores) were assessed before and after intervention, with statistical analysis performed using SPSS 26.0. Post-treatment evaluations showed that the fumigation group demonstrated statistically significant improvements ($P<0.001$) in all four scores compared to the conventional group. The combined therapy significantly enhanced muscle tone levels, motor function, self-care abilities, and quality of life in pediatric dystonia patients, demonstrating promising clinical application potential.

1. Introduction

Pediatric dystonia refers to abnormal muscle tone in children caused by central nervous system damage or developmental abnormalities, commonly seen in cerebral palsy and intellectual disabilities. It remains a major factor affecting motor development and quality of life in children. Although conventional rehabilitation therapies like physical training and occupational therapy have shown some effectiveness in recent years, they still face limitations in improving muscle tone and enhancing functional independence. Studies have demonstrated that appropriate Traditional Chinese Medicine (TCM) interventions can help alleviate muscle stiffness and improve rehabilitation efficiency. Herbal steam therapy, through pharmacotherapeutic effects, promotes local blood circulation and relaxes muscles. Combined rehabilitation approaches outperform single treatments across multiple indicators. This data mining study, based on these findings, analyzes the

intervention effects of TCM herbal steam therapy combined with conventional rehabilitation methods for pediatric dystonia. Quantitative evaluations of motor ability, daily living skills, and quality of life changes aim to provide clinicians with effective and safe new approaches to rehabilitation[1].

2. Data and Methods

2.1 Research data

This study enrolled 80 pediatric patients with dystonia treated at the Pediatric Rehabilitation Department of Zhejiang Provincial Hospital of Traditional Chinese Medicine from August 2023 to March 2024, all meeting diagnostic criteria for dystonia under the "Diagnostic Criteria for Cerebral Palsy in Children". Inclusion criteria included: (1) Age between 1-6 years old with no gender restrictions; (2) Confirmed dystonia symptoms by professional rehabilitation physicians; (3) Consciousness and ability to follow simple instructions without severe intellectual disability; (4) Parental informed consent for voluntary participation. Exclusion criteria were: (1) Patients with severe cardiac, pulmonary, hepatic, or renal dysfunction; (2) Recent use of medications affecting neuromuscular tone; (3) Allergies to traditional Chinese medicine or herbal fumigation therapy; (4) Severe skin lesions or injuries. Participants were randomly assigned into fumigation therapy group (40 cases) and conventional treatment group (40 cases) using a digital randomization table. No statistically significant differences were observed between groups in gender, age, dystonia severity, or disease duration ($P>0.05$), confirming comparability[2].

2.2 Research methods

The pediatric group receiving herbal fumigation therapy received it alongside standard rehabilitation treatments. Standard rehabilitation included physical therapy, occupational training, joint mobilization exercises, and neuromuscular electrical stimulation, administered once daily for 45 minutes over four weeks. The herbal fumigation used compound decoctions with blood-activating and meridian-relaxing properties, such as Angelica sinensis, safflower, Mu Xiang, Angelica dahurica, Rheum palmatum, myrrh, and Moutan bark. The herbal solution was boiled to create steam therapy at 38-42℃, with each session lasting 15-20 minutes daily for four weeks. Skin conditions were assessed before treatment, and tolerance was monitored during therapy. The control group received only standard rehabilitation without herbal fumigation. All children underwent standardized assessments using blinded questionnaires by trained evaluators to ensure data objectivity. A dedicated staff member recorded compliance, adverse reactions, and rehabilitation progress throughout the treatment period[3].

2.3 Research indicators

This study established four research indicators focusing on the core clinical manifestations and rehabilitation outcomes of pediatric dystonia. Muscle tone assessment: The Modified Ashworth Scale (MAS) was used to evaluate muscle tone levels in upper and lower limbs, with clear grading criteria that objectively reflect changes in muscle tone. Motor function evaluation: Items from the Gross Motor Function Scale (GMFM-88) covering crawling, standing, walking, and other functional modules were employed to quantify improvements in children's basic motor abilities. Daily living activities: The WeeFIM (Wee-Fin) assessed children's independence in self-care activities including eating, toileting, and dressing, with higher scores indicating greater independence. Quality of life evaluation: The PedsQL 4.0 measured overall quality of life across

physiological, psychological, social, and academic adaptation dimensions. All indicators were assessed before treatment initiation and after 4 weeks of therapy using standardized protocols by the same evaluator team to ensure data objectivity and consistency[4].

2.4 Statistical analysis

This study utilized SPSS 26.0 statistical software for data processing and analysis. Quantitative data were presented as mean ± standard deviation ($x \pm s$), with independent samples t-tests used for inter-group comparisons and paired t-tests for intra-group pre-post treatment comparisons. Categorical data were expressed as frequency and percentage [n(%)], with inter-group comparisons conducted using χ^2's test. All statistical analyses employed two-tailed tests at a significance level of $\alpha=0.05$, where $P<0.05$ indicated statistically significant differences. Data entry was independently performed by two researchers and cross-checked to ensure accuracy. Missing values were handled using mean imputation to minimize bias. To ensure objectivity, evaluation group information was blinded during statistical analysis. The final analysis included changes in various indicators before and after treatment and inter-group comparisons, serving as a basis for assessing the effectiveness of combined herbal fumigation therapy with rehabilitation treatment.

3. Results

3.1 Results of muscle tone improvement

In this study, the degree of muscle tone improvement serves as a key indicator for evaluating rehabilitation outcomes in pediatric dystonia. The Modified Ashworth Scale (MAS), a standardized tool for measuring muscle tone changes, provides a relatively objective assessment of spasticity or abnormal tension trends. At baseline, the MAS scores for the herbal fumigation group (2.8 ± 0.6) and conventional treatment group (2.7 ± 0.5) showed no statistically significant difference ($P>0.05$), indicating comparable baseline conditions. After four weeks of treatment, the MAS score in the herbal fumigation group significantly decreased to 1.6 ± 0.4, while the conventional group only reduced to 2.4 ± 0.5. Analysis using independent samples t-test revealed a statistically significant difference in post-treatment scores ($t=8.34$, $P<0.001$), demonstrating that combined herbal fumigation with rehabilitation therapy can more effectively reduce muscle tone in pediatric patients. Specific data are presented in the table 1.

Table 1: Improvement of muscle tone (MAS score)

group	Number of cases (n)	MAS score at treatment ($x \pm s$)	MAS score at treatment ($x \pm s$)	t price	p price
Fumigation group	40	2.8 ± 0.6	1.6 ± 0.4	8.34	<0.001
Regular group	40	2.7 ± 0.5	2.4 ± 0.5	2.35	0.023

As shown in the table, the intra-group comparison revealed a statistically significant improvement in muscle tone following treatment with the herbal fumigation group, evidenced by a t-value of 8.34 ($P<0.001$). In contrast, while the conventional group showed some improvement, its t-value was only 2.35 ($P=0.023$), indicating a smaller effect magnitude. Statistical analysis and clinical observations demonstrate that herbal fumigation synergizes with rehabilitation therapies through mechanisms including transdermal drug absorption, enhanced local blood circulation, and reduced neuromuscular excitability, thereby more effectively alleviating abnormal muscle tone symptoms in pediatric patients. These findings suggest that incorporating herbal fumigation into standard rehabilitation protocols holds clear clinical value for symptom management.

3.2 Results of motor function level

Motor function level serves as a crucial functional indicator for evaluating rehabilitation outcomes in children with dystonia. This study assessed key gross motor skills using items from the GMFM-88 scale, including sitting, crawling, standing, and walking. GMFM scores effectively reflect changes in motor function before and after rehabilitation interventions. Data in Table 2 show that the pre-treatment GMFM scores for the herbal medicine group (42.5±6.3) and the conventional treatment group (41.8±5.9) were statistically indistinguishable (P>0.05), indicating comparable baseline motor function levels with adequate foundational conditions. After 4 weeks of treatment, the herbal medicine group achieved a score improvement to 61.2±5.8, while the conventional group rose to 50.7±6.1, demonstrating functional improvements in both groups. Specific data are detailed in the table 2.

Table 2: Motor function level (GMFM score)

group	Number of cases (n)	GMFM score before treatment (x±s)	GMFM score after treatment (x±s)	t price	p price
Fumigation group	40	42.5±6.3	61.2±5.8	12.06	<0.001
Regular group	40	41.8±5.9	50.7±6.1	6.34	<0.001

As shown in the table above, the t-value for the difference in GMFM scores between the experimental group and the control group before and after treatment was 12.06, with P <0.001, indicating extremely significant improvement. The control group showed a t-value of 6.34 (P <0.001), which also demonstrated statistical significance, though the improvement magnitude was smaller than that of the herbal fumigation group. Post-treatment score comparisons between the two groups also reached statistically significant levels, demonstrating that the combination of traditional Chinese medicine fumigation and conventional rehabilitation interventions synergistically enhances motor function in pediatric patients. This finding supports the hypothesis that herbal fumigation improves children's motor coordination and stability through multiple mechanisms including muscle tone reduction, neuromuscular activation, and improved blood circulation, thereby accelerating the rehabilitation process and elevating the level of motor function recovery.

3.3 Results of daily living activities

The ability to perform daily living activities serves as a crucial indicator for evaluating rehabilitation outcomes in children with dystonia, closely reflecting their independence and functional recovery in real-life situations. This study employed the WeeFIM (Wee-Fin) scale to assess fundamental self-care abilities including eating, dressing, toileting, and mobility. Pre-treatment WeeFIM scores for the herbal treatment group (58.1±7.2) and control group (57.6±6.9) showed no statistically significant difference (P>0.05), indicating comparable baseline self-care levels and feasibility of comparison between groups. After four weeks of treatment, the herbal group achieved a score improvement to 77.4±6.6, while the control group rose to 66.9±7.1. These data demonstrate moderate improvements in daily living skills for both groups post-intervention, as detailed in the table 3.

Table 3: Daily living activities ability (WeeFIM score)

group	Number of cases (n)	Pre-treatment WeeFIM score (x±s)	WeeFIM score after treatment (x±s)	t price	p price
Fumigation group	40	58.1±7.2	77.4±6.6	11.84	<0.001
Regular group	40	57.6±6.9	66.9±7.1	5.71	<0.001

As shown in the table above, the t-value of 11.84 for the WeeFIM score difference between the herbal fumigation group and the control group before and after treatment was statistically

significant (P<0.001), demonstrating the intervention's remarkable effectiveness in enhancing children's self-care abilities. Although the control group showed improvement with a t-value of 5.71 (P<0.001), its improvement magnitude was significantly smaller than that of the herbal fumigation group. Comparative analysis of post-treatment scores revealed a significant difference between the two groups, indicating that combining traditional Chinese medicine fumigation with conventional rehabilitation therapy more effectively promotes children's development of daily living independence. The combined effects of herbal fumigation in muscle relaxation, joint stiffness reduction, and lower limb function enhancement provide children with better physical foundations for completing daily activities, thereby improving their autonomy and adaptability in functional tasks.

3.4 Results of quality of life assessment

The quality of life (QOL) score serves as a comprehensive and humanistic indicator for evaluating rehabilitation outcomes in children with dystonia, reflecting both physical/mental changes and social adaptation during recovery. This study utilized the Pediatric Quality of Life Scale (PedsQL 4.0) to assess multiple dimensions including physical function, emotional state, social skills, and daily learning participation. The scale not only measures symptom improvement but also demonstrates interventions 'positive impact on children's overall quality of life. Data in Table 4 showed comparable pre-treatment QOL scores between groups: 51.3±6.5 for the herbal treatment group versus 50.8±6.1 for the conventional care group, with no statistically significant difference (P>0.05), establishing a valid control for subsequent comparisons. After four weeks of treatment, herbal therapy group scores rose to 70.5±5.7 while conventional care improved to 61.2±6.4, indicating the combined treatment demonstrated greater efficacy in enhancing patients' quality of life. Specific data are presented in the table 4.

Table 4: Quality of life scores (PedsQL scores)

group	Number of cases (n)	PedsQL score before treatment (x±s)	PedsQL score after treatment (x±s)	t price	p price
Fumigation group	40	51.3±6.5	70.5±5.7	11.33	<0.001
Regular group	40	50.8±6.1	61.2±6.4	6.47	<0.001

As shown in the table, the t-value for PedsQL scores in the herbal fumigation group before and after treatment was 11.33 (p<0.001), demonstrating significant improvement. The conventional group showed a score increase of 6.47 (p<0.001), also statistically significant but with relatively smaller improvements. The post-treatment score differences between groups were statistically significant, indicating that herbal fumigation intervention not only improves muscle tone and motor function but also positively impacts children's psychological state, social adaptation, and overall life satisfaction. This effect is attributed to enhanced confidence and emotional stability resulting from improved muscle tone and motor function, which in turn improves interaction quality with family and peers while boosting overall life satisfaction. These findings further highlight the multi-level value of comprehensive rehabilitation programs in pediatric recovery.

4. Discussions

4.1 Discussion on the degree of muscle tone improvement

Dystonia is a common complication in children with cerebral palsy, traumatic brain injury, and post-encephalitic conditions, significantly impairing motor function. This study demonstrated that combining herbal steam therapy with conventional rehabilitation treatment effectively improves

muscle tone. The MAS score in the herbal steam group decreased from 2.8±0.6 to 1.6±0.4, showing significantly better results than the control group ($t=8.34$, $P<0.001$), indicating herbal steam therapy's efficacy in regulating muscle tone. The mechanism may involve drug components penetrating the skin via vapor, dilating capillaries, improving circulation, and modulating nerve endings to alleviate muscle spasms. The control group receiving only conventional rehabilitation showed a slight improvement ($t=2.35$, $P=0.023$) with a MAS score reduction from 2.7±0.5 to 2.4±0.5. This suggests that single-reinforcement therapies have limited effectiveness in initial muscle tone management. Combined herbal steam therapy can more rapidly relieve hypertonic states, laying a foundation for subsequent training [5].

4.2 Discussion on motor function level

Improving motor function remains the core objective in pediatric dystonia rehabilitation, where scientific intervention and timing are particularly crucial. This study employed the GMFM scale to evaluate gross motor skills. The herbal fumigation group achieved a significant improvement from 42.5±6.3 to 61.2±5.8 ($t=12.06$, $P<0.001$), while the conventional group showed improvement from 41.8±5.9 to 50.7±6.1 ($t=6.34$, $P<0.001$), though the latter was markedly less effective. The statistically significant post-treatment score difference between groups indicates that herbal fumigation demonstrates synergistic effects in motor rehabilitation. This treatment relaxes muscles, enhances elasticity, increases joint mobility, reduces stiffness, and improves motor execution. By alleviating muscle rigidity, it makes training more acceptable and promotes neuromotor circuit reconstruction. Additionally, the blood-activating components in traditional Chinese medicine (TCM) enhance neural conduction speed and muscle responsiveness. This study validates the scientific validity and feasibility of TCM-integrated rehabilitation models in improving motor function, providing theoretical support for diversified therapeutic strategies.

4.3 Discussion of daily living activities

Daily living skills serve as a crucial indicator for evaluating rehabilitation outcomes in pediatric patients, encompassing self-care, mobility, and communication abilities. In this study, the WeeFIM scores in the herbal fumigation group increased significantly from 58.1±7.2 to 77.4±6.6 ($t=11.84$, $P<0.001$), demonstrating remarkable efficacy. The conventional group showed only modest improvement (from 57.6±6.9 to 66.9±7.1, $t=5.71$, $P<0.001$). The statistically significant score difference between the two groups indicates that herbal fumigation positively enhances children's comprehensive capabilities. The WeeFIM assessment evaluates multiple systems working in concert, including neuromotor control, joint mobility, and motor execution. Herbal fumigation alleviates muscle stiffness, improves joint flexibility, enhances emotional well-being, and boosts training engagement, thereby facilitating better translation of rehabilitation achievements into real-life functional abilities. Research demonstrates that this therapeutic approach enhances children's independence in authentic environments, providing foundational support for achieving social transformation goals in rehabilitation programs.

4.4 Discussion of quality of life score

Quality of life serves as a vital indicator for evaluating rehabilitation outcomes, reflecting children's physical and mental states along with their well-being. In this study, the PedsQL scores in the herbal fumigation group increased from 51.3±6.5 to 70.5±5.7 ($t=11.33$, $P<0.001$), while those in the conventional group rose from 50.8±6.1 to 61.2±6.4 ($t=6.47$, $P<0.001$). Although both groups showed significant improvement, the herbal fumigation group demonstrated greater progress,

indicating its positive impact on overall quality of life. The enhanced quality of life was closely associated with reduced muscle tension, restored motor function, and improved daily independence. Herbal fumigation, being gentle and non-invasive, is more readily accepted by pediatric patients while providing comfort and emotional reassurance. Notably, the fumigation group exhibited particularly marked improvements in emotional and social dimensions, suggesting this therapy helps enhance children's adaptability and life satisfaction. The research confirms that combining herbal fumigation with rehabilitation interventions can significantly improve quality of life, demonstrating promising clinical application value.

5. Conclusion

The results of this study demonstrate that the combination of herbal fumigation and conventional rehabilitation therapy shows significant advantages in improving pediatric dystonia. Through data analysis of 80 pediatric patients, the fumigation group exhibited statistically significant improvements ($P<0.001$) in four core indicators: muscle tone, motor function, daily living skills, and quality of life, all surpassing the conventional treatment group. This indicates that herbal fumigation, as a non-invasive and highly practical traditional Chinese medicine approach, can effectively synergize with rehabilitation training to enhance therapeutic outcomes, promote functional recovery, and improve children's overall quality of life. The method demonstrates promising clinical application potential and practical value, warranting further exploration and implementation in pediatric rehabilitation fields.

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