

**The Effects of Using Active Wheelchair (AWC) and Standard Wheelchair (SWC) on Physical Performance
-Choosing Appropriate Wheelchair (WC)-**

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Abstract

The aim of WC exercises is to acquire technical skills required for using WC correctly, and to help improve the physical performance. This study has been carried out in order to investigate the effects of AWC and SWC exercises on physical performances and technical skills of obese individuals having no movement limitation in their upper extremities. In this study, 41 WC users (20 AWC users and 21 SWC users) aged between 18 and 26 years, and having no movement limitation in their upper extremities have been involved. For 16 weeks, a 50 min WC activity program (technique, distance walking, and effort) has been implemented 3 times a week. IBM SPSS 21 software has been used for statistical analyses, while t-test has been utilized for standard deviation, mean value and comparisons, and the level of significance has been set as $p < 0.05$. After the 16-weeks physical activity program, increases in WC usage techniques, balance skills, and physical performance have been observed. In all of tests performed, AWC group showed better performance than SWC group. It has been found that the users especially in SWC group have ache in back, shoulders, arms, and wrists. Physical activities with an appropriate WC improve the mobility, decrease pain in back, shoulders and wrists, and balance the energy consumption. This study shows that 50-min daily physical activities would contribute to WC usage techniques of AWC users, and their physical performances. This could be an important factor in eliminating the possible injuries.

Key Words: Active and Standard Wheelchair, Appropriate Wheelchair, Physical Activity

1. Introduction

Although numerous studies have found compelling evidences that physical activities have significant effects on the health of individuals; however, people by and large ignore the importance of physical exercises in their daily life. Besides regular sports based exercises, the active practicing of appropriate movements and physical activities in daily life does not get due attention (Wallmann et al. 2009). Although increasing the levels of physical activity is considered as a health priority among the people (PAH 1996), it is observed that disabled individuals are not active in this domain. The ability to *move* and *to learn mobility* is more important especially for WC using individuals than the able persons. The mobility of individuals using WCs is very limited and the improvement in performance depends mainly on learning the coordination skills (Adolph 1981). The lack of enough mobility and the consequent health problems are commonly observed in industrialized countries (Wallmann and Froböse 2007). Studies have indicated that at least 60% of the individuals are not active in terms of sports related activities (PAH 1996). This rate is much higher in disabled individuals, and the individuals using WC require more physical activities than any other disability group. Problems associated with overweight and obesity continues to increase among the population, and chronic health problems are increasingly encountered as a result of immobility. In general, there should be obligation for individuals using WC not to increase their levels of daily energy-consumption. Recent studies emphasize that, in order to decrease health problems, it is required to be active and give up sitting idle (Owen et al. 2009).

Experts emphasize that an average adult should practice mediocre level of physical activity for at least 30 minutes a day (Owen et al. 2009; Blamey et al. 2000), and this exercise corresponds to approximately 3000 steps. Similarly, in order for 18-56 year-old individuals to preserve their health, it has been recommended that they practice mediocre level of aerobic physical activity for 30-minutes for 5 days a week (Webb and Cheng 2010). Apparently, the 3000-step recommendation proposed for normal individuals is very hard for disabled people, especially for WC users having lower-extremity disabilities. Every movement a WC user performs on WC by using his/her own musculoskeletal system without obtaining help is considered as a WC step, and a daily “5000 WC-steps” is recommended for WC users. Although WC users spend around 14.5 hours per day on a WC, the duration for which they move in WC without obtaining help is less than 30 minutes (Aksay 2014a). WC users, who need to get off and on from WC for 6 times a day (Aksay 2014b), require much more energy for their daily activities (toilet, shower, transportation, etc.) than normal individuals do. It is due to this reason that in the primary goals of physical activity programs designed for WC-users concentrate on strength, endurance and WC usage techniques. Importantly, care should be taken to ensure that physical activity for WC users is not time bound. In addition, during physical activities, the speed, distance, effort, and movement skills should be determined and safety should be addressed. But the participants being under excessive time constraints may lead to increased muscle tone, occurrence of undesired movements, and the occurrence of movements requiring rapid reaction thereby increasing the possibility of physical spasm (Arslan and Aksay 2012; Gressmann 1973).

Moreover, they lead to injuries in arms, shoulders and ankles. Motor development plays a central role in learning and performance development (Aksay and Alp 2014b), and consequently, improvements in willingness to move and in mobility skills occur. Hence, physical exercises for WC-using individuals in the form of games will encourage active

participation in the activity thereby improving the sustainability of the activity (Strohkendl and Schüler 1978). Besides these, it has been shown that regular sport activities of disabled individuals increase their *quality of life and health*, and suppresses or prevents negative feelings such as fear, depression, and hostility (Janssen 2002).

Choosing the Appropriate WC

An active life begins with choosing an appropriate wheelchair. Disabled individuals are required to perform physical exercises just as normal individuals do. In the case of individuals using WC, exercise and mobility are of significant importance, and their need for mobility is much higher than in normal individuals. The pre-condition for active participation in activities designed specifically for WC-users is their access to assistive tools. The prominent one of these tools is the *wheelchair* (Bröxes and Herzog 2004). Choosing an appropriate wheelchair is a vital step to ensure hindrance free and voluntary movement of individuals having limited mobility. Hence, the wheelchair must satisfy the requirement of being handy for disabled individuals on one hand, while providing comfortable, efficient and untiring comfort of seating on the other. A wheelchair designed efficiently can compensate the deficiencies and improve the mobility of its user. An ideal wheelchair would mean an efficient and appropriately designed one rather than an expensive one (Strohkendl 1989). Most of the times, adhering to the standard dimensions is the basic element of a true and efficient design. But a wheelchair adapted for the mobility of adolescents can become obsolete in a very short period of time due to anatomical developments of the individuals. This inevitably leads to replacement with a new wheelchair. In recent years, there have been significant developments in wheelchair designs, especially for children and adolescents. Wheelchairs, now-a-days, come with a variety of different features, making it difficult to choose the right one. In the current scenario, choosing an appropriate wheelchair that suits specific needs of an individual requires an apt expertise. If the aim of the wheelchair is to provide active progression to its user, it should fit the user just as his/her shoes (Strohkendl 1978). Hence, the wheelchair should be both customizable and adjustable. The wheelchair should suit the height, skills, requirements, and usage objective of its user. During the procurement of the wheelchair, positive and negative aspects of the available features should be taken into account, and individual skills and requirements should also be taken into consideration.

AWC

The most important factor to be considered while procuring an active wheelchair is the requirements of the end-user. For individuals having arms with limited or no functionality, the wheelchair might be used primarily to perform the daily chores. Hence, an active wheelchair with bigger rear wheels and rotatable front wheels is recommended. While this design of active wheelchair is more suited for forward movements, it might not fare well when backward movements are considered.

The width and depth of the seat, height of backrest, calf length, and height of the seat of WC can be adapted to the user, and the highest possible mobility is provided. But these types of wheelchairs cannot be used widely in our country since they are very expensive.

SWC

SWC is not suitable for individual use since it is very heavy besides being moved by pushing

from behind. It does not possess the features suitable for physical activity, and it is also very hard to use. It is strenuous to move a SWC without requiring external help. This strain might cause disorders in functions of upper-extremities especially after prolonged usages, besides increasing the risk of injury. Such kind of WCs is not suitable for long-term utilization, and they hardly possess customizable features. The SWCs having limited advantages and being very heavy and cheap are preferred mainly by clinics where they are primarily used to transfer patients.

In a study by Aksay (2014), it has been established that the great majority of WC users prefer SWC because of its economy. Hence, they cannot participate in physical activities because their WCs are not suited for the same (Aksay 2014a).

2. Method

Selection of subjects

In this study, a total of 41 individuals (20 in AWC group and 21 in SWC group) aged between 18 and 26 years have been studied. They had no mobility limitations on their upper extremities, and are able to move the WC using their arms without requiring any help. The subjects in AWC group have been chosen according to their suitability to 20 AWCs available for the study. No individual suitability provision has been considered for the SWC group. The WC users participating in this study have never participated in any regular physical activity programs.

Intervention Program

The participants have been offered 50 min exercise program for 16 weeks under individual supervision. The exercises have been conducted either in open-air (athletic field, park, etc.) or in a hall. While endurance-oriented activities such as distance walking and ramp works were conducted in open-air, power- and balance-improving activities were conducted in a hall. During the exercise program, WC users did no physical activity other than their daily routines. A pre-test before the study and a post-test after the study were conducted on the participants in order to determine the changes. Also, in order to determine the WC usage durations of individuals, a 3-question survey was undertaken.

Performed Tests

In order to determine the improvements in physical performance, Aksay Wheelchair Ability and Physical Activity Test (AWAPA-Test) was implemented. AWAPA-Test was developed to measure the speed, endurance, muscle power, and balance skills of participants. WC usage techniques were taught to participants in order to implement the test.

AWAPA-Test

The test included 12 sub-tests. But, considering the physical limitations of individuals, 5 topics were chosen on muscle power, speed, endurance, and balance skills. Hence, in order to implement this test and perform the scoring, some changes were made in the original test.

100 m speed drive: It was conducted in an athletic field. It required the participants to propel

a WC to a distance of 100 m as quickly as possible without any external help. The time duration to cover the entire distance was recorded in seconds.

800 m endurance drive: It was conducted in an athletic field. It required the participant to propel a WC to a distance of 800 m as quickly as possible without any external help. The time duration to cover the entire distance was recorded in seconds.

Pull and draw: The individual was required to stay hanging in an asymmetric parallel bars and draw his/her body towards the bar. The point where the chest touches the bar is covered with a cylindrical red-colored foam, 50 cm in diameter and 10 cm in thickness. Touching to this point was considered as one score point. A 3-second rhythm was required to be maintained in order to achieve a point. If an individual failed to maintain his/her speed or cannot continue, the test was aborted and the results were recorded as repeats.

Throwing medicine ball: The participant was required to throw a 3 kg medicine ball forward over his/her head by using both hands while being seated in a WC. The distance was recorded in cm.

Balance: The participant was required to balance the WC on the rear wheel between 2 lines (drawn 30 cm apart from each other) by lifting the front (smaller) wheel without obtaining any help. The contact of front wheel to the floor or the moving out of the rear wheels off the determined place was deemed as failure, and the test was aborted. This test was video-recorded, and the duration of balancing on 2 wheels was recorded in seconds.

Trainers

The trainers were experts in the field of sports having 3-9 years of experience in training disabled individuals and were experienced WC trainers. Also, the students from physical education department voluntarily participated in this study. All of the assigned trainers were present during the entire exercise, and conducted the researcher's exercise program under the supervision of the researcher.

Statistical Evaluation

IBM SPSS 22 (for Mac) software was utilized for computing the standard deviation and mean values of the results of this study. In order to measure the difference after 16 weeks, independent t-test was used. The level of significance was accepted as $p < 0.05$.

3. Results

The mean age of 16 participants of the AWC group was 14.3, while that of SWC group was 14.6. Members of both groups have stated that they spend 12 hours a day sitting on WC, and they need to get on and off the WC for approximately 8 times a day (Tab 1).

Table 1. Results of the AWAPA-Test (age, sitting on WC, to get on and off the WC)

		N	$\bar{x} \pm SD$	F	P
Age	ATS	20	22,45±2,684	,309	,662
	STS	21	22,09±2,467		
Sitting on WC	ATS	20	12,05±2,139	1,511	,891
	STS	21	11,95±2,397		
to get on and off the WC	ATS	20	7,900±1,618	7,007	,409
	STS	21	8,238±,8890		

Significance was found at $p < 0.05$ and results was expressed as mean \pm SD.

Positive improvements were observed in the participant WC users in terms of speed, endurance, muscle power, and balance skills. In 100 m and 800 m tests conducted to determine the changes in speed and endurance, both of the AWC and SWC groups showed improved performance. In pre-tests for measuring the 100 m speed, AWC group (31.78 sec) showed better performance than SWC (37.12 sec) group. In post-tests performed after the 16-week study, AWC group showed performance improvements of 65 sec and 5 sec. In 800 m endurance pre-test, AWC group finished the race 60 sec faster than SWC group (Table 2).

Table 2. Results of the 100m and 800m Tests.

		ATS	STS	F	P
100 m	Pre-Test	31,78±1,901	37,12±2,695	2,331	0,001*
	Post-Test	25,14±2,719	32,13±3,067	2,187	0,001*
800 m	Pre-Test	278,7±9,674	339,6±11,41	,207	0,001*
	Post-Test	224,6±6,508	313,9±9,648	3,894	0,001*

* Significance was found at $p < 0.05$ and results was expressed as mean \pm SD.

In the post-tests, the observed performance improvements were 64 and 26 sec for AWC and the SWC group, respectively. In both of 100 m speed test and 800 m endurance test, AWC group performed better than the SWC group. Moreover, significant differences in the increase in performance among the groups in 100 m and 800 m tests conducted at different times were observed ($p < 0.001$). In pull-up and medicine ball throwing tests performed to determine the changes in muscle power, performance increases were observed in both of AWC and SWC groups. No significant difference was observed in the groups' scores in both pull-up and medicine ball throwing pre-tests. Both of the groups showed almost similar performances. But in pull-up post-test, AWC (3,90pre, 11,1post) group recorded better performance improvement than SWC (3,76pre, 9,38post) group. Similarly, in medicine ball throwing post-test, the performance of AWC (288,6 cmpre, 608,7 cmpost) group was better than that of the SWC (297,9 cmpre, 529 cmpost) group (Table 2). In the pull-up and medicine ball throwing post-tests, significant difference between the groups in terms of performance increase were observed ($p < 0.001$).

In tests performed to determine the improvements in balance skills, an increase in performance was observed in both the groups. While both the groups could not record any success in pre-test; in the post-test AWC (14.8 sn) group showed better performance than SWC group (8.6 sn) (Table 3).

In the post-test to determine the balance skill, significant difference among the groups in terms of performance increase were observed ($p < 0.001$). Participants interviewed after the 16-week exercise program reported a decrease in shoulder, back and wrist pains, and an improved sleep. The participants showed improved WC usage skills due to the mobility trainings imparted and also an improvement in the maneuvering skills was observed.

Table 3. Results of the AWAPA-Test (Pull-up, medicine ball throwing, balance)

		ATS	STS	F	P
Pull-up	Pre-Test	3,900±1,165	3,761±,8890	1,359	,671
	Post-Test	11,10±1,803	9,381±1,160	4,258	,001*
Medicine ball throwing	Pre-Test	288,6±29,66	297,9±30,83	,044	,331
	Post-Test	608,7±50,24	529,0±58,67	,214	,000*
Balance	Pre-Test	,0000±,0000	,0000±,0000	--	--
	Post-Test	14,80±3,302	8,619±2,108	5,549	,000*

* Significance was found at $p < 0.05$ and results was expressed as mean ±SD.

4. Discussion

The quest for better health can be achieved also in a residential area, free-time, and business environment (Wallmann and Froböse 2007). The role of interior designers in creating aesthetically designed private and public structures is obviously important (Aksay 2013). On the other hand, selecting an appropriate WC plays important role in improving the mobility of individuals. It has been observed that WC- users have lower physical performances than their normal counterparts. WC-users spend approximately 14.5 hours a day on WC, and they need to get on and off the WC for 6-8 times a day (Aksay and Alp 2014a). Such activities limit the mobility of individuals sitting on WC, and produce strain on their arms. But it has been revealed in studies that regular physical activities increase the physical performance and motor skills of individuals using WC (Aksay and Alp 2014a). Rather than a SWC designed for daily usage and being not suitable for physical activity, the procurement of an AWC adjusted to physical characteristics of individual can lead to performance improvements, even without trainings (van der Woude et al. 2008; Dallmeijer et al. 1994). In this study, the results of earlier reports are corroborated that the selection of an appropriate WC contributes to development of motor skills such as speed, endurance, muscle power, and balance skills (Janssen 2002). Physical activity prevents long-term immobility and consequently reduces risk factors of health (Owen et al. 2009; Hamilton et al. 2007).

As reported in other studies, it has been observed that physical exercises performed with an appropriate WC increase the mobility (Abel et al. 2006; Abel et al. 2003; Abel 2001) and decreases the occurrence of pain in shoulder, wrist and the back (Dallmeijer et al. 2004; Vanlandewijck et al. 2001; Janssen et al. 1993).

5. Conclusion

Just as normal individuals, disabled individuals possess the right to participate in social life just as they wish. The pre-condition to achieve this is to remove the hurdles, provide access to better amenities, and a conducive environment for disabled individuals using WC. Besides that, by providing access to assistive devices for disabled people, by eliminating the limitations of mobility, and by providing an opportunity to exhibit their skills through certain activities, the life of disabled people can be made better. One of the most important tools to help achieve this is an appropriate wheelchair. Children's desire to move around is much higher than in adults. Hence, ensuring proper mobility is much more important for younger people. An appropriate WC offered at early ages will increase the mobility of children and allow them to use WC safely. Multi-purpose WCs with customizable functionality is very useful, and it should act as the 'leg' of its user.

This study shows that physical activities performed by using an appropriate WC help in the development of WC usage techniques, increase the quality of life, contribute to physical performance which individuals require to perform their daily routines, and is an important factor for eliminating possible injuries.

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