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DESIGN A WHEEL WALKER FOR PEOPLE WITH DISABILITIES LOWER EXTREMITY FUNCTION

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Abstract

The risk of falling is a problem that can occur in people who experience lower extremity dysfunction. For the elderly due to degradation of function or sick conditions, there will be a decrease in the strength of the muscles of the lower limbs or lower extremities can be aggravated by the presence of degenerative diseases such as osteoporosis, Parkinson's, poststroke, and fractures. Lower extremity fractures are mostly the result of accidental trauma, have a high hospitalization rate and require surgery. The impact of falling incidents on the elderly is that they result in various types of injuries, physical and psychological damage. To overcome these problems, it is necessary to design road aids which are improvements to the previous road aids.

The wheel walker design method consists of the technical aspects of the mechanical design of the wheel walker, including the components involved, the materials used, and the design principles applied to achieve the optimal performance of the tool. The research design includes tools and materials, research flow diagrams and wheel walker design processes. Based on the results of the research, the wheel walker that has been designed and built in this study meets ergonomic and functional criteria for people with lower extremity function disorders. The design can be adjusted to the needs of the user, providing ease of mobilization and helping to increase the patient's independence in carrying out daily activities.

Background

The elderly or elderly human beings (seniors) are the age marked by a decline in intellectual and physical abilities that begins with some changes in life. The movement to walk is a function that needs to be helped, especially for the elderly because of degradation of function or illness (Djumhariyanto, 2014). Decreased muscle strength of the lower limbs or lower extremities can be exacerbated by the presence of degenerative diseases such as osteoporosis, Parkinson's, poststroke, and fractures.

Impaired function of the lower extremities can occur in patients or people with fractures in the lower extremities such as in the femur, tibia fibula and plantar. The most common fracture in Indonesia is lower extremity fractures. The part of the body that has suffered a lot of injuries is the lower extremities (Riskesdas, 2018). Lower extremity fractures, which are mostly the result of trauma from accidents, have a high hospitalization rate and require surgical action. Productive age is an age that has a range of injuries due to accidents, as well as the elderly can have fractures due to a decrease in bone age so that they are prone to fractures (Platini, 2020). Fractures of the lower extremities include fractures of the femur, tibia, and fibula so that the patient cannot move as usual due to immobilization.

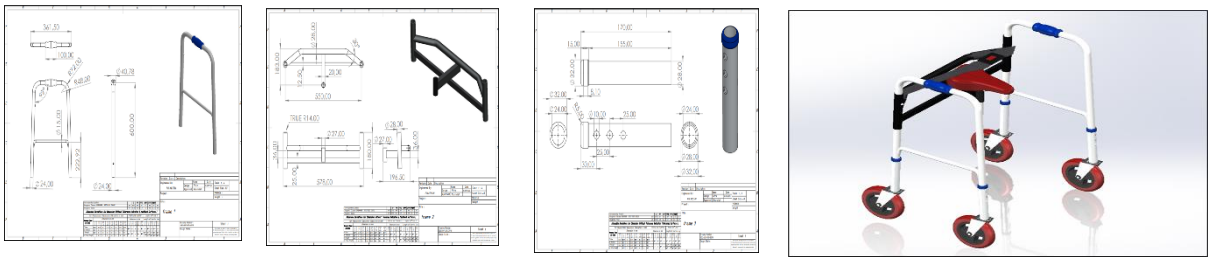
One method so that the risk of falling can be prevented is the use of a walker as an implementation of non-pharmacological therapy for patients with lower extremity function disorders. The main principle in the use of assistive devices is to reduce risk factors in individual sufferers such as supporting weight and reducing joint activity (McAlindon et.al. 2014). Walkers can mechanically relieve joint load so that they can directly reduce pain in the

joints. However, there are still some shortcomings found in the instrument where the patient has to move or lift the stick to change direction (wheel walker), use of the wheel only to go forward and backward, inflexible for left and right movements and the absence of a safety instrument or fastener between the tool and the tool user, so the patient still has the potential to fall. Other problems with conventional walking aids used by patients such as crutches, sticks, tripods, quadripots and also walkers without wheels that still use the patient's arms as a support for weight, moving/walking and balance functions (Gaxatte et al., 2011). These problems have the potential to make patients feel afraid and have difficulty in activities or mobilization (Modok & Wati, 2019).

Based on these problems, it is felt necessary to modify the walker medical device to be able to overcome the risk of falling in the patient and also make it easier for patients or walker device users to mobilize and carry out activities independently. In addition, patients who are in the healing process can use these medical devices, so that the healing process can run effectively, efficiently and adaptively.

Methods

The research, which was conducted in June – September 2024, took place at the Laboratory of the Department of Nursing, Health Polytechnic of the Ministry of Health of Banjarmasin. The mechanical design of a wheel walker is based on mechanical principles that ensure the performance and efficiency of the tool (Giachetti et al., 2002). Each component is designed to function synergism, optimizing stability and user comfort. The principles of load distribution, material strength, and adjustment mechanism are applied to achieve the desired performance and meet the needs of users. The design of this wheel walker uses the SOLIDWORK 2023 Software, as follows:



Tool manufacturing in tool design is a process that involves a series of structured stages, starting from the conceptual design phase to final production, with the aim of producing a device or component that conforms to the desired technical and functional specifications. The process of making a frame frame begins by making a working drawing using mechanical design software, after obtaining a working drawing, then cutting the iron according to the design of the working drawing and forming an iron pipe according to the pattern that has been designed, then assembling the iron that has been formed using rivets. Next, an assembly process is carried out in which individual components that have been produced or processed previously are systematically combined. The main goal of this process is to produce a final product that is intact, functional, and ready to use according to the specifications that have been set. Each component must be precisely assembled and assembled to ensure that the resulting tool can not only function as intended, but also meet the expected standards of quality, reliability, and safety. The last stage is finishing, painting the finished frame.

Wheel Walker Tool Finish


In the trial stage of the Wheel Walker tool, several tests are used to ensure that the product operates as expected and also aims to identify the limitations and weaknesses of the product. Testing is done to ensure the quality and reliability of the product and all parts/components can work. Through product testing, technical standards can be developed to produce products that are functional and safe to use by users. The first is dimensional suitability testing and ergonomics aimed at ensuring that the wheel walker can be adapted to various body sizes of users and remains comfortable to use. The aspects tested include adjustment of handle height, saddle position, and distance between components that must match the user's posture. The participants involved were 10 elderly people who met the inclusion criteria such as; Age ≥ 60 years (category of elderly according to WHO and Law of the Republic of Indonesia No. 13 of 1998), using walking aids, such as sticks, walkers, or crutches, not experiencing severe cognitive impairment and willing to be respondents (informed consent)
In tests carried out on individuals of different heights and weights, the aim is to evaluate whether the tool can be adapted to varying body proportions. The test results show that the adjusters on the handle and saddle work well in accommodating users of varying heights. The handle can be adjusted according to the user's height, so the user does not experience discomfort on the back or hands. A saddle that can withstand part of the body weight also helps reduce pressure on the arms, especially for heavier users. Finally, stability and safety testing is carried out to assess the extent to which the wheel walker can provide stable and safe support for the user during walking and turning activities. Testing involves standing, walking straight, spinning, and stopping abruptly to see how the tool handles movement dynamics.

Result and Discussion

Functionality testing aims to ensure that the wheel walker functions according to its purpose as a walking aid that supports the user's mobility. This test assesses how well each component performs in real conditions, including the ability of the wheels to move on a variety of surfaces, the flexibility of component adjustments, as well as the comfort of using the tool for long periods of time.

The test results show that the wheel walker can function well on different types of floor surfaces, such as ceramic, concrete, and rough surfaces. The caster wheel used spins smoothly without a hitch. The saddle components are able to support part of the user's body load, helping to reduce pressure on the arm and improve stability during movement. This tool is considered quite flexible in adjusting the height of the handle and saddle, so it can be used by various types of users. Overall, functionality tests show that this wheel walker operates well in helping users walk and mobilize, supporting its primary purpose as a safe and comfortable aid.

Indicator	Simulated Value
Number of respondents	10 elderly individuals
Correct use of walking aids	7 participants (70%)
Average ADL score	4.3 (partially independent)
Fully independent (ADL = 6)	3 participants (30%)
Successful walking aid use (comfortable, no issues)	8 participants (80%)
Estimated margin of error (with 95% confidence level)	± 5–7%
Average satisfaction score (scale 1–5)	4.1

Based on the results of the research that has been carried out, the wheel walker road aid project shows that this tool is able to meet the expectations set from the initial planning stage. The developed design successfully achieves functional and ergonomic goals, such as improving mobility and independence for people with lower extremity functional disorders. One of the main problems identified during this study was the inflexibility of conventional walkers, which are available in a variety of fixed sizes and types. These tools are often unable to adapt to the individual needs of the user, such as height or weight distribution, especially in situations where patients with different physical conditions require the same tools. The wheel walker designed in this study addresses these issues with an adjustment feature, which allows the tool to be used by different types of users with different postures and heights.

In the context of implementation in hospitals, it shows that this wheel walker is suitable for use in medical environments, especially in the rehabilitation section. It provides a more efficient and flexible solution than conventional assistive devices, especially for patients who are recovering from injuries or lower extremity surgery. Wheel walkers allow users to adapt more quickly to the tool, due to their modular design and customization of components such as handles and saddles, which can be adjusted according to the specific needs of the patient. Thus, this tool not only helps to facilitate patient mobilization, but also reduces dependence on help from medical staff or companions during the rehabilitation process.

Aside from the functional aspect, the wheel walkers resulting from this project have the potential to be commercially marketed. The product is designed with the needs of the user in mind, based on observations and feedback from patients and medical personnel. The existence of features that support comfort and safety, provides added value compared to existing road aids on the market. This innovation presents a great opportunity to be further developed and produced on a large scale, while having a positive impact on consumers, both for hospital needs and individual users at home.

Overall, this research has succeeded in presenting innovative and adaptive walking aid solutions, with great potential to be applied in the medical world as well as at home. These products not only benefit patients with lower extremity function disorders, but also offer commercial opportunities for manufacturers and marketers, while supporting a more adaptive and affordable transformation of health technologies for the wider community

Conclusion

The wheel walker that has been designed and built in this study meets ergonomic and functional criteria for people with lower extremity dysfunction disorders. Its design that can be adjusted to the needs of the user provides ease of mobilization and helps increase the independence of patients in carrying out daily activities with main features that include adjusters, caster wheels and safety belt systems. Additional components such as saddles to support part of the user's body weight have also been shown to help reduce the load on the arms and improve posture. The design parameters that have the most influence on the comfort and effectiveness of these aids are the total weight of the tool, the stability of the frame, and the

ease of adjusting the height and position of the components. The material used also plays an important role in ensuring that this walking aid is strong, durable, but still lightweight for patients to use.

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