International Journal for Housing Science and Its Applications
Publish August 10, 2025. Volume 46, Issue 4 Pages 3720-3731

https://doi.org/10.70517/ijhsa464496a

A Functional Study of AI-Based Intelligent Clothing Design in the Housing Lives of Porcelain Dolls with Disabilities

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Abstract How to effectively protect the housing and living conditions of porcelain dolls with disabilities, combined with artificial intelligence technology to give porcelain dolls with disabilities a new hope for life, is an important issue in caring for porcelain dolls with disabilities. In this paper, on the basis of analyzing the disease manifestations and treatment methods of porcelain dolls with disabilities, we put forward the specific design process of combining intelligent clothing with the housing life of porcelain dolls with disabilities, and analyze the life assistance as well as the functional evaluation of intelligent clothing through comparative experiments. The overall time consumed by porcelain dolls with disabilities in putting on and taking off smart garments was 85.086s and 34.899s, respectively, which only accounted for 69.20% and 73.68% of the time spent on putting on and taking off ordinary garments. After wearing the smart garments to carry out rehabilitation exercise, the dynamic and static balance abilities of porcelain dolls with disabilities were significantly different from those of the control group ($P<0.05$), and the quality of life was significantly improved. The smart clothing can monitor and warn the temperature and humidity of porcelain dolls with disabilities in real time when they carry out rehabilitation exercise, and the mean value of breathability evaluation reached 8.507 points. Combining smart clothing with the housing life of porcelain dolls with disabilities can better enhance the satisfaction of the housing life of porcelain dolls with disabilities and regain the courage and confidence in life.

Index Terms housing life, porcelain dolls with disabilities, smart clothing, functional evaluation

I. Introduction

The medical name for “porcelain doll” is osteogenesis imperfecta or osteogenesis imperfecta (OI). It is a congenital inherited pain due to underdevelopment of mesenchymal tissues and impaired collagen formation and is a congenital skeletal disorder [1], [2]. Brittle bone disease is typically characterized by skeletal deformities, brittle bones, recurrent fractures, blue sclerae, joint laxity, and progressive deafness, with frequent fractures and decreased bone mineral density being the prominent clinical features [3], [4]. Often starting at a young age, fractures can occur with minor trauma, and in severe cases, fractures may occur in utero or at birth, resulting in deformities such as scoliosis, thoracic collapse, and curvature of limbs, and even death due to cardiac and pulmonary failure caused by lung infections and thoracic deformities [5]-[8]. Patients may also have extra-skeletal manifestations such as hearing loss, laxity of joint ligaments and cardiac valvulopathy [9].

Osteogenesis imperfecta is incurable and its treatment aims to minimize the likelihood of fracture, surgically correct the deformity, reduce the likelihood of bone fragility by enhancing bone density, as well as minimize pain, and maximize the patient's flexible and independent function [10], [11]. Modification of the patient's behavior and lifestyle is the better preventive treatment available. With the help of compensatory equipment and walking aids in housing life, situations that may cause fractures can be avoided, in addition to assisting patients in specific joint stretching and muscle strength training, appropriate weight-bearing training, which can help to enhance the patient's muscle strength, promote blood circulation and improve mobility [12]-[15]. With technological advances and growing medical needs, it is just around the corner for smart products based on AI smart clothing design to become a convenient and efficient tool for patients with brittle bone disease [16], [17].

This paper proposes a smart clothing design process for optimizing the housing life of porcelain dolls with disabilities, and verifies the feasibility of the method in improving the housing life of porcelain dolls with disabilities through comparative experiments.

In different housing life scenarios, porcelain dolls with disabilities may fall and have uncomfortable environmental temperature due to their own reasons, and the proposal of smart clothing gives new solutions to these situations. The article introduces the concept of smart clothing for the design process of smart clothing for porcelain dolls with disabilities on the basis of sorting out the pathogenesis and treatment of porcelain dolls with disabilities. It puts forward the specific scheme of intelligent clothing design for porcelain dolls with disabilities and the design architecture of intelligent components, designs the intelligent clothing value evaluation process, and analyzes its life-assisting ability as well as the functional evaluation results through the comparative experiments of designing intelligent clothing to wear.

II. Porcelain dolls for the disabled and smart clothing

As a class of multidisciplinary cross-cutting technology fusion of special types of clothing, smart clothing compared to the role of traditional clothing in a broader scope, for porcelain dolls with disabilities, smart clothing to give them more possibilities for independent living. Through the smart clothing can effectively monitor the changes in their physical indicators, for the better development of porcelain dolls disabled people's treatment programs, but also for the comfort of their mental health to provide a feasible program, but also for porcelain dolls disabled people's housing life to bring new hope.

II. A. Porcelain dolls for the disabled

II. A. 1) Manifestations of disability in porcelain dolls

The medical name for “porcelain doll” is osteogenesis imperfecta or osteogenesis imperfecta (OI). Characterized by weak bones, blue sclera, deafness, and joint laxity, it is a congenital, hereditary, painful condition caused by underdevelopment of mesenchymal tissue and impaired collagen formation, and is a congenital bone disorder. It is characterized by bone fragility and susceptibility to fracture. The etiology is unknown and more than 15% have a positive family history. According to the severity of the disease, it can be divided into prenatal and postnatal types. The prenatal form is the most severe, with healed or fresh fractures at birth, and predisposes to stillbirth or death shortly after birth. Postnatal type is milder, some of the first fracture occurs only in childhood. The incidence of porcelain doll disability in China is about 1 in 15,000, about one in 12-15,000 births, and the probability of OI occurring is the same in males and females and among different races and ethnicities [18].

More than 90% of the children are born with blue sclera, although the stature is not obviously short, but multiple fractures can lead to shorter limbs and varying degrees of dwarf deformity, there may be dental anomalies, laxity of joints, excessive sweating and abnormal temperature, subcutaneous hemorrhage, keloidal body, as well as constipation and respiratory difficulties, etc. After the age of 40 years, vertigo, tinnitus and even deafness can occur. There may be central nervous system involvement and early onset of joint degeneration. Osteoporosis and osteochondrosis may cause long bone curvature, flat vertebrae and posterior protrusion of the spine, trilobar pelvis, and flat skull base, and about 1/3 of the patients may have scoliosis, thoracic deformity, large head size, temporal protrusion on both sides, and triangular face.

II. A. 2) Treatment of disability in porcelain dolls

For severe or fatal osteogenesis imperfecta the initial diagnosis can be made by prenatal ultrasound and further confirmed by computed tomography (CT) and magnetic resonance imaging (MRI) testing and genetic testing. Early prenatal diagnosis provides parents with more time to decide on reproductive options, leading to eugenic births. There is no cure for patients who have already been born, but the following measures can be taken to treat the symptoms [19].

(1) Lifestyle. Patients with osteogenesis imperfecta should pay special attention to avoiding falls in daily life. Patients may suffer from muscle atrophy if they have repeated fractures and their daily activities are limited. Therefore, functional exercises should be strengthened to increase muscle strength and improve body coordination.

(2) Diet. Calcium-rich food should be eaten more often, and at the same time, more outdoor exercise and sunshine can promote the skin to synthesize vitamin D, which is beneficial to the patient's bone health.

(3) Medication. Appropriate amount of calcium and vitamin D can provide the nutrients needed by the bones, but supplementation of transthyretin and vitamin D preparations alone is far from enough to reduce the probability of fracture in patients. Currently the most effective and widely used drugs for osteogenesis imperfecta are bisphosphonates, which can increase bone density, reduce bone pain, and lower the risk of fracture in children and adult patients.

(4) Surgical treatment. For patients with osteogenesis imperfecta who have unstable fractures, severe skeletal deformities that significantly affect the patient's quality of life, or severe traumatic arthritis, appropriate surgical treatment may be chosen.

(5) Rehabilitation. Rehabilitation training helps to enhance the muscle strength and improve the mobility of patients with osteogenesis imperfecta. Rehabilitation training is especially important for patients with delayed growth and development in infancy and childhood, and those who are sedentary due to trauma, fracture or fear of pain after surgery.

II. B. Intelligent Clothing Related Theory

II. B. 1) Basic Definition of Smart Clothing

In this paper, the definition of smart clothing is interpreted in both the broad and narrow sense. In a broad sense, smart clothing is understood as an interdisciplinary research object between different disciplines, as shown in Figure 1. It is important from what perspective researchers define smart clothing as a research object and how different research paradigms are defined among different disciplines, and on what basis the product intelligence assembled is based. In addition, according to the summary of existing related research, smart clothing is classified within an interdisciplinary field of design, research, physiology, and textile technology.

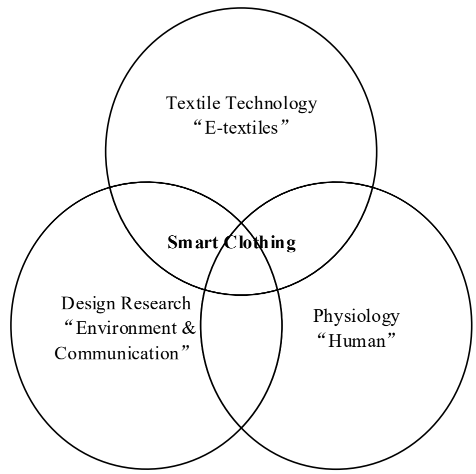

Figure 1: The definition of an interdisciplinary smart Clothing

Intelligent clothing in a narrow sense is not only able to perceive changes in the internal state and external environment, but also can make real-time processing of the resulting changes through the feedback mechanism, so it refers to clothing with the ability to simulate the life system while having both perception and processing functions [20]. Thus perception, processing and feedback are the three main elements of smart clothing. Smart clothing is a combination of electronic information technology, sensor technology, biological science and materials science and other related fields of cutting-edge science and technology, through the use of smart materials and the introduction of advanced information technology and microelectronics technology into people's daily wear of clothing in these 2 categories of methods to achieve intelligent clothing. In this paper, we start from the intelligent clothing in the narrow sense, and study the intelligent clothing design of porcelain dolls for people with disabilities.

II. B. 2) Smart Clothing Application Classification

Smart clothing is a new type of clothing designed by integrating multiple disciplines such as clothing engineering, material science, data visualization, and sensing technology, which can realize the real-time collection of a variety of human body data such as heart rate, pulse, and body temperature, and visualize the data feedback through the application program, so as to satisfy all kinds of users' needs [21]. According to different application scenarios of smart clothing, its main classification is shown in Figure 2, including four categories: work function, life and health, art experience, and protection of vulnerable groups.

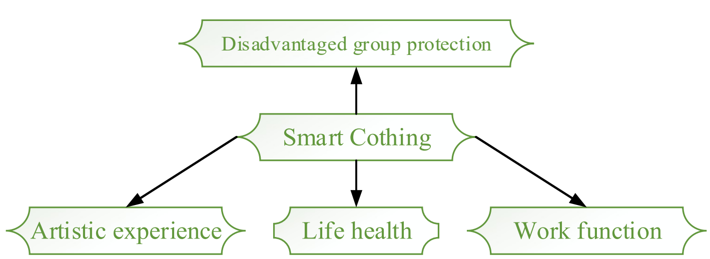

Figure 2: Classification of smart clothing applications

Among them, protective clothing will become the focus in the development of smart clothing, and the main functions of smart protective clothing are localization, intelligent warning, remote monitoring and so on. Relying on smart clothing to meet the higher requirements of people with disabilities to life, better enhance the sense of well-being, satisfaction and accessibility of people with disabilities.

III. Porcelain Doll Intelligent Clothing Design for People with Disabilities

Porcelain dolls with disabilities due to their own physical defects can not better adapt to life, and a great burden on society and life. Clothing, food, housing, transportation is the basic content of human social life, clothing as an important part of it, due to the porcelain dolls disabled people's physiological functions, physical and other special features, ordinary clothing is difficult to meet the needs of their attire, which in turn causes their own and caregiver's inconvenience, want to improve the quality of life of porcelain dolls that can not be ignored that for their physical and mental needs to provide them with intelligent clothing.

III. A. Porcelain Doll Intelligent Clothing Design Process and Elements

III. A. 1) Smart Clothing Design Process

Based on the current research and analysis related to smart clothing design, this paper proposes a smart clothing design process applicable to porcelain dolls with disabilities as shown in Figure 3, starting from the housing and living conditions of porcelain dolls with disabilities. Including the collection of intelligent wearable devices, organize information and establish a database, analyze the life needs of porcelain dolls with disabilities and health and safety hazards, program design and clothing production, clothing performance testing and improvement, market testing and feedback redesign.

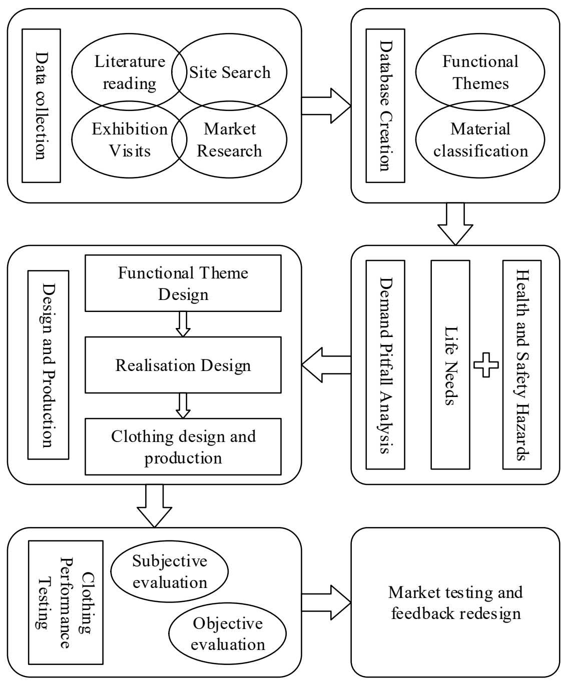

Figure 3: Design process of smart clothing

(1) Collecting information on smart wearable devices. Collecting information on smart wearable devices includes information on smart clothing and other smart wearable devices.

(2) Organize the information and establish a database. Organize the collected information and set up a library of intelligent wearable product information, which is divided by functional themes, and can be divided by clothing materials and electronic components under the same functional theme.

(3) Analyze the life needs and health and safety hazards of porcelain dolls with disabilities. Through the research of the database to analyze the porcelain doll disabled people's life needs and health and safety risks. Intelligent clothing theme function design should be close to the daily life of porcelain doll disabled people, to meet their living or learning needs.

(4) Program design and clothing production. Determine the functional theme of the design, taking the user-centered principle as the core, focusing on the principle of safety and environmental protection. And combine the functional principle with the artistic principle, from the four aspects of fabric component selection, color design, structural style design and technical process to determine the overall design and production of intelligent clothing.

(5) Clothing performance testing and improvement. Adopt subjective and objective methods to evaluate the performance of the developed garments, adjust and improve the garments and electronic components according to the evaluation results, and record the non-adjustable functional problems and deficiencies of the garments in order to prepare for the second improvement of the design.

(6) Market inspection and feedback redesign. For the better designed intelligent clothing products can be put into the market in appropriate quantities, and the use of porcelain dolls for the disabled to track feedback. Feedback results for comprehensive research and analysis, as an important source of reference for clothing redesign.

III. A. 2) Smart Clothing Design Elements

(1) Fabric design

The importance of fabric design for smart garments for porcelain dolls with disabilities lies in its direct impact on protection, comfort and durability. Fabrics in this series of designs tend to favor protective properties, breathability and comfort, durability, lightweight and portability, sustainability, and smart integration. Lightweight fabrics reduce the burden on porcelain dolls with disabilities and increase the comfort of movement. The selected fabrics need to have good electrical conductivity, flexibility, and processability in order to seamlessly integrate smart sensors, actuators, and other devices with the fabrics.

In terms of fabric processing, the smart garments designed in this paper utilize an advanced hot-pressing process to ensure high quality and superior performance of the fabrics. This processing process tightly integrates the fabric with other components through the action of high temperature and pressure, which provides excellent sealing without air leakage. Through the hot pressing process, the fabric is seamlessly connected to the other components of the garment, ensuring the overall strength and stability of the garment.

(2) Structural style design

The structural design of smart garments for porcelain dolls with disabilities aims to provide a high degree of protection, comfort and portability. The structural design needs to consider the following aspects, i.e., ergonomics, modular design, integration of smart components, and adjustability.

Safety apparel should follow the physiological structure and movement characteristics of the human body to ensure comfort and freedom. With modular design, users can easily add or remove components as needed. For effective information collection, processing and actuation, smart sensors, actuators and controllers need to be closely integrated with the structural design. To accommodate different users, designers need to consider how to provide adjustable functionality. This allows users to adjust the protective properties and comfort of the garment according to their needs and preferences.

(3) Intelligent hardware design

The composition of the intelligent hardware of the intelligent clothing for porcelain dolls with disabilities contains various types of sensors in the acquisition layer, wireless communication devices in the transmission layer, microprocessors in the processing layer, drivers in the execution layer and batteries in the energy supply layer, as shown in Figure 4. The selection principle should be based on the results of hardware reliability, power consumption, cost and other aspects of the examination, and under the premise of meeting the function as much as possible, the selection of hardware that has less impact on the comfort of the clothing.

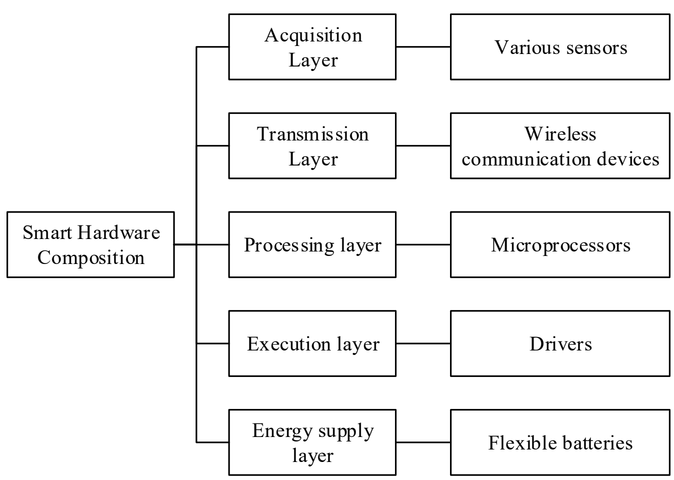

Figure 4: Intelligent hardware composition of Smart Clothing

III. B. Porcelain Doll Smart Clothing Design Program and Evaluation

III. B. 1) Smart Clothing Design Program

The structure of the garment is a streamlined split design on the basis of functionality, with a double placket design in the overall design, and a drawstring at the hem of the garment, which increases the windproof and heat preservation performance of the garment. The back of the garment uses windproof sheet design, the fabric is separated from the lining, and the lining is made of sports mesh fabric, the elasticity of the mesh fabric can provide more shapes and variables than the fabric, which can maximize the moisture vaporization and breathability of the back during the exercise. Because the smart hardware system needs to be combined with the garment, and the smart hardware related components cannot be washed, the convenience of disassembly should be considered in the design.

The sensors are arranged in the armpit because the largest area of contact between the arm and the body during human activity is at the side seam of the armpit. The location and volume size of the lithium-ion battery installation will affect the comfort of the garment, so a small invisible pocket is designed on the windproof sheet at the back of the garment, where the battery can be put into the pocket and used as needed. Small holes are left in the armpit sensors of both arms, in the center of the back neckline, and in the seams of the sleeves and the cap for the conductive threads to be threaded through the garment. The green webbing on the sleeves is designed to better support the underlying wiring, as the backing of the wiring is too thin and can cause severe creasing when sewn to the zipper. At the same time, the webbing enhances the visual effect and style of the design, and makes it easier to remove the sensor elements.

III. B. 2) Evaluation of Smart Clothing Value

The feasibility of the functional design of smart clothing for porcelain dolls with disabilities requires evaluation and analysis, and smart clothing is different from ordinary clothing and requires a different technical methodology route when conducting the relevant value evaluation. Figure 5 shows the value evaluation model of intelligent clothing for porcelain dolls with disabilities, firstly starting from the clothing sample (factory sample), the clothing is evaluated aesthetically through the principle of aesthetics, including innovativeness, stylistic expression, utilitarian value, ethnicity and symbolic information, etc., to achieve the harmony of technology and aesthetics, which is the primary evaluation standard, otherwise it will be improved from the new one. Conform to carry out the next step of functionality testing, including physicality testing, wearable (interactive) technology testing, safety testing and structural coherence testing. Comfort performance testing mainly includes subjective wearability testing and objective testing. If appropriate in the evaluation of economic value, mainly including sample accounting cost and production, which is a key test to reflect whether the smart clothing can enter the consumer market.

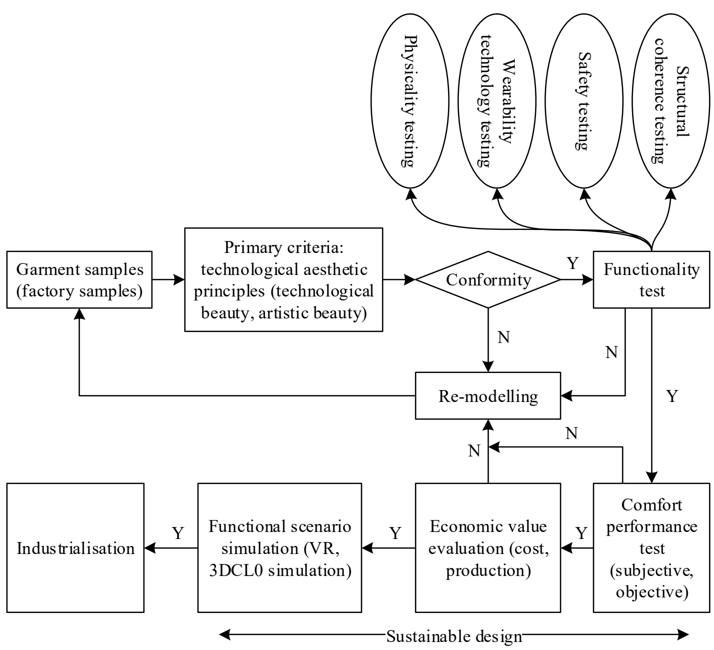

Figure 5: Value Evaluation Model of Smart Clothing

IV. Validation of Porcelain Doll Intelligent Clothing for People with Disabilities

Porcelain dolls with disabilities can not effectively realize the life of self-care, there are many inconveniences in their housing life, but also for their care work brings great challenges. Intelligent clothing starts from real-time monitoring of the physical condition of porcelain dolls with disabilities, and comprehensively provides quantifiable data to assist caregivers to carry out relevant caregiving behaviors, which can also effectively enhance the sense of well-being of porcelain dolls with disabilities. This chapter is based on the previous intelligent clothing design program, its effectiveness evaluation and analysis, aimed at enhancing the sense of satisfaction and access to housing for porcelain dolls with disabilities.

In this paper, 20 porcelain dolls with disabilities from the Porcelain Doll Rare Disease Care Center are selected as research subjects, and they are randomly ambient control group and experimental group according to the ratio of 1:1, to analyze the feasibility of the application of smart clothing in the housing life of porcelain dolls with disabilities through comparative tests.

IV. A. Assisted Living Evaluation of Smart Clothing

IV. A. 1) Ease of putting on and taking off garments

This experiment mainly investigates the wearing and taking off convenience of intelligent garments relative to ordinary garments, by making the experimental group of porcelain dolls with disabilities wear and take off intelligent garments and ordinary garments, comparing the time consumption of the two types of garments in the wearing and taking off decomposition action and the total wearing and taking off action, and comparing the advantages and disadvantages of the wearing and taking off convenience of the two types of garments, the specific experimental process is as follows:

(1) Let the subjects try on the sample garments of the two types of garments first, to understand the style structure and opening position of the garments, and to master the basic steps of putting on and taking off the sample garments.

(2) Allow the subjects to put on and take off the garments according to the specified steps and record the time consumed for each action.

(3) Repeat the dressing and undressing actions 5 times, record the time spent on dressing and undressing, and take the average value.

(4) End of experiment.

Table 1 shows the time consumed by the subjects to put on and take off the smart clothes and ordinary clothes. From the table, it can be seen that the smart garment designed in this paper consumes 85.086s and 34.899s when wearing and taking off in porcelain dolls with disabilities, which reduces 30.80% and 26.32% compared with ordinary garments, respectively. This indicates that the smart garment helps the convenience of dressing and undressing for porcelain dolls with disabilities, assists porcelain dolls with disabilities to better complete daily life behaviors such as dressing and undressing, and better enhances the confidence of porcelain dolls with disabilities in life.

Table 1: The time for smart clothes and ordinary clothes (s)

Action	Type	Smart	Ordinary	Action	Type	Smart	Ordinary
Dressing	Left	3.021	3.784	Undress	Open	2.836	9.514
	Right	3.157	3.951		Left	3.143	3.392
	Close	8.516	22.367		Right	2.637	2.785
	Collate	2.705	3.274		Total	8.616	15.691
	Total	17.399	33.376	-	-	-	-
Panties	Left	24.135	24.356	Sweatpants	Takeoff	15.313	18.347
	Right	20.182	22.188		Left	4.684	6.951
	Crotch	18.343	37.561		Right	6.286	6.375
	Collate	5.027	5.483		Total	26.283	31.673
	Total	67.687	89.588	-	-	-	-
Total time		85.086	122.964	Total time		34.899	47.364

In order to further analyze the variability between the clothing wearing and taking off time consumed, SPSS was used to process the clothing wearing and taking off data, in the normality test of wearing and taking off time consumed, except for the total time consumed to put on the pants, total time consumed to put on and take off the left pant leg did not conform to the normality test, the significance Sig value of the rest of the time consumed is less than 0.05, which is consistent with the normality of the distribution, therefore, paired samples T test. Table 2 shows the results of paired-sample t-test for clothing donning and doffing elapsed time, in which *,** denotes the significance level of <0.05 and <0.01 respectively, i.e., there is a significant difference and the difference is highly significant.

As can be seen from the table, the test results of closing the front placket, total time consumed for dressing and putting on the crotch of the pants in the dressing action and opening the front placket and total time consumed for disrobing in the disrobing action are all P less than 0.01. It means that there are differences between the smart garment and the ordinary garments in the dressing and undressing of the above actions and the differences are highly significant. The test results for opening the front placket, total elapsed time for undressing and total elapsed time for removing trousers in the disassembly action of undressing are less than 0.01, indicating that there is a highly significant difference in the actions of opening the front placket, total elapsed time for undressing and total elapsed time for removing trousers between the smart garments and the ordinary garments. The test result of total time consumed for removing pants (P=0.017) is less than 0.05, which indicates that the action of removing pants garment is significantly different between smart and normal garments.

Non-parametric tests for total time consumed to put on pants, total time consumed to put on, and the action of removing the left pant leg, which did not meet the normality test, were chosen to be tested by the Wilcoxon test in two related samples. The significance of the total time consumed to put on pants (p=0.016) and the total time consumed to put on (p=0.017) were both less than 0.05, indicating that there was a significant difference between the smart and normal garments in these two actions.

Table 2: Test of matching sample T for clothing and clothing

Dress	M±SD	t	P	Undress	M±SD	t	P
Left	0.61±1.03	1.642	0.138	Open	6.66±2.14	8.718**	0.003
Right	0.32±1.05	-0.511	0.357	Left	0.23±.85	0.374	0.472
Close	2.68±2.14	8.243**	0.000	Right	0.06±0.71	0.165	0.835
Collate	0.51±1.32	1.042	0.295	Total	6.34±1.67	9.437**	0.000
Total	3.64±2.45	8.679**	0.002	Takeoff	3.06±4.18	1.028	0.079
Left	0.53±4.35	0.337	0.747	Right	0.53±1.42	1.053	0.326
Right	1.64±4.06	1.126	0.283	Total	4.63±4.57	3.795*	0.017
Crotch	8.51±8.24	4.837**	0.000	Total time	10.24±5.46	5.414**	0.000
Collate	0.06±3.17	0.023	0.948	-	-	-	-

IV. A. 2) Healthy quality of life interventions

Rehabilitation should be actively carried out in the housing life of porcelain dolls with disabilities, and smart clothing can accurately monitor the dynamic changes in the process of their rehabilitation exercise, providing reliable data support for analyzing their rehabilitation effects. With the selected experimental group and control group as the research subjects, a 12-week rehabilitation exercise experiment was carried out, during which their dynamic and static balance data were tested and recorded. At the end of the rehabilitation exercise experiment, the collected data were entered into SPSS software and subjected to independent samples t-test. Table 3 shows the changes in dynamic and static balance data of different groups before and after the experiment. In the table, a represents P<0.05 compared with the group before the experiment, and b represents P<0.05 compared with the control group at the same experimental stage.

Based on the test result data, it can be seen that in the intra-group comparison before and after the experiment, the balance score, average rotational angular velocity, maximum rotational angular velocity, and balance grade of the experimental group after the experiment were significantly improved compared to the preexperiment (P<0.05), and there was no significant difference in the balance score, average rotational angular velocity, maximum rotational angular velocity, and balance grade of the control group after the experiment compared to the preexperiment (P>0.05). In the comparison between groups at the same stage, the balance score, average rotational angular velocity, maximum rotational angular velocity, and balance grade of the experimental group after the experiment were significantly improved compared to the control group (P<0.05). That is to say, the dynamic balance ability of porcelain dolls with disabilities can be more significantly improved after carrying out rehabilitation exercise with the support of intelligent clothing and related software.

In the intra-group comparison before and after the experiment the static displacement velocities (total displacement velocity, displacement velocity in the forward and backward directions, and displacement velocity in the left and right directions) of the experimental group after the experiment were significantly higher than those before the experiment (P<0.05), and there was no significant difference between the static displacement velocities of the control group after the experiment compared to those before the experiment (P>0.05). In the comparison between groups at the same stage, there was no significant difference between the static displacement speeds of the experimental group and the control group before the experiment (P>0.05), and the static displacement speeds of the experimental group after the experiment were all significantly higher than those of the control group (P<0.05). That is, porcelain dolls with disabilities, with the support of intelligent clothing and associated software, carried out a 12-week rehabilitation exercise exercise, more effective to improve the static balance ability.

Table 3: Dynamic and static balance data changes

Comparison of dynamic balance (M±SD)				
Index	Experimental group		Control group	
	Before	After	Before	After
Balanced score	1281.4±31.2	1596.7±44.2ab	1286.5±30.2	1288.7±30.8
Mean rotation (%)	4.15±0.38	3.14±0.26ab	4.12±0.37	3.95±0.35
Maximum rotational angular velocity (%)	8.79±0.23	7.54±0.15ab	8.87±0.21	8.85±0.34
Balance grade	2.95±0.17	2.46±0.27ab	2.92±0.15	3.01±0.06
Comparison of static displacement velocities (M±SD)				
Total displacement velocity (mm/s)	17.85±0.65	13.49±0.56ab	18.01±.52	18.02±0.34
Front displacement velocity (mm/s)	11.72±0.37	7.05±1.02ab	11.76±0.38	12.18±0.53
Direction displacement velocity (mm/s)	12.35±0.53	7.03±.71ab	12.31±0.57	12.83±0.71

In addition to objective testing and evaluation of the dynamic and static balance abilities of porcelain dolls with disabilities, a multidimensional subjective evaluation of the quality of healthy life of porcelain dolls with disabilities was also conducted. The quantitative indicators used to describe the quality of healthy life include 7 dimensions of physiological function, physiological function, somatic pain, general health, vitality, social function, mental health, and emotional function, which are expressed as T1~T7, and each dimension is scored out of 10. The higher the score, the higher the quality of healthy life. Table 4 shows the results of the comparison of the quality of healthy life of the two groups of porcelain dolls with disabilities.

According to the data of evaluation results, it can be seen that in the intra-group comparison before and after the experiment in the experimental group after the experiment there is a significant increase in physiological function, physiological function, vitality, social function, mental health, emotional intelligence compared with the pre-experiment (P<0.05), somatic pain is not significant difference compared with the pre-experiment (P>0.05). There was no significant difference in all indicators in the control group after the experiment compared to before the experiment (P>0.05). In the comparison between groups at the same stage, the physiological function, physiological function, general health, vitality, social function, mental health, and emotional function of the experimental group before and after the experiment were significantly improved compared to the control group (P<0.05), and there was no significant difference in somatic pain compared to the control group (P>0.05). That is, the 12-week rehabilitation exercise exercise for porcelain dolls with disabilities supported by smart clothing more effectively improved the quality of healthy life of porcelain dolls with disabilities, including physiological function, physiological function, vigor, social function, mental health, and emotional function.

Table 4: Comparison of the quality of health life in 2 groups (M±SD)

Index	Experimental group		Control group	
	Before	After	Before	After
T1	7.95±1.06	8.79±0.24ab	7.94±1.02	7.98±1.03
T2	8.14±0.79	8.74±0.27ab	8.12±0.81	8.15±0.82
T3	8.72±0.13	9.08±0.06	8.73±0.15	8.76±0.19
T4	7.35±1.45	8.03±0.19ab	7.32±1.44	7.35±1.43
T5	7.42±1.28	8.51±1.15ab	7.43±1.29	7.42±1.28
T6	8.91±0.51	9.47±0.37ab	8.92±0.54	8.93±0.55
T7	7.47±1.69	8.69±1.23ab	7.48±1.71	7.41±1.24

IV. B. Smart Clothing Functionality Evaluation Survey

IV. B. 1) Functional evaluation of garments

In addition to assisting porcelain dolls with disabilities in the housing life of the basic clothing and rehabilitation exercise, smart clothing can also be intelligent forecast for the temperature and humidity of their clothing environment, so as to realize the timely replacement of clothing for porcelain dolls with disabilities. In order to verify the measurement of the temperature and humidity of the environment by the intelligent clothing, five porcelain dolls with disabilities were randomly selected from the experimental group to carry out the experiment, and according to the experimental requirements, a 60-minute experimental test was required. Recorded from the starting point, every 10 minutes to record, each record includes temperature and humidity changes, and the values and conditions are recorded on the corresponding record sheet. During the experiment, the alarm time point when the temperature and humidity values exceeded the upper alarm limit should be recorded in time and recorded on the corresponding record sheet. Table 5 and Table 6 respectively for the subject's clothing micro-environmental temperature and humidity data, the bold font in the table indicates that the subject's clothing micro-environmental temperature for the first time rose to a higher range of values.

From the table, it can be seen that the temperature of the subjects' clothing microenvironment generally rises to a higher level within 20 minutes to 30 minutes after the start of the test, and then falls back appropriately, with relatively smooth changes, but a small portion of the rise and fall is obvious. The temperature rise and fall in the later period is related to the physical condition of the subjects, the intensity of the exercise at that time and other factors in the outdoor area, and the temperature in the later period is in the range of 35℃~40℃ rise and fall. According to the results of the experiment, at the beginning of the experiment, the temperature of the subjects' clothing microenvironment was lower than the alarm value, and the temperature rose during the subjects' warm-up and preparation for the exercise, and when the temperature reached the alarm value, the buzzer alarmed automatically, and stopped alarming when the temperature fell below the alarm value. In addition, the humidity of the subjects' clothing microenvironment generally rises to a higher level within 20 to 40 minutes after the start of the test and then falls back appropriately, with relatively smooth changes. In the late stage of the experiment, due to the accumulation of humidity and heat in the subjects' clothing microenvironment after a long period of exercise, the humidity of the clothing microenvironment in the late stage of the experiment was generally high, and some of the values even maintained about 98% humidity, which is a normal phenomenon. This study provides the function of individually turning off the temperature and humidity alarm, which is used to individually turn off the temperature and humidity alarm prompts when the temperature and humidity of the subject's clothing microenvironment are higher than the alarm value during the experiment and tend to stabilize. The experimental results prove that the intelligent monitoring module of this study has the functions of collecting temperature and humidity data and alarm prompting feedback, and achieves the expected results.

Table 5: The subjects' clothing micro ambient temperature data (℃)

Time	No.1	No.2	No.3	No.4	No.5
Start	30.1	30.6	31.2	30.8	30.2
10min	34.2	33.8	33.8	32.7	32.6
20min	**37.8**	34.7	35.9	**39.4**	**37.9**
30min	36.9	**38.2**	36.5	37.5	36.5
40min	35.4	37.5	37.3	36.3	36.2
50min	35.6	36.4	**39.9**	35.1	35.8
60min	35.7	35.9	36.8	34.6	35.4
Alarm number	2	2	5	4	3

Table 6 The subjects' clothing micro ambient humidity data (%)

Time	No.1	No.2	No.3	No.4	No.5
Start	94.5	91.5	91.3	91.2	92.3
10min	95.3	92.7	93.7	89.3	89.5
20min	**96.2**	94.4	95.2	**95.5**	94.3
30min	92.7	95.3	**99.6**	88.7	96.1
40min	93.5	**99.8**	97.3	97.4	97.6
50min	94.6	94.5	93.5	95.3	**98.5**
60min	93.8	94.9	95.4	93.2	98.2
Alarm number	2	2	3	2	2

IV. B. 2) Evaluation of the comfort of garments

Porcelain dolls with disabilities in the experimental and control groups were used as test subjects to perform rehabilitation exercises wearing smart and normal garments, respectively. In order to maintain the heterogeneity of the environment and the amount of exercise, the test location is in the same room with constant temperature, and the evaluation of foreign body sensation, stretching and breathability is carried out after the testers have performed 10 minutes of rehabilitation exercise. The subjective evaluation adopted in this paper, in order to make the evaluation results more informative, these three phases of evaluation are divided into 10 levels, and the average value is taken after scoring according to the three times of the testee's feelings. Table 7 shows the results of the comfort test.

As can be seen from the table, because the porcelain dolls with disabilities in the control group wore traditional loose-fitting ordinary clothing without the installation of corresponding intelligent devices, they could not be used as a control group in the evaluation of the foreign body sensation of the devices. From the mean value of foreign body sensation in the experimental group, the mean value of foreign body sensation brought by the smart garment to the porcelain dolls with disabilities was 2.582 points, which is a level of general comfort. Overall the presence of smart devices can be felt but basically meets the comfort requirements of porcelain dolls with disabilities. After comparing the stretchability rating value of the experimental group with the control group, it can be found that the stretchability of the experimental group is 2.34% lower than that of the control group respectively. The reason for this is that the ordinary clothing worn by the control group has basically no binding for the body, while the smart clothing needs to be bound with certain smart sensor parts, thus its stretchability is lower than that of the control group, but the overall difference is small. In the breathability evaluation, the evaluation score of the experimental group is 14.05% higher than that of the control group. This indicates that the sensors in the smart garment can effectively monitor the temperature changes in the body, and through the design of inflatable and deflatable and breathable mesh weaving structure, it can make the sweat emanate faster from the parts of the body with high perspiration rate, and maintain the consistency of the whole body heat dissipation and perspiration level of the porcelain dolls with disabilities.

Table 7: Comfort test results

Group	Heterosity	Extensibility	Breathe	Group	Heterosity	Extensibility	Breathe
EG1	3.277	8.489	8.796	CG1	-	8.311	6.871
EG2	2.992	8.477	8.762	CG2	-	8.723	7.032
EG3	2.921	7.905	8.415	CG3	-	8.474	7.208
EG4	2.103	8.836	8.551	CG4	-	8.826	7.829
EG5	2.014	8.598	8.334	CG5	-	8.067	6.983
EG6	2.816	8.623	8.136	CG6	-	8.011	7.327
EG7	2.249	8.742	8.427	CG7	-	8.495	7.751
EG8	2.424	8.826	8.616	CG8	-	7.913	7.079
EG9	2.218	8.625	8.201	CG9	-	8.174	7.774
EG10	2.807	8.191	8.834	CG10	-	8.712	7.262
Means	2.5821	8.531	8.507	Means		8.731	7.312

V. Conclusion

In order to better assist the housing life of porcelain dolls with disabilities, this paper proposes the design process and program of intelligent clothing for porcelain dolls with disabilities, and carries out experimental analysis.

(1) When the intelligent clothing is used to help the porcelain dolls with disabilities to wear and take off, the overall wearing and taking off time is 85.086s and 34.899s respectively, which is 30.80% and 26.32% lower than that of the ordinary clothing respectively. And the two have statistically significant differences ($P<0.01$). This indicates that smart clothing can effectively assist porcelain dolls with disabilities in daily dressing, and better enhance the life confidence of porcelain dolls with disabilities.

(2) Under the intervention of smart clothing, there is a significant difference in the quality of life of porcelain dolls with disabilities in the experimental group compared with the control group ($P<0.05$), which can better enhance the health level and emotional function of porcelain dolls with disabilities, and reduce the haze brought by the disease to porcelain dolls with disabilities.

(3) Intelligent clothing in porcelain dolls with disabilities in the process of rehabilitation exercise, can realize the temperature and humidity of real-time health and early warning, to assist porcelain dolls with disabilities to better rehabilitation exercise, and breathability evaluation of the average value of up to 8.507 points.

In conclusion, the introduction of intelligent clothing into the housing life of porcelain dolls with disabilities can significantly improve the quality of life of porcelain dolls with disabilities and the effect of rehabilitation exercise, so that porcelain dolls with disabilities can further feel the beauty of the housing life, and effectively enhance the sense of well-being, sense of achievement and sense of satisfaction of porcelain dolls with disabilities.

Funding

This research was supported by the Fund Project Tianjin 2021 Education Science Planning Project: Research on the Path Innovation of Promoting the Deep construction of University Cultural and Creative Industrial Parks between Schools and Enterprises (Project Approval Number: HIE210375; Project Approval Notice Number: 210375).

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