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Electric Wheelchair Design and its Impacts on Life among the Disabled Individuals: A Review

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Abstract:- In this article, an extensive review of the presently available electric wheelchair design and its impact on the life of disabled individuals is presented. Patients with mobility impairments are well recognized for their quality of life and physical activity, it is very important to encourage the active lifestyle of these people to live successfully in society. The design of the mechanical components used in the wheelchair play a critical role in providing good physical activity for impaired people and their active social participation. This review article focuses on the mechanical aspects of the wheeled mobility devices and their main components which help the disabled individuals to use them effectively; such as propulsion systems, assistive technologies, overuse injuries, and their modifications. The role of design adjustments that enhance physical activity and improve the quality of life has also been evaluated.

Keywords:- *Electric Wheelchair, Disability, Modification, over injuries, Joystick.*

I. INTRODUCTION

A recent survey conducted worldwide on disability reported that over one billion people or approximately 14% of the population in the world disabled. According to surveys, roughly 10% of these persons have a lower-limb handicap and need manually operated wheelchairs to get around and perform everyday duties. However, about 20 million persons with disabilities are unable to use wheeled mobility devices [1]-[8]. Those with impaired movement and balance frequently use wheeled mobility devices, amputees with lower limbs, and persons suffering from spinal cord injuries, osteoarthritis, muscle degeneration diseases, and a few instances are neurologic disorders. Physical activity is vital for these people, and leading an active lifestyle is an important component of effective rehabilitation regimens for people with ambulatory diseases, according to growing research [8]. Many aspects of wheelchair design influence overall mobility and stability. From the standpoint of medical engineering, it is a challenging challenge to adapt all of these features to the individual needs and preferences of a wide range of consumers. [20].

Thankfully, a growing corpus of research is addressing these complicated concerns to equip wheelchair users with the greatest evidence-based design and fine-tune the user wheelchair interface. This review article gives a summary of the essential features of wheelchair mobility technologies that affect wheelchair users' physical activity, participation, and quality of life [2], [3], [12], [13]. Many studies have found a link between higher levels of physical exercise and higher levels of quality of life in these people. Fewer studies have looked at how technological advancements in wheelchair design can help people with lower limb disabilities improve their quality of life, participation, and physical activity. The number of persons who require mechanical mobility aid, whether as a result of sickness or an accident, is rapidly growing. To improve the quality of life for these people and allow them to enter the labor field, these tools must grow more complicated as technology advances [2].

II. POWERED WHEELCHAIRS AND ASSISTIVE TECHNOLOGIES

Various assistive technologies have been established to promote disabled people to lead their quality of life independently, and rehabilitation specialists must keep up to date on the systems available and their benefits. Despite worries about decreased physical activity and the accompanying secondary consequences of powered wheelchairs provide several benefits and implications for those who live a less active lifestyle. Powered, wheeled mobility devices have been revolutionized and diversified as a result of major technological advancements over the last decade. Power-assisted wheelchairs offer less physiologically demanding mobility and require less energy to propel [2]-[3].

Joysticks, computer user interface technology, such as speech recognition systems are examples of assistive devices that allow people with severe physical disabilities to complete their daily activities and obtain an acceptable level of independence. Joystick interface research is becoming increasingly popular technology has changed powered wheelchair design, however, users may confront driving challenges if not properly educated [5],[6],[7].

III. WHEELCHAIR WEIGHT AND MATERIAL

The materials used in wheelchair frames determine their endurance, durability, mass, and stability. Investigations into the resistance to wear and tear of wheelchairs have been conducted. Ultralight wheelchairs are frequently composed of alloy steel, aluminum, titanium, or composites, whereas steel, aluminum, or a combination of the two are commonly used in lightweight wheelchairs. [18]-[20].

According to research, frame material has little effect on wheelchair performance in traditional durability testing, and the design which provides standard mechanical features is more important. According to available research literature, ultralight wheelchairs are more cost-effective than lightweight and depot wheelchairs due to their longer fatigue life. Furthermore, the changeable components of lightweight wheelchairs make them more adaptive to the demands of the user[15]-[16].

IV. OVERUSE INJURIES

Long-term usage of wheelchairs or any mobility aids may lead to muscle-related diseases. Many researchers have focused their studies on overuse injuries in the upper body, with a lot of efforts to resolve the physical strain caused by the long-term usage of the wheelchair by modifying the propulsion mechanisms [11]. The disabled persons who use the wheelchair for their daily activities may choose to have an inactive lifestyle to avoid the upper body discomforts, again which may result in secondary issues also. Some studies have found that learning to use a wheelchair is a predictor of quality of life owing to its involvement in preventing overuse injuries. There is now growing evidence that wheelchair skills training programs promote confidence and community involvement, particularly among inexperienced senior persons[11]-[18]. Several design changes have been proposed to lessen the impact of repeated strain on the upper limbs. Important mechanically researched alterations include the employment of alternative hand rim configurations, rear-wheel angle, inclination, and seat position, IC engines, and electrically motorized wheel rotation to alleviate user stress[20].

V. MODIFICATIONS

Figure 1 depicts a motorized wheelchair, electric wheelchair, or electric-powered wheelchair that is propelled by an electric motor rather than physical power. Motorized wheelchairs are ideal for persons who are unable to propel a manual wheelchair or who require a wheelchair to go long distances or over severe terrain, which would be tiresome in a manual wheelchair[20].

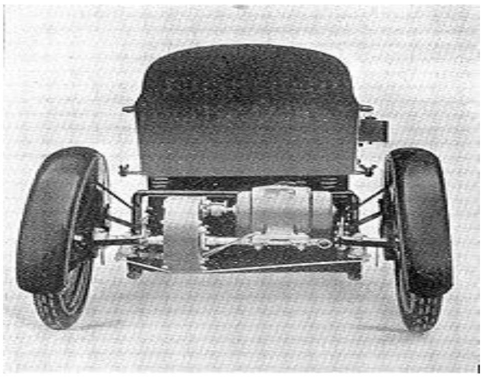

Fig. 1: Electrically Propelled Wheel Chair

The design of an electric wheelchair can be classified according to the drive system used to propel the wheelchair/chassis to support the main components, power supplying unit such as a battery, type of control system to have a control over it, type of seat used, and ease of usage. For the reason that they are used as the major mode of propulsion, they must be extremely reliable both electrically and structurally. The electric motors used in the wheelchair are generally driven by the use of 12 to 80 amp hour rechargeable deep-cycle batter having a voltage of 12; when the battery size is small, two batteries can be used together to provide a continuous power supply to keep the chair in running condition for at least one day between charging cycle [20]. The batteries are available in two forms one is the wet type and another one is the dry type. The legal transport of wet-cell batteries is prohibited on airlines if they are not removed from the wheelchair and properly packed in a shipping container, hence dry-cell batteries are generally preferred over wet-cell batteries. Many wheelchairs include an inbuilt charger that connects to a standard wall outlet; older or more portable models may include a separate recharge device. [10]-[12].

Fig. 2: Joystick

Controllers are often armrest-mounted joysticks as shown in figure 2 featuring additional controls that allow the user to modify the sensitivity or access a variety of control modes. A wheelchair can be built to be used indoors, outdoors, or both indoors and outside. A typical indoor wheelchair will be thin and short to maneuver more easily in tight spaces. Controls are typically basic, and the chair would be less stable outside due to its compact size. Outdoor wheelchairs include a long wheelbase for stability and large tires for comfort and control. These can occasionally be driven indoors in suitable situations, but not in the vicinity of a regular house[9],[12],[17].

VI. CONCLUSIONS

According to a survey of numerous published articles, researchers are always working to develop powerful and useful wheelchairs to help people with various disabilities with their everyday activities and provide more independent mobility.

Wheelchair design and mechanical modifications might assist physically challenged persons in enhancing their physical activity, quality of life, and participation level. More research is required to assess the cost-effectiveness of advanced design elements, therapies to overuse injuries should be avoided, and measures to address the secondary consequences of sedentary behavior should be implemented.

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