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RESEARCH ARTICLE

EXPLORING THE IMPACT OF MANUAL WHEELCHAIR DESIGN ON USER'S SATISFACTION AND FUNCTION IN INDIVIDUALS WITH SPINAL CORD INJURY

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ABSTRACT

Objective – To explore the impact of manual wheelchair design on user's satisfaction and function in individuals with spinal cord injury.
Research design : Descriptive.
Setting- SVNIRTAR and Regional spinal injury center (RSIC), Cuttack.
Participants: 100 SCI patients using manual wheelchair for more than 6 months.
Outcome measures: Functioning everyday with wheelchair (FEW) questionnaire, Quebec users evaluation of satisfaction with assistive technology (QUEST)
Results and conclusion: The results of the study showed that majority of the participants were not satisfied with their wheelchair. There is an urgent need to prescribe wheelchair based on individual requirement along with modifications, if any. The lifespan of wheelchairs are pretty low compared to global standards.

INTRODUCTION

Spinal cord injury (SCI) is one of the most common severe disabilities which negatively influence physical and psychological aspects of health and QOL (Haisma *et al*., 2008). It is generally a debilitating disorder that can have a profound impact on independence and lifestyle, related to loss of motor and sensory function as well as associated problems. *The condition can lead to lifelong loss of function and reduced quality of life, as well as increased morbidity and mortality*. Therefore restoring persons with SCI to their optimal level of functioning and participation and improving their QOL are essential goals of rehabilitation program. Approximate 20,000 new cases of SCI are added every year in India. 60-70% of them are illiterate, poor villagers. Over 90% of paraplegics in India come from the low income or lower middle class income group (Pandey *et al*., 2007). Mobility is perceived as one of the most restricted domains of social participation after spinal cord injury (SCI). When ambulation is impaired, wheelchair provides a relatively fast and effective means of mobility for people with SCI. Hence the ability of people with SCI to successfully participate in the community and regain independence depends much on access to appropriate and adequate wheelchairs.

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It has been proposed that greater satisfaction with a wheelchair should result in enhanced use of that technology and make possible a better subjective quality of life. On the other hand, a poor wheelchair fitting may be perceived as negatively impacting a person's life as it does not enable him/her to perform key daily activities. Thus, the wheelchair can be a limiting factor or facilitator for participation dependent upon how well it matches the person's needs and environment (Chaves *et al*., 2004). People with SCI rely on manual and power wheelchairs to compensate for mobility needs to accomplish daily activities. The manual wheelchair is designed to be propelled by the individuals with paraplegia or by an attendant (WHO, 2015). The "powered" wheelchair is designed to be propelled by a battery-powered electric motor or motors and used by individuals with tetraplegia. We would be focusing on manual wheelchairs in our study.

Usually, the WCs are distributed with little professional, clinical or technical inputs and the majority of the products are "one size fits all" (Kim and Mulholland, 1999). Regardless of the delivery mechanism that is employed, daily use and exposure to weather conditions and rough terrain often results in WC failures (Kim and Mulholland, 1999 and Fitzgerald *et al*., 2005). When the WC is in disrepair or requires frequent repairs, the individual's function can be reduced; without any form of mobility the individual may be injured or left out (Gaal *et al*., 1997, McClure *et al*., 2009 and Borg *et al*., 2008).

Additionally, when the WC performs poorly, user satisfaction is significantly reduced and it is more likely to be abandoned (Phillips *et al*., 1993). This is especially true in developing countries where access to WCs is generally limited to imported ones, replacement parts are almost impossible or too costly to find, and users often do not have a back-up WC, thereby reducing their mobility and community participation for an undetermined period of time (Hotchkiss *et al.*, 1987). Although being one of the most used mobility technology, the wheelchair is still referred by users as the main limiting factor in community participation (Chaves *et al*., 2004). Why does the wheelchair, as mobility equipment, fail in providing full independence to its users? To understand this limitation, several factors must be considered. Studies have shown high prevalence of pain among wheelchair users, which negatively affects their quality of life and increases their dependence of caregivers (Chaves *et al*., 2004).

The push rim propulsion has been shown to contribute to the development of upper limb overload injuries, mainly due to its mechanical inefficiency. (Van der Woude *et* al., 2001). Equally important, cost and specific features of the equipment such as weight, size, structure and appearance can also determine the success of its use. The prescription of customized wheelchairs has become a practice, albeit uncommon, in India in the last 5-10 years. Most wheelchairs in India are acquired through vendors, government agencies, or charitable foundations without clinician input. They tend to be heavy, poorly designed, prone to mechanical failure, and do not allow their users to be independent or to move about efficiently with assistance (Mukherjee *et al*., 2005 and Saha, 1990). Such wheelchairs are often inappropriate for the terrains within India. Many are manufactured locally, but chairs of similarly poor quality are also donated (Mukherjee *et al*., 2005). Because the built environment of India is more challenging to wheelchair users than in western countries, and because many people live in undeveloped areas, wheelchair durability and stability are much more important than some charities and manufacturers may realize. In a recent study of Indian home accessibility by Pearlman *et al* (Toro *et al*., 2012), unstable surfaces, narrow doorways, steps, steep ramps, and inaccessible bathrooms were found to be some of the most frequent and challenging obstacles. Though accessibility in India may be slowly improving, a much more immediate impact on participation could come through the provision of wheelchairs that allow the user to exercise better skills.

Rationale for the study

Although several studies have described the advantages and disadvantages of manual wheelchairs, no study to date have related them to level of satisfaction and functional independence. Most of the literature on wheelchairs is focused around issues of design, consumer preferences, abandonment, cost and policy. What is not known is how manual wheelchair users report different levels of satisfaction depending on their level of functional independence considering manual wheelchair to be their source of mobility. Therefore, the overall aim of this study is to investigate the effect of manual wheelchairs on the level of satisfaction and functional independence of individuals with SCI.

Aim of the study

- To explore the impact of wheelchair design on user's satisfaction and function
- To evaluate whether there is any difference amongst the different wheelchair brands in regards of user's satisfaction and function.

MATERIALS AND METHODS

Study Design: Descriptive,

Sample size: 100 patients,

Sampling: Convenient sampling

Inclusion criteria: SCI patients using manual wheelchair for more than 6 months, both traumatic and non traumatic SCI patients, tetraplegics as well as paraplegics, complete and incomplete lesion both

Exclusion criteria: Acute SCI patients who haven't yet started using or have used wheelchair for less than 6 months, patients who are not well oriented or cognitively sound.

Procedure: Patients selected on the basis of inclusion and exclusion criteria were taken consent to participate in the study. Thereafter they were interviewed in person through Functioning everyday with wheelchair (FEW) questionnaire which explored the impact of wheelchair design on users function and through Quebec user's evaluation of satisfaction with assistive technology (QUEST) which evaluated the users satisfaction with their wheelchair. Then the wheelchair brands most commonly used were compared with each other in order to find out any difference between them regarding the users function and satisfaction.

Data Collection

This was a descriptive study where participants were interviewed in person through the two questionnaires (QUEBEC and FEW). For Quebec the rating scale was as 1-least satisfied and 5-most satisfied while on FEW it was as 1-completely disagree and 6-completely agree.

Data Analysis

- Statistical analysis was performed using SPSS version 16.0
- The scores on FEW and QUEBEC was analyzed using Man Whitney U test. P was set at 0.05 for level of significance.

RESULTS

A total of 100 spinal cord injury patients (tetraplegics and paraplegics) using manual wheelchair for more than 6 months were interviewed through questionnaire to find out impact of wheelchair design on users function and satisfaction.

Demographics

Tetraplegics + Paraplegics	52% (n=52) +48% (n= 48)
Males : Females	80% (n=80) : 20% (n=20)
Married : Unmarried	69% (n=69) : 31% (n=31)
Mean age	35.61 (Min-19yrs, max- 57yrs)
Rural residents : Urban	67% (n=67) : 33% (n=33)
Mean duration of disability	1.5yrs (Min -8 months, Max-34 yrs)
Vocationally rehabilitated	4% (n=4)

Wheelchair brand	Population using (%)	Cost range (Rs)
Alimco	45% (n=45)	2000-5500
Karma fighter	35% (n=35)	3700-12000
Invacare	5% (n=5)	10,000-12000
Samson	5% (n=5)	4000-5200
I-care	4% (n=4)	4200
Motivation	2% (n=2)	8000
Indsurgical(customized)	1% (n=1)	11000
Kayang (semiactive)	1% (n=1)	8500
Karma(active)	2% (n=1)	25000

Donated wheelchairs	37% (n=37)
ALIMCO (by SVNIRTAR)	33% (n=33)
KARMA fighter (by Lion's club)	4% (n=4)

Wheelchair characteristics

			Tetraplegics	Paraplegics
Mean time spent on wheelchair	4.6hrs, Min-3hrs Max-14 hrs			
Mean time of active propulsion	2 hrs, Min- 15 mins Max-14 hrs	10-	Completely dependent-55% Assistance required-45%	Assistance required-43%Independent indoors-49% Independent indoors and outdoors- 8%
Transfers			Dependent- 100%	From bed to chair and viceversa-12% Dependent-88%
Surfaces	Cemented tiles-100% Grass-5% Ramps-90%	and		

Component	Problem	Percentage encountered	Wheelchair brand
Brakes	Loosened and inefficient functioning	46%	ALIMCO-30% Karma fighter-8% Invacare -4% I-care - 4%
Foot rest	Broke frequently	19%	Karma fighter-10% ALIMCO- 8% Customized-1%
Back rest and seat	Poor quality, loosened and torn	24%	ALIMCO -12% KARMA- 10 I-care- 2%
Knobs and axle	loosened	17%	ALIMCO-12% KARMA- 5%
Tyres	Puncture	18%	ALIMCO-8% KARMA-6% Invacare- 3% Motivation-1%
Castors	Broke frequently	20%	ALIMCO-12% KARMA-8%

Impact of wheelchair design on user function

	Completely disagree	Mostly disagree	Slightly disagree	Slightly agree	Mostly agree	Completely agree
Comfort needs	15%	30%	50%	2%	1%	2%
Health needs	20%	34%	40%	3%	1%	2%
Reach outs	17%	47%	30%	2%	1%	3%
Transfers	39%	30%	26%	1%	1%	3%
Personal care tasks	50%	30%	16%	2%	1%	3%
Operation indoors andoutdoors	30%	36%	30%	2%	2%	
Personal/public transportation	93%	3%	none	1%	3%	

User's Satisfaction

	Not satisfied at all-	Not very satisfied-	More or less satisfied	Quite satisfied	Very satisfied
Dimensions(size, height, length, width)	10%	34%	50%	4%	2%
Weight	None	40%	56%	2%	2%
Ease in adjusting parts	76%	7%	10%	2%	5%
Durability	44%	28%	22%	4%	2%
Comfort	15%	36%	45%	2%	2%
Effectiveness	80%	5%	12%	1%	2%
Overall satisfaction	10%	47%	40%	2%	1%
Service delivery programme	33%			67%	
Repairs andservicing provided	97%			3%	
Professional services	94%			6%	
Follow up services	97%			3%	

Repairs

The users encountered various parts to be broken or loosened for which some or the other repair had to be made or they had to purchase a new one from outside. Amongst all we found a greater percentage of people using ALIMCO (group 1) and KARMA (group 2) wheelchairs, so we compared the scoring of users on function and satisfaction between these two groups. To compare scores on FEW in the two groups, Mann Whitney U test was performed. The test shows the U value is 601.000 and p value is 0.892 indicating there isn't any significant difference in the scores of FEW between groups. To compare scores on QUEBEC between the two groups, Mann Whitney U test was performed, the U value is 609.000 and p value is 0.967 indicating there isn't any significant difference in the scores between groups.

DISCUSSION

The overall results of the study provided with information regarding various types of the wheelchairs used, the impact of wheelchair design on user's satisfaction and function. The higher percentage of wheelchair users was of males(n=80) in our study which is in consensus with the results obtained by other researchers, which show higher trends of SCI among males and the younger population (Essi *et al*., 2012). The users were preoccupied with some or other vocation prior to sustaining SCI but post injury except four, none other were gainfully employed. The depression related to their disability was quite high such that they were not interested in getting employed. While a greater percentage stated *"In this condition we aren't able to perform our own activities of daily living then how will we do our job."* others mentioned their plight as "*Our employer has asked to get back to normal condition only then we will be taken back for job"*. It is possible that the low level of education among persons with SCI in our study population would have further decreased their chances of finding a job.

In the US, less than 30% of the 18 to 62 year- old persons with traumatic SCI were employed (Hunt, 2005). Dorsett (2001) found that the employment of the respondents dropped from the pre-injury figure of 83% employed to only 14% employed immediately following discharge from hospital (Dorsett, 2001). Contrary to this the four employed were from urban areas hence the encouraging environment, better opportunities and awareness would have contributed to employment after SCI. In addition many of the factors identified as predictors of employment for spinal cord injured persons are biographical characteristics such as age, gender, or race, and as such are not amenable to intervention by rehabilitation professionals.

Impact of wheelchair design on Function

Whilst the active and semi active wheelchair users perceived themselves to be capable of performing all functional activities in the wheelchair, categories pertaining to daily activities, wheelchair dexterity and mobility created challenges for other manual wheelchair users. As the purpose for providing a wheelchair is to enhance function and mobility this finding remains worrying. The reasons for this can be multiple and might include a lack of training and a lack of physical ability (Vegter *et al*., 2010). Borg *et al.* 2012 found that training significantly decreased activity limitations and participation restrictions of wheelchair users. However, functional challenges might also be related to wheelchair design, fit and biomechanical set up. (Medola *et al*., 2014 and Øderud, 2014). Users using a basic four-wheel frame design experienced poorer overall function than those using other wheelchair designs. This may be because this design is not suitable for active users or for outdoor use on uneven terrain. In addition this design provides little scope for biomechanical adjustments that could enhance user function (Medola *et al*., 2014 and Provincial government of the Western Cape 2009b). However, this design was the one most often issued and the wheelchair of choice for both therapists and users. This finding might be attributable to one or a combination of several factors.

The greater usage of ALIMCO (45%) can be contributed to the fact that they were being donated by the Institute under the ADIP scheme whose main objective is to assist the needy disabled persons in procuring durable, scientifically manufactured standard aids and appliances that can promote their physical, social and psychological rehabilitation (ADIP Scheme). About 33% ALIMCO wheelchairs were being given to participants from SVNIRTAR itself while the other 4% KARMA fighter wheelchairs were donated by the LIONs Club. These WCs were the hospital-type/depot wheelchairs which are most commonly distributed in developing countries through the charitable model of delivery (Pearlman, 2006 and Pearlman, 2008). This type of WC is designed for temporary indoor use only (Kim *et al*., 1999), is not adjustable (Howitt, 2006), and not designed to provide postural support (Borg *et al*., 2008). Finally, it was the cheapest option and funding challenges made therapists select it. Whilst appropriate in some instances, for example for the users who were older than 60 or who had suffered a high level cervical injury (their

diagnosis and age are associated with lower activity levels (Steffen *et al*., 2002) it might have limited the function of more active users (paraplegics). Visagie *et al* mentioned in their study that a lack of funding results in therapists prescribing cheaper designs, even if less appropriate than others, to increase their ability to provide more users with wheelchairs (Visagie *et al*., 2015). It is disquieting that none of the participants living in a rural setting were issued a WC that was specifically designed for rural use. Relating to this, users from rural sections reported that they weren't made aware by the concerned specialists in this field of any other good quality wheelchairs and also that how a proper fit and good quality wheelchair can pave their ways towards independence so this lack of knowledge let them be content in whatever they had believing the fact that something is better than nothing. The semiactive and active wheelchair (3%) design is considered appropriate for active wheelchair users in urban settings.

These are more hard-wearing, can withstand higher strains than other manual wheelchairs and can be used for up to 16 hours a day, 365 days per year, a degree of usage few other devices are required to withstand (Cooper *et al*., 1999). Its greater maneuverability, lighter weight and transportability make this the wheelchair design of choice for many young, active users such as younger persons with spinal cord injuries (Dryden, 2003). This will, however, need to be explored further as only two active and 1 semiactive WC were used by participants in this study. In our study the wheelchair design wasn't compatible with the comfort needs and hence users faced discomfort in one aspect or the other. The sagging seat and the poor quality back rest made the users sit in a slouch posture thus leading to neck and back pain especially in those who used to sit on WC for prolonged periods. Toro ML in their study on wheelchair breakdown reported that the sling seat and back in depot type of WC are designed for short-term use because they are made of stretchable material that encourages pathologic postures. For instance, over a period of time upholstery problems can lead to deterioration in posture which will give rise to back and neck pain, as well as spinal and pelvic deformities (Cooper *et al*., 1999). Even worse, users get used to these pathologic body positions and their bodies could permanently become deformed. The need for WCs with good postural support systems is also a concern (Borg *et al*., 2008). Appropriate postural support for those who need it represents the difference between independence and dependence, as well as the risk of serious injury that can even lead to death (Howitt, 2006). About 18% reported to have a pressure sore on the buttock region, posterior aspect of thigh and greater trochanter on prolonged sitting in wheelchair due to poor quality seat without cushions. Those who purchased good quality gel cushions on their own costed them approx 4000-6000 Rs in addition to the basic wheelchair charges hence it wasn't affordable by majority of the users. Scovil CY *et al* in a follow-up study of SCI patients after discharge from inpatient rehabilitation in Nepal in 2007 found that donated standard wheelchairs did poorly in this study. Within two years, two thirds needed replacement. Since cushions were not included with the wheelchair, poor-quality locally available materials were used for pressure relief. Inappropriate wheelchairs restricted accessibility and poor quality wheelchair cushions made pressure ulcer prevention more difficult (Scovil *et al*., 2012). A high percentage of users were completely dependent on others for propulsion. The reasons were many for the same. The high level tetraplegics blamed their disability for not being able to propel their wheelchair. These people weren't able to use their fingers which prevented them to do any of their ADLS including propelling a wheelchair. About 6% weren't able to do so because of associated upper extremity injury (2%- Right brachial plexus injury, 2% sustained post fracture stiffness in hand, 2%- Shoulder subluxation). Approximately 21% had shoulder, elbow, back or chest pain while propulsion, basically when doing it outside on unleveled terrain. This could be attributed either to inappropriate propulsion skills or the wheelchair design wasn't compatible enough to be used on unleveled terrain in rural areas. Based on epidemiological studies, it seems evident that manual wheelchair propulsion and wheelchair-related daily life activities cause a heavy load on the upper extremities, especially for persons with cervical spinal cord injury, and more than two-thirds of manual wheelchair users with SCI report suffering or having suffered shoulder pain (Curtis *et al*., 1999).

The reason for being able to propel inside but not outside could be due to the environmental barriers and many associated it with the poor quality wheelchair tyres .The solid (airless) tires weren't good shock absorbers so whenever the wheel hit the unleveled ground it transmitted vibrations to the body causing back pain. Moreover the castors used to get stuck in muddy roads and potholes. Some didn't feel the need of doing it themselves because attendants were doing it for them. One participant said-"*My wife takes me wherever I need to so I don't feel the need of propelling the wheelchair myself*." Mukherjee G in their study on Wheelchair charity: a useless benevolence in community based rehabilitation concluded that hand rim-propelled manual WC are unsuitable for outdoor ambulation due to low speed and high physiological demand; they are also of little use indoors as they are difficult to manoeuvre under the environmental conditions and architectural restraints. So, they should not be recommended without proper assessment of the user's activity level and requirements (Mukherjee *et al*., 2005).

A study in Scotland determined that users experienced difficulties with wheelchair propulsion and daily use. Overall, 59 percent of the participants felt their wheelchairs did not sufficiently meet their needs; technical problems (28%), general discomfort (31%), small casters (18%), and wheelchair weight (16%) were a few items that participants felt caused inefficient wheelchair propulsion and accomplishment of daily activities. Going up and down the ramps was problematic for many as while going up much force was required and also the wheelchair used to slip backwards while on propelling down the slope, there was a fear of slipping down because the brakes weren't efficient enough to control or stop the wheelchair leading to the fear of fall. Medola FO *et al* in their study on manual wheelchairs mentioned that going uphill is almost impossible due to both the difficulty of propelling and the risk of the wheelchair toppling over, causing the user to fall down. Thus, the user needs the help from another person. Another difficulty is to move around for relatively long distances, because this task requires long-term activity with relatively high frequency use of the upper limbs, causing fatigue and discomfort (Medola, 2014). About 88% paraplegics were dependent for transfers for which many blamed their disability, others to the wheelchair design for example non removable

armrests, inappropriate seat height, and width for the same. About 13% weren't aware that they can possess this ability of transferring as according to them they haven't yet been taught how to transfer. Furthermore 10% reported their sagging seat to be the culprit. According to them, had the seat been firm it would have provided a stable base for transfers. Transport created a big challenge for user participants in the study. Other South African studies have reported similar findings (Chakwizira, 2010 and Kahonde, 2010) However, this might be attributable to factors other than wheelchair design. As described by current users, bus/taxi operators often refuse transport to wheelchair users or charge extra, because it takes longer for the person to transfer into the bus/taxi and the wheelchair takes the room another paying passenger could have occupied. Hence there is a stringent need for public awareness regarding disability.

About 21% couldn't reach for objects at heights such as shelves but could manage those kept at leveled surfaces. This is in consensus with study of Salisbury *et al* 2006 who found that the most painful activity was lifting an object from overhead. KARMA user's complaint the armrest wasn't of proper height so it interfered with the reaching activities. One user reported, "I *use wheelchair for bathing purpose but it takes long time to dry and then use it again so for the same I wish to have a separate seat which can be used for bathing or an altogether different wheelchair for bathing and defecation purpose.*" Amos and Winter (2013) supported the rationale that many wheelchair users should have two wheelchairs (Provincial government of the Western Cape, 2009b). They further told that however a lack of funding often prevented users from timely accessing a wheelchair or from receiving the most optimal wheelchair design. Thus, issuing one user with two wheelchairs seems impossible. Many users found wheelchair to be no good except as a means of transportation to the Institute for treatment. This may be because apart from transportation, they weren't aware of the many benefits that can be derived from wheelchair in getting independent.

Impact of wheelchair design on users satisfaction

A wheelchair with proper dimensions is mandatory for enhancing user's satisfaction. For instance a seat too narrow is not only uncomfortable, but access to the chair is made difficult. Furthermore, the chances of pressure sores developing are increased. A seat that is too wide encourages the user to lean toward one side, thus promoting scoliosis and increased pressure over the buttocks on one side .In addition, a seat wider than is necessary makes propulsion more difficult. A seat that is too shallow reduces the area in contact with the seat and causes more pressure on the soft tissues in contact with the seat than is necessary. Furthermore, if the footrests do not support the feet and legs properly, the balance of the user is affected. A seat that is too deep or longer than it should be, can restrict circulation in the legs, and causes the patient either to sit with his legs extended or to slide forward in the chair. The wheelchair needs to be modified as per the physical stature of the beneficiary; higher and deeper seat for a tall person and a lower seat for a shorter person. The individual requirements of the beneficiary has to be individually analyzed for the cushion or seating system (Wilson, 1987). Seat types available from wheelchair manufacturers are sling, or hammock, made of a flexible material, and solid seats which are generally removable. The sling seats are by far the type used most promoting pathological postures. Black *et al* associated increased posterior pelvic tilt with lumbar flexion and increased forward head and shoulder positioning, and these postural features have been associated with chronic neck and shoulder pain. The SCI population differs from the able-bodied population in that the sitting position is not transitory but rather the position of locomotion and interaction with the environment. In the absence of trunk musculature, the individual with SCI is more at the mercy of gravity, and with a posterior pelvic tilt, the mass of the head and upper trunk will facilitate trunk flexion. People with SCI who have paralyzed trunk musculature can learn a functional unsupported position of balance. This is accomplished with a posterior pelvic tilt and full spinal flexion, with high cervical extension, known as C sitting. This is a functionally stable position of balance, which allows bimanual activity. In a study of patients with severe neurologic disability who require wheelchairs, Pope found that the "predominant posture" mirrors C sitting. This suggests that the wheelchair is not providing support for postural alignment and may in fact be creating the need for the individual to assume this position of balance to function.17 Researchers looking at balance and chair configuration have confirmed that the tilted or reclined chair imposes a posterior tilt of the pelvis. Kyphosis and scoliosis occur to a greater degree in persons with tetraplegia than in controls, and these postural deformities have been shown to develop early after injury (Hastings, 2003). The backrest of the basic chair is made of a flexible material stretched between the two side frames which are fixed with respect to the seat .The backrest should be high enough to provide support without inhibiting motion, and not so low that the scapulae can hang over the back of the chair and cause discomfort.

Persons using Karma fighter wheelchair basically complaint about the arm rest being at greater height which caused obstruction in propulsion, resting hands, and also interfered in transfers. The reason for this could be lack of assessment before prescribing a wheelchair and hence the wheelchair wasn't ergonomically devised for the user. Medola FO *et al* in his study reported that despite being equipment for promoting mobility, the wheelchair is perceived by the users as the main cause of their limitation at and away from home (Medola *et al*., 2014). Surprisingly, users find the wheelchair more limiting than their own physical and functional condition. The main complaints are related to weight and higher dimensions of the equipment, making it hard to manoeuvre, especially in places where space is restricted. In accordance to this statement, Mann *et al*. (1997) found that 26% of the problems with a wheelchair were related to its weight and size: too heavy to push, too wide to use inside the home (Mann, 1996). Our results were somehow similar to the survey study by Perks BA on marginal wheelchair users who reported that the majority (59 percent) of users questioned said that their wheelchairs were inadequate for their requirements. Typical wheelchair problems included inadequate wheel positions (11 percent), castor wheels that were too small (18 percent), high rolling resistance (16 percent), obtrusive footplates (11 percent), and unsatisfactory hand rims (6 percent) (Perks, 1994). Amongst all, hardly 11% users were evaluated for proper fit before the wheelchair prescription. Moreover input regarding user's requirements wasn't taken from them before providing them with the wheelchair. A dilemma in prescription

is the traditional view of users as patients, subject to expert assessment and prescription; not as individuals with a right to express preferences or allowed the possibility to choose (Sapey *et al*., 2004). Many obese individuals didn't find the wheelchair dimensions efficient enough for their body structure hence for these particular individuals bariatric wheelchairs can be used. Only 10% were provided with the manuals for the wheelchair, rest just learnt about the parts and mobility skills by themselves or other health care worker. Though how expensive a wheelchair was, the repairs and servicing (maintenance) and the follow up services wasn't provided in any case. Our results resemble those in study by Fitzgerald SG *et al* where participants were least satisfied with service delivery and owner's manual. Jedeloo *et al*. reported as well that their participants were least satisfied with the service delivery process, including the length of time to receive their wheelchairs and the extent to which their opinion was valued in the decision-making process (Fitzgerald *et al*., 2005). As was evident from the results we found that the brands most prevalent were ALIMCO and KARMA so we compared them both in respect of impact of wheelchair design on users function as well as on level of satisfaction but we couldn't find any significant difference between them (p= 0.892, p= 0.967 respectively). The reason behind this could be that so there wasn't any difference between both in terms of quality and design. Moreover neither of these WC was ergonomically designed for the user so as to enhance function and satisfaction.

Repairs

As seen from the results of this study, the WCs fail quickly, whereas current WC provision guidelines indicate that their average life expectancy should be 5 years (Sheldon, 2006). High rates of brake and seat sling and/or back support failures were found. These failures are of particular concern because they represent a threat to the users' safety and wellbeing. Some of the repairs that were identified suggest the possibility that bicycle repair shops, or other places that do not specialize in WC repairs, make repairs without understanding the human-WC interaction. This could pose unintended safety threats to WC users. Fitzgerald SG *et al* in their study reported that satisfaction with durability decreased over time as number of repairs increased. A comprehensive assessment is required to determine appropriate design and should include a thorough investigation of the environments in which the user functions. It seems from the findings as if a comprehensive assessment was not always performed. This omission may be why some users received wheelchairs not suitable to the environment in which they lived. Visagie, Scheffler and Schneider (2013) described assessment challenges which may negatively impact wheelchair prescription and overall wheelchair service delivery in a different South African setting (Visagie *et al*., 2015). Amos and Winter (2013) argue that there is currently no wheelchair design that enables a user to travel both long distances over rough terrain and function in small indoor spaces. The therapists indicated two wheelchairs: one for indoor use and one for outdoor use that might be more appropriate in some circumstances. Every user in need of a wheelchair should receive an appropriate wheelchair, even if the appropriate wheelchair is more expensive than the cheapest model that is available, and budgeting should be implemented accordingly (Visagie *et al*., 2015). Rural and semi-rural devices are more expensive than the basic, four-wheel, folding frame design and ordering these devices will deplete the wheelchair budget faster. Therapists issued cheaper designs to ensure that more users are assured of receiving a wheelchair. Whilst this argument might seem reasonable, exhaustion caused by trying to propel a wheelchair designed for urban use, over rugged terrain with narrow, steep footpaths and roads might cause users to discard the wheelchair even if it is their only means of mobility (Chakwizira *et al*., 2010).

Conclusion

The results of the study showed that majority of the participants were not satisfied with their wheelchair. There is an urgent need to prescribe wheelchair based on individual requirement along with modifications, if any. The lifespan of wheelchairs are pretty low compared to global standards. The Government and manufacturers of wheelchair need to understand the requirements of wheelchair users. Moreover there wasn't any difference in level of satisfaction and function between ALIMCO and KARMA fighter users.

Limitations of the study

- Small sample size
- Limited brands of wheelchair
- The research was basically carried out in a rural area so the environment, culture, thoughts of people was almost similar and hence would have influenced the results. Thus had more regions been taken into consideration, it would have given a broader perspective of the topic.

Recommendation

Prior to prescription of a wheelchair proper assessment needs to be carried out keeping in mind the proper ergonomic, biomechanical and environmental requirements specific to the particular individual in order to maximize their satisfaction and functional independence.

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