ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2019;100:1648-54

ORIGINAL RESEARCH

Relationships Between Wheelchair Services Received and Wheelchair User Outcomes in Less-Resourced Settings: A Cross-Sectional Survey in Kenya and the Philippines

R. Lee Kirby, MD,[a,b] Steve P. Doucette, MSc[b,c]

From the [a]Division of Physical Medicine and Rehabilitation, Department of Medicine, Dalhousie University, Halifax, Nova Scotia; [b]Department of Community Health and Epidemiology, Dalhousie University, Halifax, Nova Scotia; and [c]Research Methods Unit, Nova Scotia Health Authority, Halifax, Nova Scotia, Canada.

Abstract

Objective: To explore the relationships between wheelchair services received during wheelchair provision and positive outcomes for users of wheelchairs.

Design: Secondary analysis of cross-sectional data.

Setting: Urban and periurban communities in Kenya and the Philippines.

Participants: Adult basic manual wheelchair users (N=852), about half of whom reported having received some wheelchair services with the provision of their current wheelchairs.

Interventions: Not applicable.

Main Outcome Measures: Participants completed a survey that included questions related to demographic, clinical, and wheelchair characteristics. The survey also included questions about the past receipt of 13 wheelchair services and 4 positive outcomes for users of wheelchairs. The relationships between individual services received and positive outcomes were assessed using logistic regression analyses. In addition to assessing individual services and outcomes, we analyzed a composite service score (the total number of services received) and a composite outcome score (≥3 positive outcomes).

Results: The top 3 individual services from the perspective of relationships with the composite outcome score were "provider did training" ($P=.0009$), "provider assessed wheelchair fit while user propelled the wheelchair" ($P=.002$), and "peer group training received" ($P=.033$). The composite service score was significantly related to "daily wheelchair use" ($P<.0001$), "outdoor unassisted wheelchair use" ($P<.0001$), "high performance of activities of daily living" ($P=.046$) and the composite outcome score ($P=.005$), but not to the "absence of serious falls" ($P=.73$).

Conclusions: The receipt of wheelchair services is associated with positive outcomes for users of wheelchairs, but such relationships do not exist for all services and outcomes. These findings are highly relevant to ongoing efforts to optimize wheelchair service delivery.

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Wheelchairs can have positive effects on the health, mobility, and social participation of users and on the burden of caregivers.[1-5] However, many people who need appropriate wheelchairs (as defined by the World Health Organization [WHO]), especially in less-resourced settings, do not have access to them.[6]

The means by which people obtain wheelchairs vary. At the "commodity" end of the wheelchair-provision spectrum,[7] a family member may purchase a wheelchair without any input from a health care professional or a nongovernmental organization may donate a wheelchair without adequate accompanying services during a mass-distribution event. At the other end of the wheelchair-provision spectrum, the WHO has advocated an 8-step service-delivery process[8] that has been widely endorsed by rehabilitation professionals.

Presented to the European Seating Symposium, June 13-15, 2018, Dublin, Ireland.

Supported by the United States Agency for International Development, under the terms of the Technologies for Health award (grant no. AID-OAA-A-11-00050). The contents of this study are the responsibility of the authors and do not necessarily reflect the views of United States Agency for International Development or the United States Government.

Disclosures: none.

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https://doi.org/10.1016/j.apmr.2019.02.002

The 8 steps are (1) referral and appointment; (2) assessment; (3) prescription; (4) funding and ordering; (5) product preparation; (6) fitting; (7) user training; and (8) follow-up, maintenance, and repairs.

Although there is growing research evidence to support the safety and effectiveness of some of the individual WHO steps (eg, wheelchair skills training[9,10] and structured follow-up[11]), a systematic review of 24 studies by Greer and colleagues[12] identified no evidence to support the process as a whole. However, since then, a small number of research groups have begun to report such evidence,[13-19] although there are challenges in conducting well-designed studies in less-resourced settings.

One cross-sectional study[13] used a questionnaire to assess 149 users of manual wheelchairs in Bangladesh. The users of the wheelchairs who reported receiving assessment and training services experienced more positive outcomes related to satisfaction, activity, quality of life, and participation. Another cross-sectional study[14] used questionnaires to compare 167 people in Indonesia on a waiting list to receive a wheelchair with 142 who had received a wheelchair using the WHO service-delivery process. In the latter group, the investigators identified significantly better satisfaction, health, and quality-of-life outcomes. An uncontrolled cohort study[15] used questionnaires to compare 55 users of wheelchairs in Zimbabwe before and after receipt of wheelchairs provided according to the WHO Guidelines. Satisfaction significantly increased in relation to most of the services provided. Shore et al[16] used a questionnaire to study 191 users of wheelchairs from Peru, Uganda, and Vietnam, comparing a control group that received an older model of manual wheelchair provided with only a tool kit and a written manual of instructions with an intervention group that received a better model of wheelchair and some WHO-type services (assessment, fitting, training). The intervention group reported a slight but statistically significant improvement in satisfaction at 12 months.

The Accelovate Program[20] of Jhpiego (an organization affiliated with The Johns Hopkins University) in a single study carried out a cross-sectional survey of 420 users of basic wheelchairs in Kenya and 432 in the Philippines. Assessing the 2 countries separately, they identified significant relationships between some individual wheelchair services and some individual outcomes.[17,18] The Accelovate investigators did not assess combined-country data nor did they assess the effect of the overall WHO process on outcomes. Another study[19] conducted a qualitative analysis on a subset of 48 of the Accelovate users of wheelchairs and identified problems due to ill-fitting wheelchairs, little in the way of formal training, a paucity of maintenance and repair services, and the importance of peer-support networks.

Our objective for the current study was to explore the relationships between wheelchair services received during wheelchair provision and positive outcomes for users of wheelchairs.

Methods

Upon completion of their analyses, the Accelovate Program transferred their data to the International Society of Wheelchair Professionals (ISWP)[21] to make it available to other researchers. We carried out a secondary analysis of the cross-sectional Accelovate data available from the ISWP, combining the data from the 2 countries. Details about ethical issues, recruitment, screening, inclusion and exclusion criteria, sample-size estimation, instrument development, in-person data collection by questionnaire, and data management have been previously reported,[17] but are briefly summarized in the methods section of supplemental appendix S1 (available online only at http://www.archives-pmr.org/).

The survey included questions related to demographic, clinical, and wheelchair characteristics. The survey also included questions about the past receipt of the WHO wheelchair service-delivery steps considered most amenable to self-reporting and about outcomes of users of wheelchairs. For our secondary analysis of these cross-sectional data, we used 16 of the Accelovate study's service questions to derive 13 dichotomous (yes/no) variables representing the wheelchair services received (table 1) and 4 outcome questions from which we derived 4 dichotomous (yes/no) variables representing positive outcomes for users of wheelchairs (table 2).

Data analysis

We combined the data from the 2 countries. Although differences between the countries have been reported[17-19] and were expected to slightly confound the analysis of the combined data, we considered that the combined-country analysis would have more power than separate-country analyses (see supplemental appendix S1) and would share the merits of meta-analysis in which data from sometimes widely different settings are combined. Data were summarized as means and SD for continuous variables if the data were normal or as medians and interquartile ranges if they were not. Categorical data were summarized as frequencies and percentages. Missing data were dealt with by reporting the n values for all variables.

The relationships between individual services received and individual positive outcomes were assessed using logistic regression analyses adjusted for possible confounding variables (age, sex, country, duration of wheelchair use, condition necessitating wheelchair use, type of wheelchair used that has been reported to affect wheelchair-related outcomes)[17,19,22,23] and expressed as odds ratios (ORs) and 95% confidence intervals (CIs). In addition to assessing each of the individual services and outcomes separately, to meet our objective we analyzed a composite service score (the total number of services received [0-13]) and a dichotomous composite outcome score (those who reported 3 or more positive outcomes). We used SAS statistical software[a] for our analyses and an alpha level of .05.

Results

Demographic, clinical and wheelchair data (supplemental table S1, available online only at http://www.archives-pmr.org/), details about wheelchair services received (supplemental table S2, available online only at http://www.archives-pmr.org/) and positive outcomes for users of wheelchairs (supplemental table S3, available online only at http://www.archives-pmr.org/) are shown in supplemental appendix S1.

The relationships between the individual and composite wheelchair service items and positive outcomes for users of wheelchairs are presented in supplemental tables S4 to S7 (available online only at http://www.archives-pmr.org/). The relationships

List of abbreviations:

CI	**confidence interval**
ISWP	**International Society of Wheelchair Professionals**
OR	**odds ratio**
WHO	**World Health Organization**

Table 1 Wheelchair services received

Service Received	Participants Were Asked…
1. Provider asked or physically checked for skin problems, sensation or pressure sores.	Related to the current or most recently acquired wheelchair, "Did the wheelchair provider ask you or physically check you for skin problems, sensation, or pressure sores?"
2. Provider checked for unsafe pressure at seat surface.	Related to the current or most recently acquired wheelchair, "Did the wheelchair provider check for unsafe pressure at your seat cushion surface (this would have required the assessor putting his/her hand under your buttocks)?"
3. Provider's assessment and/or fitting occurred at home.	Related to the current or most recently acquired wheelchair, "Did the wheelchair provider's assessment and/or fitting occur at your home?"
4. Assessment duration at least 30 minutes.	Related to the current or most recently acquired wheelchair, "How long did the assessment take? This would include measuring your body, checking the fit of the wheelchair, or making adjustments to the wheelchair."
5. Assessment on at least 2 aspects.	Related to the current or most recently acquired wheelchair, "Did the wheelchair provider measure your body?", "Did the wheelchair provider let you express your needs related to the wheelchair?", "Did the wheelchair provider listen to your needs and use the information you expressed?", and "Did the wheelchair provider measure or ask about your home environment (such as doorways and indoor spaces)?" or "Did the wheelchair provider ask you about how and where you would use your wheelchair?"
6. Provider helped user choose the right wheelchair.	"Has a wheelchair provider ever helped you choose the right wheelchair? They might have measured your body, checked the fit of the wheelchair or made adjustments to the wheelchair."
7. Provider did fitting of wheelchair.	Related to the current or most recently acquired wheelchair, "Did the wheelchair provider adjust or modify the wheelchair according to your needs?"
8. Provider assessed wheelchair fit while user propelled the wheelchair.	Related to the current or most recently acquired wheelchair, "Did the wheelchair provider assess the fit of the wheelchair while you propelled the chair?"
9. Provider did training.	"Did you ever receive any training related to the use of a wheelchair?"
10. Peer group training received.	"Have you ever received peer group training? This is a special training program from other wheelchair users on several topics, usually not at the time that you received the wheelchair for the first time."
11. Provider instructed user in taking care of the wheelchair.	"Have you ever been instructed in taking care of your wheelchair, such as any of the following: keeping it clean, oiling moving parts, tightening spokes, and pumping tires?"
12. Provider told user where to seek help with wheelchair repairs.	"Have you ever been told where to seek help with wheelchair repairs that you cannot manage yourself?"
13. Provider in contact to see how user was doing with the wheelchair.	"Has a wheelchair provider ever contacted you to ask how you are doing with a wheelchair since you received it?"

between wheelchair services received and a composite of positive outcomes for users of wheelchairs are shown in table 3. The ORs and 95% CIs are also illustrated as plots in figure 1. The top 3 individual services from the perspective of statistically significant relationships with the composite outcome score were "provider did training" where the OR was 1.96 (95% CI, 1.32-2.91); "provider assessed wheelchair fit while user propelled the wheelchair" with an OR of 1.67 (95% CI, 1.21-2.31); and "peer group training received" with an OR of 1.67 (95% CI, 1.04-2.67). The composite service score was significantly related to "daily wheelchair use" ($P<.0001$), "outdoor unassisted wheelchair use" ($P<.0001$), "high performance of activities of daily living" ($P=.046$) and the composite outcome score ($P=.005$), but not to the "absence of serious falls" ($P=.73$).

Discussion

We achieved our objective of exploring the relationships between wheelchair services received during wheelchair provision and positive outcomes for users of wheelchairs. We identified a number of significant relationships, but such relationships were not found for all individual services or outcomes. The implications of these

Table 2 Positive outcomes for users of wheelchairs

Outcome	Participants Were Asked…
1. Daily wheelchair use.	"How often do you use or occupy your wheelchair?" If they answered at least "daily," this was considered a positive outcome.
2. Outdoor unassisted use.	"During the past 4 weeks have you been to an area outside your home (in a wheelchair)?"
3. High performance of ADLs.	"For each activity that I read (bathing/showering, dressing, eating and toilet hygiene), please let me know if you perform it independently or assisted." Performance was considered "high" if at least 3 items were carried out independently.
4. Absence of serious falls.	"With your current wheelchair have you ever fallen?" If yes, followed by, "Was this a serious fall? By serious, I mean a fall that left you with pain or soreness that lasted more than one hour, bruising, skin cuts or abrasions, or injuries to your bones or joints." The absence of a serious fall was considered a positive outcome.

findings are important, providing general support for the WHO model of wheelchair service delivery in comparison with the commodity model and more specifically support for some services (eg, training) more so than for others. Many of the statistically significant service items relate to the wheelchair provider also delivering the service. The 6 most frequently performed services were also 6 of the 7 services that had a statistically significant association with a positive composite outcome. The findings related to specific services should be of use to the WHO, the ISWP and others as they refine their service-delivery processes and educational offerings, as well as to researchers looking for ways to optimize service delivery.

The results of our analyses are consistent with those of previous researchers (as described in the introduction) looking at the effects of WHO-like services.[13-19] Two main aspects of our study distinguish it from the 2 previous quantitative reports[17,18] based on the Accelovate data. First, we combined the data from the 2 countries rather than analyzing the data from Kenya and the Philippines separately; this provided a larger sample size and corresponding power for the analyses. Second, we added composite scores for both services and outcomes rather than only looking at separate services and outcomes; this allowed us to draw conclusions related to the overall association between services and outcomes, in addition to the relationships between specific services and specific outcomes.

As a byproduct of this study, we were able to describe the prevalence of services provided to and positive outcomes experienced by the participants, data that we hope will be of use to other researchers and policy developers. The survey instrument developed by the Accelovate investigators performed well. However, the results of our analysis should be of use when refining the instrument for future use. Discussion of each service and each outcome can be found in supplemental appendix S1.

About half (54%) of the individual services had significant positive relationships with the composite outcome score and the composite service score was also significantly related to this outcome. The composite outcome score might be even more sensitive in the future if the "absence of serious falls" outcome was removed.

None (0%) of the individual services nor the composite service score had significant relationships with the "absence of serious falls" outcome. This finding that a measure of safety is unaffected by the receipt of wheelchair services is counter-intuitive and difficult to interpret. One would expect that a user of a wheelchair who receives a wheelchair in the way recommended by the WHO would have fewer injuries than a user of a wheelchair who receives a wheelchair without accompanying services. One potential explanation for this finding is the possibility that the dosage of the received services (eg, the amount of training) was inadequate to affect this outcome. An alternative possibility is that the provision of appropriate wheelchairs allows users to get out into their communities where injuries are more likely to occur. A post-hoc test of the latter hypothesis, comparing the "absence of serious falls" between participants reporting "yes" vs "no" to "daily wheelchair use," 79.1% vs 93.3% ($P<.0001$), provided some support for this explanation.

In addition to looking at each of the outcomes separately as we have done above, we looked at each of the 13 service variables across the outcomes to determine how each contributed overall. The composite service score was significantly related to all of the outcomes except "absence of serious falls." Although the magnitude of the ORs is small (eg, 1.08 for the composite outcome score), these ORs represent a per-additional-service basis (eg, the difference between receiving 5 vs 4 services). To illustrate the effect of receiving several services (as many participants did), in figure 1 we have also illustrated the OR per 5 services (ie, an OR of 1.08 for a single service would correspond to an OR of 1.40 for 5 services). Despite the apparent usefulness of the composite service score measure, future versions of this measure may benefit from eliminating, combining, or adding to the 13 variables used in this study.

Study limitations

The study had a number of limitations, many of which have already been discussed. Because our data were from 2 less-resourced countries in different parts of the world, our findings cannot be generalized without caution to other regions or more-resourced settings. Although we only had data from 2 countries, our study (and those of the other authors who have used the Accelovate data[17-19]) broaden by 2 the countries in which similar types of studies relevant to the WHO process have been conducted; these other countries are Bangladesh,[13] Indonesia,[14] Zimbabwe,[15] Peru,[16] Uganda,[16] and Vietnam.[16]

The Accelovate target sample size of 500 participants per country was not achieved, but that power analysis was based on providing adequate power for individual countries. By combining the data from the 2 countries, our total sample of 852 should have been adequate, a conclusion supported by the number of statistically significant findings that we have identified. The 852 participants in our study are more than the total of 704 participants in the 4 earlier studies[13-16] we have cited. As noted earlier, there are benefits (eg, greater power, broader generalizability) as well as limitations to combining the data from 2 countries.

Table 3 Relationship between wheelchair services received and a composite of positive outcomes for users of wheelchairs (N=852)

		Composite of Positive Outcomes for Users of Wheelchairs*		
Services Received	Response	No. (%) 3+ Positives	OR (95% CI)†	*P* Value
1. Provider asked or physically checked for skin problems, sensation or pressure sores	No	317 (46.0)	0.97 (0.65-1.44)	.88
	Yes	97 (59.5)		
2. Provider checked for unsafe pressure at seat surface	No	354 (47.3)	1.01 (0.63-1.60)	.97
	Yes	60 (57.7)		
3. Provider's assessment and/or fitting occurred at home	No	356 (49.2)	0.86 (0.55-1.36)	.52
	Yes	58 (45.3)		
4. Assessment duration at least 30 minutes	No	329 (46.7)	0.95 (0.63-1.43)	.81
	Yes	85 (57.8)		
5. Assessment on at least 2 aspects	No	228 (41.8)	1.48 (1.06-2.06)	.023‡
	Yes	186 (60.8)		
6. Provider helped user choose the right wheelchair	No	199 (39.1)	1.55 (1.12-2.15)	.009‡
	Yes	215 (62.7)		
7. Provider did fitting of wheelchair	No	249 (41.7)	1.42 (1.00-2.02)	.049‡
	Yes	165 (64.7)		
8. Provider assessed wheelchair fit while user propelled the wheelchair	No	202 (39.8)	1.67 (1.21-2.31)	.002‡
	Yes	212 (61.4)		
9. Provider did training	No	286 (42.9)	1.96 (1.32-2.91)	.0009‡
	Yes	128 (68.8)		
10. Peer group training received	No	333 (45.2)	1.67 (1.04-2.67)	.033‡
	Yes	81 (70.4)		
11. Provider instructed user in taking care of the wheelchair	No	271 (42.9)	1.48 (1.02-2.12)	.036‡
	Yes	143 (64.7)		
12. Provider told user where to seek help with wheelchair repairs	No	319 (44.6)	1.44 (0.93-2.25)	.11
	Yes	95 (69.3)		
13. Provider in contact to see how user was doing with the wheelchair	No	331 (47.0)	1.42 (0.93-2.15)	.1
	Yes	83 (56.5)		
Composite no. of services (per unit, 0-13) adjusted			1.08 (1.02-1.14)	.005‡

* At least 3 positive outcomes.
† Adjusted for age, sex, country, duration, and condition and type of wheelchair.
‡ Significant.

Regarding the number of participants reporting each of the services and positive outcomes, these numbers were probably inflated by the recruitment strategy; as noted in supplemental appendix S1, the Accelovate investigators used a screening question to enroll a sample that was composed about equally of participants who had received services with their current wheelchairs and those who had not. Also, because of the inclusion and exclusion criteria, the sample included no users of wheelchairs who were children,[24] who needed postural support, or who used arm-crank-propelled tricycles (which are popular in less-resourced settings).

The cross-sectional survey study design has limitations. For instance, although associations between services and outcomes can be identified, causality cannot be inferred. A randomized controlled trial would be a preferred design. However, given the consensus among experts that a formal process like that of the WHO should be used for wheelchair service delivery[8,12] and the supporting evidence from previous studies[13-19] and our own, we believe that it would be unethical to withhold such a process for the purpose of performing a randomized controlled trial. A waitlist-controlled study (as used by Toro et al[14]) would be a reasonable option for future studies. Because the survey was based on self-report, recall bias is a concern. There are limitations to using self-reported data (and we have provided in supplemental appendix S1 some suggestions for alternative data sources that might be used in the future), but the use of a questionnaire is practical when studying a process like wheelchair provision that can take many months.

Future research

Further research is needed to address the study limitations and to explore related questions. A wider range of countries should be studied. The survey instrument needs to be revised along the lines discussed and, where feasible, objective measures added to validate the variables chosen. Also, the 2008 WHO wheelchair service-delivery model[8] needs to be reviewed and revised. There is now a decade of experience with the use of this model and research evidence like ours is accumulating. For instance, one study[12] suggested the additional step of outcome assessment after wheelchair delivery. Also, one might argue that there is a distinction to be made between WHO steps 1 and 8 that reflect on systems and policies and WHO steps 2 to 7 that are carried out by teams of wheelchair practitioners. Within the scope of practice of such a practitioner, there seem to be 2 broad categories of steps: (1) providing an appropriate wheelchair (comprised of WHO steps 2-6); (2) training in how to use and take care of the wheelchair (comprised of WHO step 7). The results of our study suggest that the training step should be provided more emphasis within the WHO process.

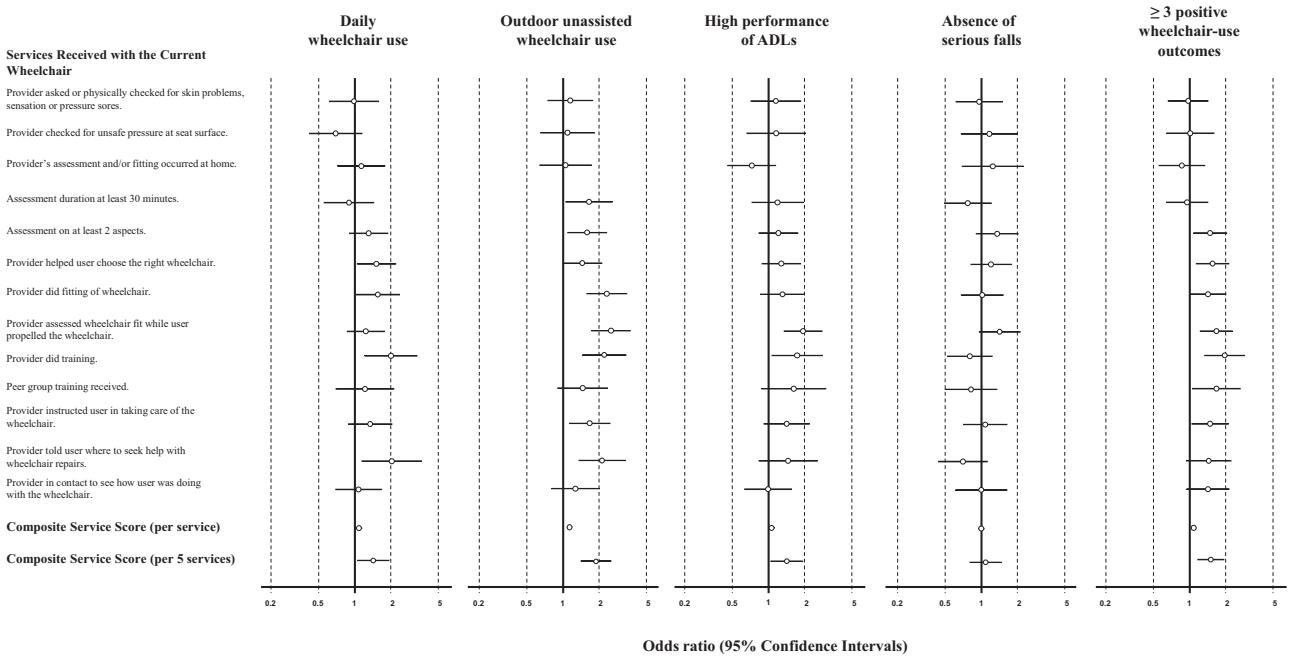

Fig 1 Plot of services received with the current wheelchair against outcomes. Adjusted ORs and 95% CIs are shown for each service and each outcome. An OR >1 implies increased odds of a positive outcome with the corresponding service received. For the composite service score, we have shown the OR both per additional service (eg, 5 vs 4 services) and per 5 additional services (to illustrate the effect of receiving multiple services).

Recommendations

The results of this project support the importance of providing services during wheelchair provision. The "commodity" approach does not appear to have much to commend it as a general approach. We nevertheless acknowledge the promise of community vs center-based provision of assistive technology,[25] the importance of involving the user of the wheelchair and his/her caregivers in decisions about the most appropriate wheelchair for that person in his/her context,[7] the virtues of the social vs medical model of disability,[26] and the value of universal design in product development.[27] We recommend that nongovernmental organizations avoid donating wheelchairs without ensuring that there are adequate accompanying services, including those needed for follow-up after distribution events. We recommend that the WHO conduct a thorough review of its service-delivery model and that such a review include input from a broad spectrum of stakeholders. We recommend that those responsible for wheelchair service delivery use the evidence-based service steps that we and others have identified as being related to positive outcomes for users of wheelchairs.

Conclusions

The receipt of wheelchair services is associated with positive outcomes for users of wheelchairs, but such relationships do not exist for all services and outcomes. These findings are highly relevant to ongoing discussions regarding optimization of the wheelchair service-delivery process.

Supplier

a. SAS, version 9.4; SAS Institute.

Keywords

Accidental falls; Kenya; Philippines; Rehabilitation; Wheelchairs; World Health Organization

Corresponding author

R. Lee Kirby, MD, Nova Scotia Rehabilitation Center, 1341 Summer Street, Halifax, Nova Scotia, Canada B3H 4K4. *E-mail address:* kirby@dal.ca.

Acknowledgments

We thank the Accelovate Program of Jhpiego for making their data available to the ISWP, and Tricia Karg, MSE, for facilitating access to the ISWP Data Center.

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Supplemental Appendix 1

This Appendix provides additional details to the main body of the paper.

Methods

The Accelovate study[17] received ethical approval from the institutional review boards of The Johns Hopkins University Bloomberg School of Public Health in Baltimore, Maryland, U.S. (#5839). The study was also approved by the Kenya Medical Research Institute in Nairobi, Kenya (Non-SSC Determination #457) and the University of Philippines, Manila Research Ethics Board (UPMREB) (#2014-351-01). All participants provided informed consent.

The countries selected were based on a number of factors including their diverse locations and their socioeconomic circumstances that made it likely that participants could be identified who had and had not received WHO-like services. Other considerations were the availability of willing in-country partners and in-country Jhpiego infrastructure. Field visits were carried out in both countries before the selection was finalized. Resource constraints prevented studying more than two countries.

The Accelovate investigators attempted to enrol a sample that would be composed about equally of participants who had received services with their current wheelchairs and those who had not, using the screening question "*When you received your current or most recent chair, did a wheelchair provider help you choose the right wheelchair? The provider might have measured your body, checked the fit of the wheelchair, or made adjustments to the wheelchair.*"

Eligible wheelchair users were at least 18 years of age, did not require postural support and had received their most recent wheelchairs more than 3 months and no more than 10 years prior to enrolment. Exclusion criteria were being a temporary wheelchair user, being a user of an arm-crank-propelled tricycle, inability to communicate or inability to understand the questions.

The sample size estimate of 500 participants per country was based on a power analysis. The development of the survey instrument included a review of 22 previously published instruments, of which 5 were most useful.[13,28-31] Some of the 8 WHO steps (e.g. referral and appointment, product preparation) do not lend themselves well to a survey based on self-reports. The survey instrument was translated into Swahili in Kenya and Filipino in the Philippines and back-translated to English. Pilot testing was carried out in both countries.

Results

Participants

Data were collected between December 2014 and June 2015. For this secondary analysis, all of the data from Kenya and the Philippines (the data from 420 and 432 participants respectively) were analysed.

Demographic, clinical and wheelchair data are shown in Table A1. The mean age was about 50 years, there was a slight predominance of males, the number of respondents from the two countries were similar, about half were married, almost two-thirds had at least secondary education and just over half were working in some capacity. The most commonly reported conditions requiring the use of wheelchairs were polio or post-polio, spinal cord injury and stroke. Current wheelchairs were basic indoor wheelchairs for three-quarters of the sample and under half had a cushion. Over three-quarters of participants had their current wheelchairs donated or received them at no cost. The most common sources of the current wheelchairs were government, charity or a friend.

Wheelchair services received

Less than half (41.6%) of the participants were classified in the service-received category according to their responses to the screening question. The number of participants who reported receiving each of the 13 services, and the WHO step that each of these services corresponded most closely to, are shown in Table A2. The proportion of participants who received each service ranged from 12.2-40.5%. The median (IQR) number of services received was 2.0 (0-5).

Positive wheelchair-user outcomes

The number of participants reporting each of the four positive outcomes are shown in Table A3. Over two-thirds of participants reported 'daily wheelchair use', less than a quarter reported 'outdoor unassisted wheelchair use', over two-thirds reported 'high performance of activities of daily living (ADLs)' and over 80% reported the 'absence of serious falls'. About half of participants reported at least three of the four positive outcomes.

Relationships between services received and outcomes

The relationships between the individual and composite wheelchair service items and positive wheelchair-user outcomes are presented in Tables A4-A7. Incidental note is made of significant relationships (OR [95% CI]) for the composite outcome suggesting that younger participants (0.97 [0.96, 0.98] per year, $p < 0.0001$), males (1.41 [1.02, 1.95], $p = 0.036$) and those with longer durations of wheelchair use (1.12 [1.04, 1.20] per 5 years, $p = 0.003$) had better overall outcomes. No such significant relationships were identified between the composite outcome and country, the condition necessitating wheelchair use and the type of wheelchair used.

Discussion

Individual Services

We have looked at each of the 13 service variables across the outcomes to determine how each contributed overall. None of the relationships between service #1 and any of the 5 outcomes (including the composite) were significant. The same was true for service #2. The content of the service #2 question appears to be included in that of #1 and the two could be combined in the future. These two services might have proven significant if one of the outcomes had been 'absence of pressure sores'.

None of the relationships between service #3 and the outcomes were significant. The failure of this service to contribute could be due to confounding considerations; for instance, it

could have been the case that providing services in the home was more often the case for wheelchair users with more severe mobility problems.

Services #4 and 5 were significantly related to 'outdoor unassisted wheelchair use' and Service #5 was also significantly related to the composite outcome. These relationships suggest that a more in-depth assessment is likely to improve outcomes. The content of services #4 and 5 may overlap enough to warrant combining them for future studies.

Services #6 and 7 were significantly related to 'daily wheelchair use' and the composite outcome. Service #7 was also significantly related to 'outdoor unassisted wheelchair use'. Both suggest that having a knowledgeable provider assist with the choice and fitting of a wheelchair contribute to positive outcomes, as Greer et al.[12] have suggested. These variables performed well and should be retained for future surveys.

Service #8 was significantly related to 'outdoor unassisted wheelchair use', 'high performance of ADLs' and the composite outcome. However, the sensitivity of this service could be enhanced by the use of a more formal and comprehensive assessment (e.g., the Wheelchair Skills Test[28]).

Service #9 was significantly related to all of the outcomes except the 'absence of serious falls'. There have been two recent systematic reviews and meta-analyses[9,10] that have documented the safety and effectiveness of wheelchair skills training in a variety of settings. In future studies, it may be useful to seek more details about training − what was the content, how much training was provided, who provided the training (related to Service #10), how it was provided (e.g. in one-on-one or group sessions) and in what setting (e.g. rehabilitation center, community, home) did training took place?

Service #10 was significantly related to the composite outcome. Best et al.,[32] Gassaway et al.[33] and Norris[34] have all provided evidence about the value of peer training on a variety of positive outcomes. Greer et al.[12] have recommended that wheelchairs be provided by a team of professionals; it would appear that a good case can be made for inclusion of a peer trainer on the team.

Service #11 was significantly related to the composite outcome. Toro et al.[35] have developed training materials on the care and maintenance of wheelchairs that will serve as a valuable resource in practice and future studies. Service #12 was significantly related to the 'daily wheelchair use' and 'outdoor unassisted wheelchair use' outcomes but not the composite outcome. This apparently valuable service seems to be similar to #11 and might be combined with it in future studies.

Service #13 was not significantly related to any of the outcomes. This was a surprising result because, as noted earlier, the studies of Hansen et al.[11] and Hogaboom et al.[36] have suggested the value of check-ups following wheelchair provision.

Individual Outcomes

About one-third (31%) of the individual services had positive and significant relationships with the 'daily wheelchair use' outcome and the composite service score was also significantly related to the outcome. However, if resources permit, this outcome could be validated and made more sensitive by the use of sensors and dataloggers to record wheelchair occupancy and daily distance travelled.[37]

About half (54%) of the individual services had positive and significant relationships with the 'outdoor unassisted wheelchair use' outcome and the composite service score was also significantly related to this outcome. However, if resources permit, this outcome could be more sensitively documented by the use of global-positioning-system instrumentation. In addition to inadequate wheelchair service provision, environmental barriers may limit the ability to get outdoors.[38]

Only two (15%) of the individual services had significant relationships with the 'high performance of ADLs' outcome but the OR for composite service score was significantly related to this outcome. The assessment of this outcome could be enhanced by the use of a validated instrument like the Barthel Index.[39] However, it may be that ADLs (as important as they may be as an outcome of rehabilitation in general) are not related closely enough to wheelchair use to be affected by the nature and extent of wheelchair service provision.

Although Hansen et al.[11] found that structured check-ups after wheelchair provision reduced the incidence of injuries and Hogaboom et al.[36] found that wheelchair breakdowns are associated with a number of negative outcomes, our follow-up service (#13) was not significantly related to the 'absence of serious falls'. In the future, if resources permit, researchers should consider using telecommunications technology to reduce the time between an injurious event and the subsequent documentation of it. Also, obtaining more detail about such events (e.g., a tip-over vs. an equipment failure) might allow researchers to tease out which, if any, services might be improved to prevent injury.

Table A1 Demographic, clinical and wheelchair data (N = 852)

Variable	Category		n	%
Age mean (SD)			49.2 (18.8)	
Sex	Male		468	54.9
	Female		384	45.1
Country	Kenya		420	49.3
	Philippines		432	50.7
Marital status	Married		387	46.0
	Divorced/separated/widowed		145	17.2
	Never married		310	36.8
Education	None		44	5.2
	Primary		271	31.8
	Secondary/post-secondary/vocational		321	37.7
	College/university		215	25.2
Employment	Any work (yes)		469	55.2
	Type of work	Trading/selling	112	13.2
		Craftsman	84	9.9
		Student	71	8.4
		Office worker	51	6.0
		Other	151	17.8
	No work/unemployed		381	44.8
Condition related to need for wheelchair	Polio or post-polio		183	21.5
	Spinal cord injury		160	18.8
	Stroke		115	13.5
	Congenital disorder		74	8.7
	Old age/arthritis		71	8.3
	Other		249	29.2
Current wheelchair type	Basic indoor		639	75.0
	Rough terrain		131	15.4
	Other		17	2.0
	Unavailable/don't know		65	7.6
Wheelchair has a cushion			348	40.9
Current wheelchair funding	Donated/received at no cost		663	77.8
Current wheelchair source	Government unit		283	33.5
	Charity		247	29.2
	Friend		130	15.4
	Pharmacy		54	6.4
	Mission hospital/church		51	6.0
	Other		81	9.6

Abbreviation: SD = standard deviation.

Table A2 Wheelchair services received (N = 852)

WHO Step	Wheelchair	Service	n	%
Assessment	Current	1. Provider asked or physically checked for skin problems, sensation or pressure sores	163	19.1
		2. Provider checked for unsafe pressure at seat surface	104	12.2
		3. Provider's assessment and/or fitting occurred at home	128	15.0
		4. Assessment duration at least 30 minutes	147	17.3
		5. Assessment on at least 2 aspects	306	35.9
Prescription (selection)	Ever	6. Provider helped user choose the right wheelchair	343	40.3
Fitting	Current	7. Provider did fitting of wheelchair	255	29.9
		8. Provider assessed wheelchair fit while user propelled the wheelchair	345	40.5
User training	Ever	9. Provider did training	186	21.8
		10. Peer group training received	115	13.5
Follow-up, maintenance and repairs	Ever	11. Provider instructed user in taking care of the wheelchair	221	25.9
		12. Provider told user where to seek help with wheelchair repairs	137	16.1
		13. Provider in contact to see how user was doing with the wheelchair	147	17.3

Table A3 Positive wheelchair-user outcomes (N = 852)

Outcome*	n	%
1. Daily wheelchair use	597	70.1
2. Outdoor unassisted wheelchair use	191	22.4
3. High performance of ADLs	608	71.4
4. Absence of serious falls	720	83.3
Number of positive outcomes		
0	1	0.1
1	134	15.7
2	303	35.6
3	290	34.0
4	124	14.6

Abbreviation: ADLs = Activities of Daily Living.
* In current wheelchair.

Table A4 Relationship between wheelchair services received and the outcome of 'daily wheelchair use' (N = 852)

		Daily Wheelchair Use		
Services Received	Response	# (%)	OR (95% CI)*	P-value
1. Provider asked or physically checked for skin problems, sensation or pressure sores	No	465 (67.5)	0.98 (0.60, 1.58)	0.92
	Yes	132 (81.0)		
2. Provider checked for unsafe pressure at seat surface	No	521 (69.7)	0.69 (0.41, 1.15)	0.15
	Yes	76 (73.1)		
3. Provider's assessment and/or fitting occurred at home	No	511 (70.6)	1.13 (0.71, 1.81)	0.61
	Yes	86 (67.2)		
4. Assessment duration at least 30 minutes	No	482 (68.4)	0.89 (0.55, 1.46)	0.65
	Yes	115 (78.2)		
5. Assessment on at least 2 aspects	No	358 (65.6)	1.30 (0.89, 1.91)	0.18
	Yes	239 (78.1)		
6. Provider helped user choose the right wheelchair	No	320 (62.9)	1.51 (1.03, 2.21)	**0.034**
	Yes	277 (80.8)		
7. Provider did fitting of wheelchair	No	386 (64.7)	1.55 (1.01, 2.37)	**0.046**
	Yes	211 (82.7)		
8. Provider assessed wheelchair fit while user propelled the wheelchair	No	330 (65.1)	1.23 (0.85, 1.78)	0.26
	Yes	267 (77.4)		
9. Provider did training	No	436 (65.5)	2.00 (1.19, 3.33)	**0.008**
	Yes	161 (86.6)		
10. Peer group training received	No	502 (68.1)	1.21 (0.68, 2.13)	0.52
	Yes	95 (82.6)		
11. Provider instructed user in taking care of the wheelchair	No	418 (66.2)	1.34 (0.87, 2.06)	0.19
	Yes	179 (81.0)		
12. Provider told user where to seek help with wheelchair repairs	No	478 (66.9)	2.03 (1.13, 3.64)	**0.017**
	Yes	119 (86.9)		
13. Provider in contact to see how user was doing with the wheelchair	No	491 (69.6)	1.07 (0.68, 1.68)	0.78
	Yes	106 (72.1)		
Composite # of services (per unit, 0-13) adjusted			1.08 (1.01, 1.15)	**< 0.0001**

* Adjusted for age, sex, country, duration, condition and type of wheelchair. Abbreviations: CI = confidence interval; OR = Odds Ratio. Significant p values are highlighted in bold font.

Table A5 Relationship between wheelchair services received and the outcome of 'outdoor unassisted wheelchair use' (N = 852)

		Outdoor Unassisted Wheelchair Use		
Services Received	Response	# (%)	OR (95% CI)*	P-value
1. Provider asked or physically checked for skin problems, sensation or pressure sores	No	141 (20.5)	1.15 (0.74, 1.80)	0.54
	Yes	50 (30.7)		
2. Provider checked for unsafe pressure at seat surface	No	160 (21.4)	1.09 (0.64, 1.85)	0.76
	Yes	31 (29.8)		
3. Provider's assessment and/or fitting occurred at home	No	154 (21.3)	1.05 (0.63, 1.75)	0.85
	Yes	37 (28.9)		
4. Assessment duration at least 30 minutes	No	140 (19.9)	1.65 (1.04, 2.61)	**0.032**
	Yes	51 (34.7)		
5. Assessment on at least 2 aspects	No	86 (15.8)	1.59 (1.08, 2.34)	**0.018**
	Yes	105 (34.3)		
6. Provider helped user choose the right wheelchair	No	76 (14.9)	1.45 (0.99, 2.14)	0.06
	Yes	115 (33.5)		
7. Provider did fitting of wheelchair	No	90 (15.1)	2.32 (1.56, 3.45)	**< 0.0001**
	Yes	101 (39.6)		
8. Provider assessed wheelchair fit while user propelled the wheelchair	No	68 (13.4)	2.52 (1.72, 3.71)	**< 0.0001**
	Yes	123 (35.7)		
9. Provider did training	No	119 (17.9)	2.21 (1.44, 3.40)	**0.0003**
	Yes	72 (38.7)		
10. Peer group training received	No	148 (20.1)	1.46 (0.89, 2.38)	0.13
	Yes	43 (37.4)		
11. Provider instructed user in taking care of the wheelchair	No	106 (16.8)	1.67 (1.12, 2.49)	**0.012**
	Yes	85 (38.5)		
12. Provider told user where to seek help with wheelchair repairs	No	127 (17.8)	2.12 (1.34, 3.34)	**0.001**
	Yes	64 (46.7)		
13. Provider in contact to see how user was doing with the wheelchair	No	149 (21.1)	1.27 (0.79, 2.04)	0.32
	Yes	42 (28.6)		
Composite # of services (per unit, 0-13) adjusted			1.13 (1.07, 1.20)	**< 0.0001**

* Adjusted for age, sex, country, duration, condition and type of wheelchair. Abbreviations: CI = confidence interval; OR = Odds Ratio. Significant p values are highlighted in bold font.

Table A6 Relationship between wheelchair services received and the outcome of 'high performance of ADLs' (N = 852)

		High Performance of ADLs		
Services Received	Response	# (%)	OR (95% CI)*	P-value
1. Provider asked or physically checked for skin problems, sensation or pressure sores	No	475 (68.9)	1.16 (0.71, 1.89)	0.56
	Yes	133 (81.6)		
2. Provider checked for unsafe pressure at seat surface	No	524 (70.1)	1.17 (0.66, 2.09)	0.58
	Yes	84 (80.8)		
3. Provider's assessment and/or fitting occurred at home	No	527 (72.8)	0.73 (0.45, 1.16)	0.18
	Yes	81 (63.3)		
4. Assessment duration at least 30 minutes	No	488 (69.2)	1.20 (0.72, 1.98)	0.48
	Yes	120 (81.6)		
5. Assessment on at least 2 aspects	No	367 (67.2)	1.22 (0.83, 1.80)	0.31
	Yes	241 (78.8)		
6. Provider helped user choose the right wheelchair	No	333 (65.4)	1.29 (0.88, 1.89)	0.19
	Yes	275 (80.2)		
7. Provider did fitting of wheelchair	No	395 (66.2)	1.32 (0.85, 2.04)	0.21
	Yes	213 (83.5)		
8. Provider assessed wheelchair fit while user propelled the wheelchair	No	322 (63.5)	1.96 (1.34, 2.86)	**0.0005**
	Yes	286 (82.9)		
9. Provider did training	No	449 (67.4)	1.75 (1.06, 2.88)	**0.028**
	Yes	159 (85.5)		
10. Peer group training received	No	507 (68.8)	1.64 (0.87, 3.07)	0.12
	Yes	101 (87.8)		
11. Provider instructed user in taking care of the wheelchair	No	424 (67.2)	1.43 (0.91, 2.24)	0.12
	Yes	184 (83.3)		
12. Provider told user where to seek help with wheelchair repairs	No	490 (68.5)	1.47 (0.83, 2.61)	0.19
	Yes	118 (86.1)		
13. Provider in contact to see how user was doing with the wheelchair	No	500 (70.9)	1.00 (0.63, 1.59)	1
	Yes	108 (73.5)		
Composite # of services (per unit, 0-13) adjusted			1.07 (1.00, 1.14)	**0.046**

* Adjusted for age, sex, country, duration, condition and type of wheelchair. Abbreviations: ADLs = Activities of Daily Living; CI = confidence interval; OR = Odds Ratio. Significant p values are highlighted in bold font.

Table A7 Relationship between wheelchair services and the outcome of 'absence of serious falls' (N = 852)

		Absence of Serious Falls		
Services Received	Response	# (%)	OR (95% CI)*	P-value
1. Provider asked or physically checked for skin problems, sensation or pressure sores	No	583 (84.6)	0.97 (0.61, 1.53)	0.89
	Yes	127 (77.9)		
2. Provider checked for unsafe pressure at seat surface	No	625 (83.6)	1.18 (0.68, 2.05)	0.56
	Yes	85 (81.7)		
3. Provider's assessment and/or fitting occurred at home	No	598 (82.6)	1.26 (0.69, 2.29)	0.44
	Yes	112 (87.5)		
4. Assessment duration at least 30 minutes	No	599 (85.0)	0.78 (0.49, 1.24)	0.29
	Yes	111 (75.5)		
5. Assessment on at least 2 aspects	No	458 (83.9)	1.37 (0.90, 2.07)	0.14
	Yes	252 (82.4)		
6. Provider helped user choose the right wheelchair	No	431 (84.7)	1.22 (0.82, 1.83)	0.33
	Yes	279 (81.3)		
7. Provider did fitting of wheelchair	No	510 (85.4)	1.03 (0.68, 1.56)	0.88
	Yes	200 (78.4)		
8. Provider assessed wheelchair fit while user propelled the wheelchair	No	425 (83.8)	1.44 (0.96, 2.16)	0.07
	Yes	285 (82.6)		
9. Provider did training	No	570 (85.6)	0.81 (0.52, 1.26)	0.35
	Yes	140 (75.3)		
10. Peer group training received	No	624 (84.7)	0.83 (0.50, 1.38)	0.48
	Yes	86 (74.8)		
11. Provider instructed user in taking care of the wheelchair	No	535 (84.8)	1.09 (0.71, 1.68)	0.69
	Yes	175 (79.2)		
12. Provider told user where to seek help with wheelchair repairs	No	609 (85.2)	0.71 (0.44, 1.15)	0.17
	Yes	101 (73.7)		
13. Provider in contact to see how user was doing with the wheelchair	No	590 (83.7)	1.01 (0.61, 1.68)	0.96
	Yes	120 (81.6)		
Composite # of services (per unit, 0-13) adjusted			1.01 (0.95, 1.08)	0.73

* Adjusted for age, sex, country, duration, condition and type of wheelchair. Abbreviations: CI = confidence interval; OR = Odds Ratio. Significant p values are highlighted in bold font.

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