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REHABILITATION IN PRACTICE

Wheelchair charity: A useless benevolence in community-based rehabilitation

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Abstract

Purpose. Hand rim-propelled manual wheelchairs (WC) are conventionally distributed to persons with dysfunctioning lower limbs for independent ambulation in community-based rehabilitation. The purpose of the present study was to survey the fate of the donated WCs and the difficulties encountered by the users by identifying the cause of rejection, and to evaluate the performance by assessing physiological strain on the recipients during their routine ambulation using cardiorespiratory parameters.

Methods. Personal interview was arranged for the recipients and they were to answer regarding the fate of the donated WC and the cause of rejection for the recipients who rejected their WC. A simple field test was also administered to the users to evaluate the ambulatory performance using the WC. The energetics of WC propulsion at freely chosen speed was studied.

Results. Of the WC, 10.49% were for attendant-dependent ambulation, 57.4% were not used, 14.19% were sold and 7.4% were in regular use and 10.5% in occasional use. Most of the recipients rejected their WC due to pain, fatigue and discomfort and lack of habitat adaptability. The cardiorespiratory response was higher in occasional users than regular users. Locomotive tasks using WC are highly energy demanding and contribute to physiological strain.

Conclusions. 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 maneuver under the environmental conditions and architectural restraints. So, they should not be recommended without proper assessment of the user's activity level and requirements.

Keywords: *Wheelchair, community-based rehabilitation, physiological strain, hand-rim propulsion*

Introduction

Different social welfare organizations come forward to render their services for physically handicapped persons, and the wheelchair (WC) is conventionally distributed to persons unable to walk for their independent ambulation and to enhance social functioning despite impairments. It is well established that manual WC propulsion is the inefficient form of human locomotion as it involves cardiovascular strain [1,2] but it is still considered as a simple and all purpose ambulatory device and most commonly used due to its excellent maneuverability within a confined space and is an effective propulsion interface which provides the user with maximum feedback and control [3]. Most WCs are randomly

distributed through non-government organizations (NGO) and various voluntary organizations. These WCs are like the conventionally used hand rim-propelled manual WCs, cheap, locally made and of rigid type. The tragic end of the endeavor is the absolute rejection of the distributed WCs by the disabled population as they are unsuitable for regular use. Hence the whole effort becomes futile. This truth was exhibited while undergoing research regarding community-based rehabilitation. In an Indian study, Saha et al. [4] found that WCs were simply abandoned in rural areas due to their incompatibility with the environment. The purpose of the present study was to survey the difficulties encountered by the users by identifying the cause of rejection, the fate of the donated WCs and to

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evaluate the performance by assessing the physiological strain of the recipients during their routine ambulation using cardiorespiratory parameters.

Methods

Wheelchairs

The distributed WCs were of rigid type, cheap, and locally made with solid tires, and a non-detachable armrest. The configurations of a typical WC are: wheelbase 24 inches, wheel thread 28 inches, seat height 22 inches, seat depth 17 inches, seat breadth 18 inches, wheel diameter 24 inches, rim diameter 20 inches, castor wheel diameter 4.5 inches, back rest height 16 inches, ground clearance 5 inches and weight 25 kg.

Settings

The name and addresses of the recipients were collected from the relevant NGOs and were assembled in different zones of West Bengal. Personal interview was arranged with the recipients with regard to their clinical history and fate of the WCs, and this was attended by their guardians. Two types of questions were administered.

In first set they were to answer regarding the fate of the donated WC and in the other set the recipients who rejected their WCs were interviewed and they were to choose only one point from the list of answers (the list was prepared from frequent causes of rejection encountered by the users) as the cause of rejection. Those using the donated WC regularly, are considered as regular users (RU) and those using other ambulatory devices but using the WC casually were occasional users (OU).

A simple field test was also administered amongst the users, RU and OU, to evaluate the ambulatory performance using the WC. After resting for 15 min, the baseline data were collected. Both groups of participants were instructed to propel the test WC at a sustained speed (that found to be most convenient), continuously for 5 min. The speed was calculated each minute by dividing the time with the total distance covered in each minute by the subject and heart rate was monitored by using Sportstester PE3000 (Polar Electro Inc., Finland; a lightweight telemetric heart rate monitor), oxygen consumption directly with the help of Oxylog [5] (a portable oxygen consumption meter) during last 3 min of exercise and averaged. Physiological cost index (PCI [6]; the ratio of heart rate to speed of ambulation; $b \text{ m}^{-1}$), the energy cost per unit time oxygen consumption; (VO_2 , $\text{ml kg}^{-1} \text{ min}^{-1}$) and per unit distance; oxygen cost (VO_2 , $\text{ml kg}^{-1} \text{ m}^{-1}$). The means and standard deviation of the experi-

mental parameters were calculated and the equality of means between the two groups (OU and RU) for each parameter was tested by using two-sample *t*-test.

Written consent was obtained from each subject or guardian before participating in the study. The purpose and the methods of the study were explained to them and their right to terminate without assigning any cause.

Results

The names and addresses of 167 recipients were collected and the 162 were found at their addresses and the rest remained untraced. Three recipients were female and rest were male. The fates of the donated WCs are shown in Table I. Twenty-nine recipients were found to be using their WC, and of these only 7.4% were using the WC for routine ambulation, and were considered as RU; 10.49% were dependent on other ambulatory devices but used the WC casually and were considered as OU. The 116 recipients were again called to state the cause of rejection of the donated WCs, four of them did not come and 112 were interviewed. The causes of rejection stated by the recipients are shown in Table II.

In the field study, of 12 in the RU group three recipients were not available and the remaining nine completed the test sessions satisfactorily and without any adverse situation occurring.

In the OU group, 17 recipients attended the test session. Six subjects could not propel the test chair continuously for 5 min at a sustained speed due to excessive cardiorespiratory stress and local muscular

Table I. Fate of the donated wheelchairs.

Fate of the wheelchairs ($n = 162$)	(n)	%
1. Attendant-dependent ambulation	17	10.49
2. Left without use	93	57.40
3. Sold	23	14.19
4. Occasional use	17	10.49
5. Regular use	12	7.4

Table II. Cause of rejection of the donated wheelchairs.

Causes of rejection ($n = 112$)	No. of users	%
1. Pain, fatigue and discomfort	32	28.57
2. Upper limb involvement	13	11.6
3. Habitat adaptability	38	33.92
4. Frequent damage	17	15.17
5. Unable to drive	12	10.71

fatigue, and five could not maintain a steady pace, and their data were not included.

The physical characteristics of the recipients in both groups (shown in Table III; i.e., the OU ($n=6$) and RU ($n=9$)) did not differ significantly with respect to the chosen physical parameters, e.g., age, height and weight as revealed from the result of the t -test for two sample means tested at $P < 0.05$.

Speed and physiological observations of both groups of users are shown in Table IV. The mean speed for the OU group was recorded as 45.3 m min^{-1} (± 5.32) and for the RU group it was 54.5 (± 8.06). The increase was 21.19% for RU and was significant at $P < 0.01$. All physiological parameters noted were lower in the case of the RU group of users with respect to the OU group. The average ambulatory heart rate (b min^{-1}) for the OU was 139, while it was 128.88 for the RU. The difference (7.28%) in RU was not significant ($P > 0.01$), whereas when compared with PCI (b m^{-1}), where the difference was 29% lower in RU, the two respective mean values were 1.31 and 0.93 ($P < 0.001$). For oxygen consumption (VO_2 , $\text{ml kg}^{-1} \text{ min}^{-1}$), the mean values were 14.47 and 13.68, respectively, for OU and RU groups; the value was 5.45% lower in RU and was non-significant. This difference was significant ($P < 0.001$) for oxygen cost ($\text{VO}_2 \text{ ml kg}^{-1} \text{ m}^{-1}$), the average values being 0.322 (± 0.036) and 0.252 (± 0.035), respectively.

Table III. Physical characteristics of the participants.

Participants	Age (year)	Height (cm)	Weight (kg)
Occasional users ($n=6$)	31.6 ± 8.53	154.5 ± 6.32	44.22 ± 6.89
Regular users ($n=9$)	29.9 ± 6.63	155.2 ± 7.28	45.15 ± 7.02

Table IV. Speed and physiological observations.

Participants	Speed (m. min^{-1})	Heart rate (b. min^{-1})	PCI (b. m^{-1})	O_2 consumption ($\text{ml. kg}^{-1} \text{ min}^{-1}$)	O_2 cost ($\text{ml kg}^{-1} \text{ m}^{-1}$)
Occasional users ($n=6$)	45.3 ± 5.32	139 ± 4.73	1.31 ± 0.15	14.47 ± 1.06	0.322 ± 0.036
Regular users ($n=9$)	54.9 ± 8.06	128.88 ± 8.35	0.93 ± 0.18	13.68 ± 1.03	0.252 ± 0.035
% Δ	21.19%	7.28%	29%	5.45%	21.73%
$P <$	0.01	.01	.001	NS	.001

Values are mean \pm standard deviation, % Δ = % difference for OU group with reference to RU group, $P <$ indicates the level of statistical significance.

Discussion

Subjects and wheelchairs

Most of the recipients belonged to poor socio-economic status and resided in rural areas. General health status was weak due to poor nutrition and disease. Moreover, degeneration due to prolonged illness and inactive lifestyle decreases physical work capacity. The subjects were quite ignorant regarding the operational skill of WC propulsion, and none had participated in any exercise program or sports activities to increase physical fitness. The physical characteristics of the subjects are consistent with Indian studies [7,8].

All the WCs were distributed without compromising standard WC measurements required by the users, the manufacturer making WCs in bulk in order to reduce production costs. As a result, a single size is distributed among the recipients regardless of age or size. An improper fitting WC is liable to be discarded, as it does not provide comfort, safety, stability or optimal functionality. The technical quality with respect to weight, stability, dimensions, operation and seating comfort was undoubtedly not up to the mark. The distributed heavy WCs are disadvantageous from a physiological perspective [9]. The plain bearing used in the WCs offers a high coefficient of friction which results in loss of internal energy [10]. The smaller castor wheels are easily obstructed by small ditches and potholes on rough terrain. The rolling resistance is also higher due to the small size and the fluttering of the castors due to misalignment [9]. Seating comfort (suitable cushions) is totally ignored.

The WCs are not strong enough to stand unfriendly terrain and other accessory hazards, which in turn cause damage that needs extensive repair; surprisingly this occurs with even very little use. Incidence of damage of castors and wheel bearings, breaking of axle and tearing of solid tires are very common. Local repair and service facilities are not available in rural areas because of unavailability of skilled labor and spare parts. The users were not

aware of the requirements of regular maintenance and periodic lubrication. According to the survey, an estimated 15.17% of WCs were found to be damaged beyond repair. In most cases, repair became pointless because it was uneconomical and ineffective.

Mode of ambulation

The objective of providing WCs was self-ambulation with a view to transportation and availing the recipients of the benefits of exercise and the resultant physiological conditioning. But it was found that 17 recipients could use the WC only with the assistance of an attendant, as they could not carry out propulsion independently. Hence, it transpired that the WCs failed to provide the intended utility, as independent mobility with optimal independence was not achieved. However, the OU and RU used the WCs mostly outside of their houses for short rides, but not inside their homes. Their mode of transportation (either outdoor or indoor) was not carried out in a proper way.

Habitat adaptability

It was seen that 33.92% of recipients rejected WC as their residential environment was not suitable for WC use. The maneuverability of the WC is extremely limited due to small doors, with inadequate space in rooms and corridors, doorsills, absence of ramps, positioning of furniture also restricts indoor ambulation and activities using the WC. The activities of daily living are traditionally performed on floor level in rural areas, and household necessities [4] and other arrangements are made accordingly. In such a situation, WCs and the amenities are mismatched and, hence, the desired advantages of WCs are not available. The typical Indian style sanitary pan (floor-level) is very difficult to use for WC users. The poor socioeconomic status of rehabilitees does not permit a radical addition and alteration of houses or the modification of furniture positioning according to the requirements of WC maneuverability. Mobility outside the house is also greatly hindered by the unfriendly traveling surfaces, ditches, muddy roads, inclines, etc. Narrow lanes in residential areas, unplanned turning points, and the risk of roads crowded with fast-moving vehicles, and uneven surfaces, do not permit proper functioning of the WCs.

Speed and physiological responses

Some of the OUs were unable to maintain a steady pace because the physiological adaptations arising out of the interaction between the desired level of individual performance and the propulsion mechan-

ism was not established. This adjustment is possible only through regular use. The propulsion speed and the physiological variables of the RU group are in close agreement with recent Indian studies [8,11]. Propulsion speed is considered to be a basic and reliable assessor of performance evaluation of WC mobility [12]. The significantly higher speed of the RU group indicates a higher activity level of that RU group compared to the OU group.

The physiological strain of both groups, in terms of HR response falls under the category of 'moderately heavy' type of work (range: 125–150 b min⁻¹) according to the 'scale of heaviness' proposed by Christensen [13] and this indicates that in such a situation the WC is not recommended for long-term use as the reasonable limit [14] is 110 b min⁻¹.

The other physiological parameters were also reported to be higher in the OU group than in the RU group. The differences are more pronounced when they are compared with the energy cost as a function of speed, i.e., oxygen cost and PCI. This seems to indicate that the poor activity level and improper cardiovascular adjustment due lack of operational skills for WC use increase the physiological demands of the OU to accomplish the same locomotive task.

The wasteful propulsion biomechanics [15] and poor technical quality of the distributed WCs are energy demanding and provide cardiovascular taxation. Moreover, the lower level of physical fitness of the disabled population and the high energy demands of locomotion, bring about exhaustion and early fatigue.

Clinical recommendation

In this survey it was found that many recipients were not in a position to propel their WC because of insufficient muscle strength, joint stiffness in the upper body and they had to discard their WCs due to pain, fatigue, and discomfort of the upper limbs. In several cases, incidence of overuse injury was noted due repetitive use of weak limbs, and the painful conditions were more aggravated in some arthritic conditions. WC use combined with low fitness levels (cardiorespiratory capacity) increased physical strain and resulted in concomitant fatigue and discomfort; this discourages users from WC locomotion and ultimately they felt compelled to discard them. In order to increase physical fitness, an additional exercise program should be performed prior to WC use, as normal use is not sufficient to provide cardiopulmonary fitness [16]. None of the subjects in the present study had performed any kind of training to improve their fitness and hence they were unable to use their WC. Due to poor comfort in sitting, the incidence of decubitus ulcers on the

ischial tuberosities and other weight-bearing areas were very common.

It is essential to incorporate the recipient for the functional training according to the users need and anticipated lifestyle, to promote individual WC mobility like transferring, maneuvering and operating the WC components. No training was given to the present recipients group to promote individual WC mobility like transferring, maneuvering and operating the WC components. So the recipients could not use their WC due to their ignorancy of the operation skill of independent propulsion and different WC-related activities. The persons using upper extremity powered device are subjected to fatigue and discomfort even with quite limited physical activities. A suitable mode of propulsion system provides locomotive economy optimizing energy cost of ambulation.

A thorough medical check-up of functional status, assessment of fitness status in terms of strength and endurance of the individual, and the physiological response to the use of the proposed WC, should be performed prior to clinical recommendation. Choice of suitable propulsion system considering locomotive environment, requirement and activity level of the users, proper training of WC propulsion and use of different components to achieve functional independence and training of physical fitness should be considered. The mechanical and ergonomic optimization of WC user interface, dimension and weight of the WC and influence of anthropometrical factors should also be considered.

Conclusion

Finally, after a careful survey it has to be emphatically pronounced that the hand rim-propelled manual WC is unsuitable for outdoor ambulation due to inefficient propulsion biomechanics [11], low speed and high physiological demands [8], and it is also useless for indoor use as it is difficult to negotiate the environmental conditions and architectural restraints. So, the WC has totally failed to bring the desired facility to its users although it has been described as an all-purpose ambulatory device [3]. So, it is necessary to devise an effective substitute for the rehabilitees in order to provide social interaction as well as occupational resettlement.

In this connection it may be stated that the arm-crank propulsion technique is appropriate for outdoor use because of its higher efficiency and due to its biomechanical advantages and lower cardiopulmonary stress, enabling the users to ride long distances at high speed [8]. For indoor ambulation the WC was like an ornament – of no use; and, in situation where a person spends the whole day on the ground a ground level mobility device [17], i.e., a castor cart, is more

effective. Future research is needed regarding indoor ambulation considering environmental conditions and the activities of daily living.

The present study concludes that the distribution of WCs to rehabilitees resulted in mass rejection because of improper technical estimation in assessing the need of the individuals. A judicious recommendation of the WC should be executed in a multidisciplinary manner, as dictated by the complexity of the user's requirement, considering the level of disability, functional ability, needs and activities. Inappropriate implementation of WCs results in drastic deterioration of the morale of the users, excessive cardiorespiratory strain, fatigue and musculoskeletal injuries.

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