

Research on the Design of Lower Extremity Rehabilitation Assistive Devices Based on User Experience

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Abstract. With the aggravation of social aging, patients with lower extremity movement disorders are also increasing year by year. The elderly with lower extremity movement disorders have their own characteristics in physiology, psychology and behavior. Firstly, this paper analyzes the research and development status of lower extremity rehabilitation assistive devices by data analysis and induction. Secondly, the physiological, behavioral and psychological characteristics of the elderly were analyzed through interviews and observation to understand the use of lower extremity assistive devices, and in-depth analysis was made on user needs and product pain points. Based on this analysis, this paper puts forward the design principles and elements based on the theoretical basis of user experience elements, increases the humanized design of lower extremity rehabilitation assistive devices, improves the safety and interest of products, and enhances user experience.

Keywords: Lower extremity rehabilitation assistive devices, user experience, stroke patients, the elderly.

1. Introduction

In 2023, China has about 220 million people aged 65 and above, accounting for 15.4% of the total population, and nearly 40 million elderly people aged 80 and above, accounting for about 2.8% of the total population. China is expected to enter a super-aging society in 2030 [1]. It can be seen that in the next 30 years, China will be in a rapid deepening period of aging. With the increase of age, the probability of middle-aged and elderly people suffering from cardiovascular and cerebrovascular diseases is greatly increased, and patients with lower extremity function deterioration caused by stroke are in the majority. It is usually manifested as low muscle strength, joint stiffness, extremity movement disorder, decreased balance ability, extremity pain and numbness, etc., which affect the normal life of the elderly. Stroke patients in China generally choose home-based rehabilitation, and few elderly people choose rehabilitation therapists for one-to-one treatment or long-term treatment in rehabilitation centers. Therefore, home-based rehabilitation training for patients with lower extremity movement disorder caused by stroke has become an urgent problem to be solved [2].





In this paper, behavior observation and user interview are first used to conduct an in-depth study on the patient's training behavior, summarize the physiological and psychological characteristics and user needs of the elderly, transform the elements of user needs into a description of function and design, put forward the design method of home-based lower extremity rehabilitation assistive devices, and guide the product design. In this paper, humanized design concept is integrated into the product to improve user experience and comfort.

2. Research and Development Status of Lower Extremity Rehabilitation Assistive Devices

Patients with degenerative lower extremity function caused by stroke need long-term rehabilitation training with the help of assistive devices and others. Therefore, a variety of assistive device products have been developed in the market. Lower extremity rehabilitation assistive devices refer to the medical equipment used to help patients recover walking function and improve their quality of life in case of lower extremity injury, disease or disability. It includes equipment that supports, fixes, corrects, enhances and replaces the functions of lower extremity, which can help patients recover and maintain their physical balance and exercise ability in activities such as walking, standing, sitting and lying in daily life [3]. It can be divided into auxiliary walking assistive devices (such as crutches,

walking support frames and power-assisted walking robots) and simulated movement assistive devices. This paper focuses on the analysis of simulated movement assistive devices. As shown in Table I.

Table 1. R&D Status of Lower Extremity Rehabilitation Assistive Devices for the Elderly

Product type	Applicable population	Application scenarios	Product advantage	Product disadvantages	Product picture
Suspension type	People with severely impaired lower extremity function	Large hospitals and professional rehabilitation institutions	The patient can customize a more natural gait pattern. With multiple protective measures	It is expensive, requires a large space, and professional medical staff are required to guide the training and operate assistive devices	
Running table type	Moderate and severe impairment of lower extremity function	Large hospitals and professional rehabilitation institutions	Use a secondary bandage to move the patient about. It has a matching weight loss vest to make the patient feel more relaxed. The patient's gait characteristics can be analyzed to customize the training system.	It is expensive, requires a large space and relatively poor comfort, requiring the guidance and operation of professional medical personnel.	
Riding type	Groups that can stand upright on the upper body	Hospital, home	Help patients recover lower extremity strength and coordination by simulating the movement of cycling. Moderate price, small space required and simple operation	Single training content, simple reciprocating motion	
Pedal type	Patients with severe stroke and unable to walk	Hospital, home	Moderate value, requires less space, is easy to move and assists the patient with lower extremity movement	Single training content, simple reciprocating motion	

In conclusion, there are two ways to design and develop lower extremity rehabilitation assistive devices. One is the large-scale assistive device used in hospitals and rehabilitation centers. However, this kind of device is expensive, requires a large space, and needs professional operation and maintenance. The other is assistive devices suitable for home-based rehabilitation training, which are more in line with the current situation of home-based elderly care and home-based rehabilitation for patients in China and have the characteristics of popularization.

3. User Analysis and Research

3.1. User Survey

To understand the situation and needs of patients using assistive devices, this study was carried out by observation and interview. The observation method has the characteristics of strong intuition, life and authenticity [4]. Face-to-face communication can help us understand the life status of users and their views on product use in a deeper way, find out the subtle pain points of users during use, and prepare for subsequent user demand analysis and product design.

Six patients and their families and two rehabilitation physicians were observed and interviewed. The details of the interviewees are shown in Table 2.

Table 2. Summary of Interviewers

Interviewer name	Age	Sex	Physical condition	Daily rehabilitation training condition
Grandpa Li	80	Male	The patient had been ill for 3 years and was a severe patient with unclear speech, hemiplegia in bed, unable to sit up and walk independently.	Regular massage by family members, no training assistive devices at home.
Aunt Zhang	63	Female	The patient had been ill for 1 year and was a mild patient with slow speech and walking on crutches.	The patient has pedal training assistive devices at home, and usually practices for 20 minutes every day. There is no specific training plan. Family members arrange exercises according to the patient's mood. The patient is depressed, anxious and unwilling to participate in rehabilitation training.
Grandpa Chen	59	Male	The patient had been ill for 3 years and was moderately sick, with unclear speech and weak extremities. He needed to walk with the help of assistive devices.	There are riding-type lower extremity training assistive devices at home, but they are rarely used. Patients are more resistant to rehabilitation training and unwilling to go to a rehabilitation center for rehabilitation training.
Grandpa Li 2	74	Male	The patient had been ill for 3 months and needed to walk with the help of assistive devices.	The patient has a riding-type lower extremity training assistive device at home, and trains for 15-20 minutes in the morning and 15-20 minutes in the afternoon every day. The patient is more positive and optimistic and cooperates with the training.
Uncle Ying	68	Male	The patient had been ill for 7 years, severely ill, hemiplegic in bed.	No training assistive devices at home, daily massage and simple extremity exercises. The patient is reluctant to contact with outsiders and has a stubborn temper.
Grandma Liu	87	Female	The patient had been ill for 13 years and was severely paralyzed in bed with little or no verbal communication.	For the first 3 years of illness, she regularly went to the rehabilitation center for rehabilitation training every year. There were riding-type and pedal assistive devices put in bed at home. The patient used riding-type assistive devices for daily training before and used foot-pedal assistive devices in the last two years. The patient was more cooperative.
Dr. Zhang	45	Male	Associate Chief Physician of Neurology Department	
Nurse Sun	38	Female	Medical staff in the rehabilitation center with more than 10 years of nursing experience can use various training instruments	

The interview contents of patients and their nursing staff include the basic information of patients, the experience and evaluation of lower extremity assistive devices, and the demand for lower extremity rehabilitation assistive devices. The basic information of patients includes patient name, age and time of illness. The daily rehabilitation training of patients includes: the mode, duration and frequency of rehabilitation training, the cooperation of patients, and the psychological and physical changes of patients. The experience of using lower extremity rehabilitation assistive devices includes: Is it necessary to use lower extremity rehabilitation assistive devices for rehabilitation training, and why is it not used? The advantages and problems of the product are found after use, and the assistive device is evaluated from the perspectives of appearance design, operation convenience and safety of lower extremity rehabilitation assistive devices. The purpose is to understand the specific feelings and needs of users using the product. The interviews with medical staff focused on the emergencies that stroke patients are prone to have in home-based training and matters needing attention, as well as how to conduct scientific training. At present, the existing problems of home-based lower extremity rehabilitation assistive devices and suggestions on the function and design of riding-type lower extremity rehabilitation assistive devices are discussed.

3.2. Survey Summary

Through interviews, it is found in this paper that most patients use riding or pedaled lower extremity rehabilitation assistive devices for rehabilitation training, which indicates that patients and their families can realize the importance of rehabilitation training for stroke patients, and also shows that home-based lower extremity rehabilitation assistive devices are becoming more popular. Interviewees think that the assistive devices occupy less space and are more convenient to operate, and they are satisfied with the space and convenience of assistive device design. However, the problems of assistive devices are also raised. 1) The overall function is simple. At present, the assistive devices used by patients can only perform simple repetitive movements without timing function, monitoring function and feedback function. Patients and their families need to keep time by themselves. In addition, many stroke patients are accompanied by hypertension and slow consciousness response. Therefore, it is very necessary to monitor the intensity and duration of exercise, as well as the patient's indicators during exercise. Some family members will worry about abnormal changes in blood pressure and heart rate during exercise, and some uncomfortable reactions of patients. 2) The training function is relatively single, and different instruments are required for multi-directional training. 3) It does not take into account the psychological, emotional and behavioral characteristics of patients and lacks humanized design. In the process of observation, the author found that during rehabilitation training, patients sweated a lot and sometimes were thirsty. At this time, nursing staff had to pour water for the patient and wipe his/her sweat, but there was no space to place cups, towels and other items in the assistive tools. In addition, stroke patients are emotionally unstable and often have depressed, avoidant and agitated moods. Some patients resist daily rehabilitation training. Therefore, two family members of the patient proposed whether some functions that the patient liked could be added to attract or encourage patients to participate in daily rehabilitation training and reduce their irritability caused by long-term rehabilitation training. 4) The design of lower extremity assistive devices lacks comfort. Stroke patients are prone to pain, so the setting of armrests, seats and structures is very important. During the interview, it was found that the structural design of some riding-type assistive devices was not completely reasonable. The space between their seats, armrests and pedals was too large to maintain balance during training. In addition, the hard armrests and seats will also aggravate the pain of patients during rehabilitation training. 5) The appearance of rehabilitation assistive devices for lower extremity is mostly in cold colors, lacking a sense of design and giving people a sense of mechanical splicing. 6) Lack of quick response to emergencies. The two medical personnel mentioned that during the daily rehabilitation training of patients, some patients would suddenly stop training and develop strong resistance psychology and behavior. At this time, it is necessary to stop training in time. Therefore, if some voice control functions can be added, the convenience of operation can be increased.

It can be seen that the patients' needs for rehabilitation appliances for lower extremity are as follows: 1) The product has a simple and elegant appearance design, small volume, comfortable color, beautiful appearance and is easy to clean. 2) The material of the product is warm and soft, with skid resistance and comfort. 3) The functions of the product are practical and easy to use. It can be used for voice control, display the basic situation of rehabilitation training, increase interaction with the elderly, and add some interesting designs, such as video playing and music playing functions, to relieve irritability during training. 4) An assistive device can train multiple parts. 5) The product has strong support, safety and adjustability.

3.3. Analysis of Users' Physiological Behaviors and Psychological Characteristics

During the investigation, patients, their families and medical staff repeatedly mentioned the psychological, emotional and behavioral characteristics of stroke patients. By studying the psychology, behavior patterns and characteristics of users, we can more accurately grasp their needs, to design products that meet their expectations and enhance their experience [5].

With the increase of age, the vision and hearing of the elderly appear sadness, muscle atrophy gradually occurs, and extremity strength is insufficient. Stroke causes disorders in the lower extremities, which will degrade the muscle strength of the lower extremity and reduce the flexibility of knee joints, thus leading to reduced mobility and physical coordination. The imagery thinking and analytical ability of the elderly will also be reduced to an unpredictable extent. They are prone to forgetfulness, mistakes, slow reaction, and poor acceptance and judgment of new things. Compared with the general population, the elderly pay more attention to the characteristics of easy learning and use, convenient operation, high quality and low price for rehabilitation products. At the same time, ergonomic issues should also be considered. Simple and lightweight products can effectively reduce the physical and mental burden of the elderly, which helps them use rehabilitation products more conveniently.

Lower extremity movement disorder caused by stroke reduces the patient's movement self-care ability and has a serious impact on his daily life. They may feel that they cannot act freely as before, feel worthless, and become retreated, frustrated and isolated. At this time, patients are anxious, collapsed, face the future life negatively, and refuse to communicate with others. All kinds of negative emotions outburst, paranoia, depression, pessimism of anxiety lead to insomnia, or even self-injury. Due to lower extremity movement disorder, patients' range and form of activity are limited, and the place of activity is also dominated by home and rehabilitation centers, which leads them to contact fewer people and gradually reduce their range of activity, resulting in a sense of loss. At the beginning of exposure to training assistive devices, some patients will be afraid and fear that they cannot use the assistive devices or may fall down during training and cause secondary injuries. This fear and fear will also make patients unwilling to participate in rehabilitation training. Frustration and discomfort may be encountered during the recovery process, which can lead to low self-esteem, rage or avoidance. And avoidance psychology will produce avoidance behavior. Avoidance refers to the behavior of trying to avoid or prevent contact with negative stimuli that one feels uncomfortable [6]. This behavior is a self-protective mechanism that allows people to avoid emotional pain or anxiety. This avoidance behavior may prevent them from returning to walking and movement function as planned. In addition, some patients are accompanied by long-term rehabilitation training, but they cannot see the effect of rehabilitation. They will be lazy and self-abandoned, unwilling to actively participate in rehabilitation training, or even have a psychological resistance to rehabilitation training, irritable emotions, and anti-training behaviors, and are prone to depression [7]. Therefore, the design of lower extremity rehabilitation assistive devices should not only meet the rehabilitation training function, but also provide patients with temperamental value to make them feel safe and reassured, relieve anxiety and enhance mental health.

4. Research on the Design of Lower Extremity Rehabilitation Assistive Devices

4.1. Product Orientation

In this paper, 5W2H analysis method is used for product positioning analysis. 5W2H analysis method is an analytical tool applied to product design, including Why: The purpose of product research and development. What: Core functions of the product. Who: Target users of the product. Where: Indicating the usage scenario of the product. When: The applicable time of the product. How to realize product requirements and technical solutions. How much: quantitative evaluation of products [8].

Why: As the elderly population and stroke patients increase, the number of people with lower extremity movement disorder also increases. Home-based rehabilitation training has become the first choice for patients with lower extremity movement disorders. At present, the existing lower extremity exercise rehabilitation assistive devices on the market have the problems of simple function and lack of humanized and interesting design, which cannot meet the training needs of home-based rehabilitation, nor can it provide emotional value for patients. This product aims to give users a humanized experience and improve their comfort and satisfaction when using lower extremity rehabilitation assistive devices.

What: The core function of this product is to improve the patient's lower extremity strength and knee flexibility, enhance the patient's extremity coordination, reduce the patient's irritability during training, and increase the safety and comfort of lower extremity rehabilitation appliances.

Who: The target group of this product is people aged 60-80 who have lower extremity movement disorders caused by stroke, including those who can take care of themselves and those who need medical assistance. Compared with normal people, the self-care group has weaker muscle strength and less affected mobility and can move independently. Because of weakened muscle strength, people with mediation can drive joints to move, but their movements are slow and uncoordinated, so they often need some auxiliary devices to carry out daily activities.

Where: The application site of this product is the home-based environment and rehabilitation training center.

When: According to the patient's rehabilitation training plan, this product can provide rehabilitation training services for patients at any time.

How: This product takes into account the psychological and behavioral characteristics of patients in its design, adding humanized design and temperamental design. Enhance product safety by optimizing the structure of products. The comfort of the product is increased by optimizing the material of the product.

How much: The goal of this product is to create a lower extremity rehabilitation appliance that can be used by the public. Therefore, the research and development cost, material cost and price of this product are relatively low, so ordinary families can also afford the purchase cost.

4.2. Product Design Principles and Design Elements

According to the above user survey, demand summary and R&D status of existing lower extremity rehabilitation assistive devices, the riding-type lower extremity rehabilitation assistive devices proposed in this paper will be designed based on the principles of safety, usability, intelligence and emotionality. 1) Safety design principles refer to structural safety, size safety, material safety and modeling stability. First of all, the structure is safe. The structure of lower extremity rehabilitation assistive devices for home use must be stable and firm. Therefore, the supporting and connecting parts of the rehabilitation assistive devices should be made of materials with high strength and good stability, and a reliable connection method should be adopted to ensure that the assistive device will not loosen or break during use. Second, the size is safe. The size of rehabilitation assistive devices should be adjusted according to the patient's height, weight and other special needs to ensure that patients feel comfortable and can maintain balance when using them, thus reducing the risk of falls or other safety accidents. The shape of rehabilitation assistive devices should avoid edges and sharp

edges as much as possible to reduce the risk of patients being scratched. Finally, the shape of rehabilitation assistive devices should conform to ergonomic principles to ensure its comfort and stability. 2) Usability means that the design of lower extremity assistive devices should pay attention to the patient's use environment and operation habits. Rehabilitation assistive devices should be easy to move and clean. Rehabilitation assistive devices should be fault-tolerant. When the patient operates improperly, there should be corresponding safety measures or voice reminders to avoid danger. For example, set the automatic stop function and limit the maximum movement range. At the same time, the operation of rehabilitation assistive devices should be simple and easy to understand so that patients can quickly master and use them. 3) Intelligence is the trend of product design. However, considering that the elderly have poor acceptance of intelligent devices, the degree of intelligence needs to be combined with their behavioral habits. Intelligent functions such as voice control of lower extremity assistive devices, voice prompt and body indicator monitoring can be added to increase the convenience of operation. 4) Emotional design refers to the personalized, affinity and humanized design of assistive devices, which builds trust between patients and lower-extremity rehabilitation assistive devices and improves users' sense of pleasure. For example, soft materials and fine processes can be used. In terms of functional design, considering the needs and usage scenarios of users, music and video playback functions and voice interaction function are added to make rehabilitation training more interesting. Attention is also paid to the adjustability and adaptability of functions, so that lower extremity rehabilitation assistive devices can meet the personalized needs of patients and enhance users' experience.

User experience is divided into three levels: sensory level, behavioral level and emotional level [9]. The sensory layer refers to the user's five senses: vision, hearing, smell, taste and touch. The behavior layer focuses on the user's behavior in the process of interaction with the product. The emotional level focuses on whether the product can arouse users' emotional resonance and stimulate positive emotional reactions. These three levels interact with each other and jointly affect the overall feelings and evaluations of users on products [10]. The sensory level mainly refers to the appearance modeling design, voice system design and material selection of products. Behavioral level and emotional level mainly refer to the functional design of products. First, the exterior design elements are shown in Figure 1. Including modeling design, color design, material design and sound design. According to the survey on the needs of the elderly, this paper finds that the elderly like a refreshing, concise and generous design appearance. Therefore, in terms of color, white and light gray are the main colors of lower extremity rehabilitation assistive device. White brings a refreshing and clean feeling, gray gives a low-key feeling, these two colors together give a calm, elegant feeling. Warm colors such as orange are used in some details to highlight keys and icons, so that they can be more recognizable and clearer for the elderly. This color combination makes the rehabilitation assistive devices for lower extremity present a fashionable and warm tone. In terms of modeling, it is necessary to first ensure the stability of the structure and conform to ergonomics. As this product is suitable for the home environment, it has a small size and is easy to move and disassemble. In addition, when people see a product, the first thing that meets their eyes is modeling design in addition to color. Therefore, smoothness and intimacy of modeling design are very important. Therefore, the streamlined design is adopted in this paper to reduce the sense of mechanical stiffness. The structure with smooth and no sharp edges and corners and burrs is adopted to reduce the bumping of sharp edges and corners against the elderly and increase the safety and comfort of users. In terms of design size, the elderly prefer loose space design, while their body shape and weight are also quite different. The specific dimensions of the product are shown in Table 3.

Table 3. Product Size Specification

Human dimensions	Application of lower extremity rehabilitation products	Dimension
Sitting height in sitting posture	Direct-view screen seat height	43-53cm
Backrest sitting height	Seat height	42-46cm
Eye height in sitting posture	Height of electronic screen	115-120cm
Distance from sitting posture to feet	Distance from seat cushion to pedal	56-72cm
Hip breadth in sitting posture	Seat width	36-45cm
Shoulder width	Handle width	38-45cm
Arm length in sitting posture	Distance between backrest and armrest	55-73cm

In terms of material, this paper pays attention to the safety and environmental protection of materials. Select safe, non-toxic, odorless and environmentally friendly materials. Mainly used iron, durable plastics and leather materials. Iron has strong stability, high mechanical strength, not easy to age, with a strong durability, not easy to stain dust and easy to clean. Leather has good abrasion resistance, comfort and breathability to help seniors stay comfortable and dry during training, while waterproofness and heat resistance increase its ease of use and durability. Leather also has a good sense of luxury, which can improve the overall texture of lower extremity assistive devices. In addition, the soft nature of leather can reduce accidental bumps that may occur during use and provide comfortable touch feeling. Durable plastics have the advantages of being lightweight, cheap to manufacture, durable, waterproof and easily shaped. Iron, leather and durable plastic are common materials, which can not only reduce costs, but also arouse the familiarity of the elderly and reduce the strangeness between rehabilitation assistive devices and the elderly. In terms of sound design, it mainly includes timbre, pitch and volume. In the process of rehabilitation training, sound can play a role in prompting and encouraging. As far as prompts and broadcasts are concerned, the voice can be customized. For example, a female and gentle voice to make the patient feel more comfortable and relaxed. When the patient completes a set of training, the assistive device can make encouraging sounds to make the patient feel more confident and happier. A child's voice to say, "Cheer up", or use cheers and applause. Children's voice is playful, lovely and loud, which can inspire patients.

The core of the lower extremity rehabilitation trainer for the elderly is to realize training and other functions. In this paper, based on the preliminary observation method and interview method to sort out user needs and market research, combined with design principles, eliminating design elements that are difficult to achieve, the functions of the lower extremity rehabilitation trainer for the elderly are proposed, as shown in Table 4.

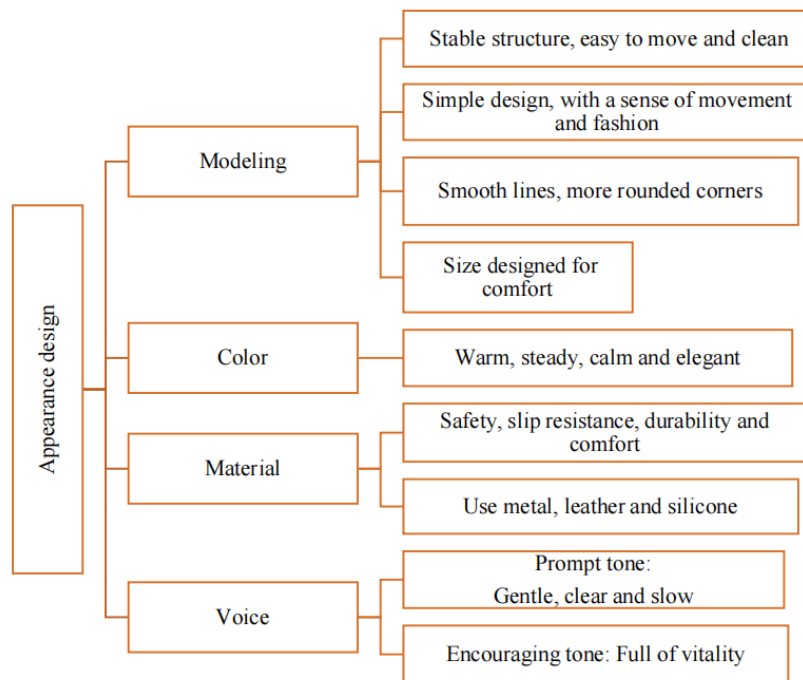


Figure 1. Elements of Exterior Design

Table 4. Functional Description

Functional layer	Design elements
Safety function	Stable structure of assistive devices
	Safety armrest design of the seat, anti-skidding and easy to hold
	Seat comfort and height-adjustable design
	Seat rotatable
	Height of the nose section where the display is located, with adjustable tilt
	Design of armrests and pedals, anti-skidding and comfortable
	Focus on rounded corner design to reduce edges and sharp corners
	Bandage fixation
Training function	Lower extremity training pedal
	The pedal can be used for forward and reverse training
	Pedal anti-skid and anti-falling design
	Adjustable resistance gear design
Data monitoring function	Sensor design
	Heart rate monitoring
	Statistics of daily training data: exercise duration, exercise intensity level
User-friendly design	Seat armrest foldable
	Storage basket for items
	Voice control: Voice safety prompt, voice broadcast of training situation, voice control and voice encouragement
Interesting design	Music and video playback function

4.3. Product Draft

According to the above analysis, Draft 1 is designed in this paper. The patient adopts sitting posture and performs leg training on the lower extremity rehabilitation trainer, which can not only protect the knee joint, but also exercise the patient's leg strength and knee flexibility. However, considering the size of the elderly, there are differences in balance ability, and osteoporosis, spinal compression deformation, intervertebral disc aging and other diseases are common in the elderly. Draft 2 is designed in this paper. Compared with Draft 1, the lower extremity rehabilitation assistive devices in Draft 2 adopts a steel pipe structure to support the base, which has higher stability and gives people

a sense of lightness visually. The heightened backrest is more comfortable. Both the head and seat are adjustable, and the armrest can be folded to facilitate patients to get on and off the trainer. With higher safety and adjustability, it increases the experience and comfort of lower extremity rehabilitation assistive devices.

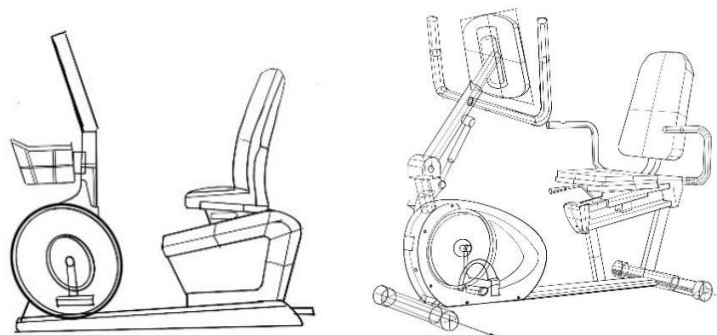


Figure 2. Draft 1. The Rudimentary Form Draft 2. Draft Design of Lower Extremity Rehabilitation Assistive

4.4. Product Effect Picture and Function Description

As shown in the figure3. It includes the nose part, pedal part and seat part. The adjustment button of the bare mobile device can adjust the height and angle of the bare mobile device according to the patient's needs. The handle of the nose is designed with anti-skid design and increased concave-convex, which makes it convenient for patients to hold the handle. A heart rate sensor is installed to detect the patient's heart rate. The display can show the patient's movement data and play music or video. The storage basket is designed to allow the patient to hold items such as cups and towels.



Figure 3. Effect drawing

For pedal riding, the position of the pedal is additionally equipped with anti-skid and anti-falling design to prevent accidents caused by slipping during leg training. It is also designed with 8 resistance adjustment buttons, which can enable patients to adjust the resistance during training and adjust the training intensity according to their own conditions. The pedal supports both forward and reverse training, allowing the legs to work in both directions.

In the seat section. Rehabilitated patients with lower extremity of different heights can use the adjusting handle under the seat to adjust the height and front-back distance of the seat. Both sides of the seat are designed with foldable safety armrests, and patients can choose to hold the armrests

according to their own conditions to increase safety. The user can also lower the armrest when getting on or off the assistive device to increase convenience. In addition, a push-pull buckle is provided under the seat to rotate the seat so that patients can get on and off the trainer from the side without worrying about bumps and tripping.

4.5. Design Evaluation

Due to the limitation of objective conditions, it is impossible to make real objects. Therefore, in this design evaluation, renderings and oral description are adopted to explain the details and functions of the product for users. The interviewees mentioned above were invited to evaluate the appearance, function and humanized design of the product. First of all, the light-colored appearance is clear and beautiful. The dark color is stable and resistant to dirt, which meets the needs of elderly people with different personality traits. The design is small in shape, requires less space, and has a sense of fashion, lightness and movement. The appearance design meets the needs of users very well. In addition, the storage basket, rotatable seat and head with adjustable height and angle also solve the pain points of users. The humanized design such as voice control makes it more convenient and interesting to operate. Users are willing to try this assistive device. However, in terms of function, users think that although the assistive devices can train legs and knee joints, the joints that can be exercised are relatively single with relatively simple functions. This paper believes that this is also the direction of future research. In the future, whether it is possible to increase the multi-joint exercise function through external devices or changing the structure of auxiliary tools.

5. Conclusion

This paper first sorts out the R&D status of lower extremity rehabilitation assistive devices for the elderly, explores the shortcomings of existing products in combination with interviews, analyzes the physiological, behavioral and psychological characteristics of the elderly from the user level, summarizes user needs, and provides design basis and ideas for product practice. Secondly, it puts forward the design principles of lower extremity rehabilitation products for the elderly. Combined with user experience theory, it discusses the elements of product design and carries out design practice. This lower extremity rehabilitation assistive device for the elderly has added humanized design, focusing on users' feelings and needs at the spiritual level and user experience, making the product highly usable. In the future, more attention should be paid to the intellectualization and datafication of lower extremity rehabilitation products for the elderly, to make patients' rehabilitation training more scientific and convenient.

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