The Association Between Falls and Physical and Psychological Conditions in Physically Disabled Elderly People: A Retrospective Cohort Study

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Abstract

Background

Falling in physically disabled people is a worldwide social issue and associated with declined physical and psychological health. This study aimed to clarify the physical and psychological conditions in physically disabled people and to explore whether those conditions are the risk factors of falls.

Methods

One hundred and forty-six physically disabled people were recruited (age 64.2 ± 5.7 , ranging from 43 to 77). Their demographic information, psychological status, musculoskeletal conditions, and history of falls in the past year were collected, and mobility was evaluated. A logistic regression analysis was used to clarify the risk factors of falls with the receiver operating characteristic (ROC) curve exploring the effectiveness of the regression model on fall diagnosis via area under the curve (AUC). A subgroup analysis was done between the disabled participants with and without poliomyelitis (polio).

Results

The cause of disability (polio or no-polio), gender, disability grade, and functional gait assessment were significantly associated with falls (all $p < 0.05$, Nagelkerke $R^2 = 0.320$), and ROC curve indicated that AUC of this model was 0.805 ($p < 0.001$, 95% CI 0.735–0.876, Youden Index = 0.502). The subgroup analysis showed that the polio group (75 of the 146 participants) had a longer history of disability ($t = 12.360$, $p < 0.001$) than the no-polio disabled group while there were no significant differences in the other demographic information (all $p > 0.05$). The proportion of moderate anxiety in the no-polio participants was significantly higher than that in the polio group ($p < 0.001$) but the polio group had more musculoskeletal conditions. In the mobility test, the polio participants walked slower in the timed-up-and-go test ($t = 2.050$, $p = 0.042$) and had a higher rate of recurrent falls ($\chi^2 = 14.916$, $p < 0.001$) than the no-polio disabled group.

Conclusions

The disabled people with a high risk of falling can be identified through a 10-minute screening (cause of disability, gender, disability grade, and gait stability testing). The physical conditions of the polio disabled people were relatively more affected.

Key Points

Severe disability, females, and gait instability were related to fall.

People with poliomyelitis had decreased mobility and a high rate of recurrent falls.

The positive rates of anxiety and depression were high in physically disabled people.

Background

Physically disabled people, varying on different causes, generally have declined mobility, psychological sub-health, and limited activities of daily living ¹. With an improved life expectancy as well as aging in individuals with physical disabilities, a constantly growing number of disabled individuals are stepping into middle age and beyond ^{2,3}. Similar to the elderly community dweller without disability, physically disabled individuals of older age also suffered from health issues secondary to the aging process ⁴, especially some musculoskeletal conditions, which not only increases healthcare expenditure but also reduces productivity. Depression and anxiety usually co-occur in later life ⁵, and it is also of importance when psychologically derived health issues were addressed in the social well-being⁶.

Disabled people tend to fall even in a slight perturbation because of the narrow base of support and muscle weakness ⁷. Compared to the community dweller, there are more frequent falls that threaten health and quality of life in elderly people with disabilities especially in poliomyelitis (polio) survivors ⁸. The combination of disability severity and psychosocial circumstances makes fall prediction difficult, but recognition of risk factors is essential in fall prevention targeting and prioritizing for middle-aged and elderly disabled people with disabilities who have multiple physical and psychological conditions ⁹.

Polio is an early-onset disease and one of the typical causes of physical disability. Late effects referring to long-period infection of paralytic poliomyelitis or post-polio syndrome may occur in people with polio while aging ¹⁰. It includes a variety of new musculoskeletal, neurological, and systemic symptoms, such as muscular atrophy, generalized fatigue, and pain ¹¹ that leading to falls and hip fracture ¹². Although elderly polio individuals have experienced many secondary diseases, it remains unknown whether there are differences in physical and mental functions between physically disabled people with and without polio.

This study aimed to clarify the indicators associated with falls in people with physical disabilities and to find the differences in physical and mental conditions between physically disabled persons with and without polio. We hypothesize that both physical and psychological factors contributed to falls while people with polio had worse functional outcomes than no-polio disabled people.

Methods

Participants

One hundred and forty-six physically disabled participants were recruited from local communities in Shanghai in August 2020. The potential participants should have more than 1 year of disability history

with a disability certificate and be able to walk over 20 meters with or without walking aids or orthosis. The exclusion criteria were (1) upper limbs disability only (2) severe cardiopulmonary diseases, (3) lower extremity or spine injuries in the past 6 months¹³, (4) cognitive impairments that cannot understand the experiment process.

Outcome Measures

Disability Information

Demographic information was collected, such as education, marital status, and family income. The grade of physical disability was determined by the “Disability Classification and Grade” National Standard (GB/26341 – 2010)¹⁴, as level 1 was the most severe disability, while level 4 is relatively mild. Musculoskeletal complaints were collected by a physiotherapist and the affected body parts were recorded.

Gait Stability

To assess the gait stability, functional gait assessment (FGA) and time up and go test (TUG) were introduced. FGA consists of 10 functional walking tasks, such as changes in gait speed or ambulating backward. There are four grades for each task: 3 means normal function while 0 means severe impairment. In TUG, participants were required to stand up from an armless chair and to walk forward when they heard the instruction “Begin”. Timing stopped when the participants walked 3 meters, turned back to the chair, and sit down. TUG was repeated 3 times and the average time was then calculated.

Activity of Daily Living

The self-maintaining and instrumental activities of daily living scale is a physical self-maintenance scale evaluating both basic and instrumental activities of daily living, including toilet, ambulation, shopping, food preparing, etc.

Physical Activity

Physical activity was quantified by the international physical activity questionnaire - short form (IPAQ-S). The minutes that the participants spent in vigorous and moderate physical activities as well as walking in the last seven days was recorded. Then vigorous activity is considered to be 8 MET and moderate-intensity activity is considered to be 4 MET, while walking is 3.3 MET. Scoring the level of physical activity is based on the MET minutes achieved in one week. The sedentary time of the last 7 days was also recorded for reference.

Psychological Status

The Stigma Scale for Chronic Illness-8 (SSCI-8) was used to assess the enacted and self-perceived stigma of their physical disability¹⁵. SSCI-8 was developed on the basis of the original 24-item SSCI by Rao et al.¹⁶, of which 3 items were drawn from the aspect of internalized stigma and 5 items were

extracted from the enacted stigma part. Each item of SSCI-8 is measured by a 5-point Likert scale (1 = Never and 5 = Always) with a high score representing severe stigma.

The Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS) were both designed by Zung. Each of the scales includes 20 items relating to affective and somatic symptoms. The standard score of over 50 points (raw score = 40) indicates clinical positive, and the severity is stratified into 3 levels: mild (50–59), moderate (60–69), and heavy (70 points or more).

Falls

The participants were required to report the falls they experienced last year. All the incidents of resting on the floor or other lower plane would be included in the number of falls¹⁷ except the falls caused by external events (e.g. irresistible external forces) or internal events (stroke or dizziness)^{18,19}.

Data Analysis

Significance was set to 0.05 and the statistical analyses were performed in SPSS (version 20 for Windows). Continuous variables were described using mean $\pm$ SD or median with quartile.

To clarify whether falls in disabled people were associated with their demographic characteristics, psychological conditions, musculoskeletal conditions, and mobility, a univariate logistic regression was used to screen the potential factors for falls and then the variables with a significance level of less than or equal to 0.1 would be then entered in the multivariate logistic regression analysis (forward selection: likelihood ratio).

Receiver operating characteristic (ROC) curve was then used to explore the effectiveness of the regression model on fall diagnosis and the cutoff point was calculated via Youden's Index.

For subgroup comparison, the subjects were divided into two groups according to the causes of disability (polio group and no-polio group). The differences between the groups were tested by two independent samples t-test, Wilcoxon signed-rank test, and Chi-square test according to the data types.

Results

Falls and related factors

A total of 146 physically disabled people participated in this study (age 64.2 ± 5.7 year., ranging from 43 to 77, male/female 91/55, height 164.3 ± 8.0 cm, and weight 64.4 ± 9.9 kg) with a history of disability 46.3 ± 23.3 year. The causes of disability compromised polio (51.4%), accident (15.8%), osteoarthritis (14.4%), congenital deformity (6.8%), cerebrovascular accident (4.1%) and others (7.5%). The physical and psychological outcomes were shown in TABLE 1. Fifty-four participants (37%) had at least one fall while 88.9% of the fallers had recurrent falls.

Screened by univariate linear regression, there were 8 variances whose significance level was less than or equal to 0.1: cause of disability (polio or no-polio), gender (male or female), height, years of disability, level of disability (level 2, 3, and 4), anxiety score, FGA, IADL. Results of further multivariate logistic regression were shown in TABLE 2, and people with polio, women, people of high-level disability, and low FGA scores were more possible to fall.

$$\text{Logit P} = 0.615 - 1.386X_{\text{cause of disability}} + 0.955X_{\text{gender}} + 1.899X_{\text{level of disability}(1)} + 1.119X_{\text{level of disability}(2)} - 0.078X_{\text{FGA}}$$

This formula was then used to calculate the cutoff point of fall diagnosis through ROC Curve. FIGURE 1 showed that AUC value was 0.805 ($p < 0.001$, 95%CI [0.735, 0.876]) and the cutoff point was -0.482 (Sensitivity = 0.741, Specificity = 0.761, Youden Index = 0.502).

Subgroup Comparison

Demographic Information

TABLE S1 and TABLE S2 showed that there were no significant differences in terms of all demographic information (all $p > 0.05$), except the polio disability group had a longer history of disability ($t = 12.360$, $p < 0.001$) than the no-polio disability group.

Musculoskeletal conditions

As shown in TABLE S3, the main musculoskeletal conditions of the participants are contracture, short limb, pain, numbness, and scoliosis, and over 90% of polio participants had contracture or short limb. The lower extremities are the most common areas of pain, and the proportion of lower extremity pain was 88.9% in the polio disability group and 90.7% in the no-polio disability group with VAS scores of pain 4.2 ± 1.3 and 4.2 ± 1.3 , respectively.

The distribution of the number of musculoskeletal conditions was shown in TABLE S4. Fisher's exact test showed that polio participants had significantly more musculoskeletal conditions than no-polio disabled participants had ($p = 0.002$).

Psychological Status

TABLE S5 showed the psychological status of the 2 groups. The difference in the stigma between polio and no-polio disabled participants was not significant ($t = 0.662$, $p = 0.509$), with the stigma score ranging from 8 to 27. Overall, the positive rate of anxiety and depression were 16.4% and 24.0%, respectively. The scores of SAS and SDS also did not show significance between the 2 groups ($t = -0.311$, $p = 0.756$ and $t = -0.583$, $p = 0.561$) as well as the percentage positive ($\chi^2 = 0.352$, $p = 0.533$ and $\chi^2 = 0.144$, $p = 0.704$). However, Fisher's exact test showed that no-polio disabled participants had more severe anxiety than polio participants ($p < 0.001$).

Mobility and Falls

In TABLE S6, the polio group was significantly slower than the no-polio group in TUG ($t = 2.050$, $p = 0.042$), while there were no significant differences in FGA and IADL ($t = -1.900$, $p = 0.059$, and $t = 1.887$, $p = 0.062$). In terms of physical activity, the intensity in participants with polio was higher than that of participants in the no-polio disability group ($t = 2.160$, $p = 0.032$) but the ratio of physical activity level and sedentary time did not show significance ($\chi^2 = 1.887$, $p = 0.389$ and $t = -1.006$, $p = 0.316$).

Falls in polio and non-polio groups over the past year are shown in TABLE S7. The proportion of participants with a history of falls in the polio disability group was significantly higher than in the no-polio disability group ($\chi^2 = 14.916$, $p < 0.001$). Recurrent falls were dominant in the polio disability group (accounting for 48.0%), and 12.0% of polio participants fell more than 5 times in the past year. In contrast, only 16.9% of participants in the no-polio disability group fell over twice.

Discussion

This study established a fall prediction model for physically disabled people and investigated the differences between polio and no-polio disabled participants in demographic information, psychological status, musculoskeletal conditions, and mobility. The cause of physical disability, gender, disability grade, and FGA constituted the fall prediction model, which had reasonable sensitivity and specificity in the fall diagnosis. The history of disability was longer in the polio group than that in the no-polio group, but significantly more severe anxiety was found in no-polio disabled participants. Meanwhile, the incidence of musculoskeletal conditions in the polio group was significantly higher than that in the no-polio group. In the mobility tests, the polio group had relatively weak performance in TUG but they were more active in terms of physical activity. Furthermore, the Polio group not only had a higher rate of falls but also mainly recurrent falls.

The results of this study showed that indicators related to the severity of disability, rather than age²⁰, were important in the prediction of falls in middle-aged and elderly disabled people. Female participants in this model were more likely to fall, which may indicate the balance of female disabled people declines faster after middle age than the males^{21, 22}. In addition to the demographic indicators, FGA was entered in this model, suggesting that FGA can also be employed in the evaluation of the people with physical disabilities in addition to the elderly community dwellers²³. ROC curve further verified the effect of the model in fall prediction and provided the cut-off point for clinical reference. Previous studies have found that TUG had both good discriminant validity^{24, 25} and responsiveness²⁶ in disabled people²⁵. This study also showed that TUG test can effectively distinguish the mobility of the polio group and the no-polio group, but the effect in fall prediction was insignificant. The explanation was that as a quick screening tool, TUG only included three aspects of position transferring, walking, and turning, while fall evaluation of the disabled should take more circumstances into consideration²⁷.

Compared to psychological issues, health conditions in the musculoskeletal system had more negative impacts on activities of daily living²⁸. In this study, the five most frequently reported musculoskeletal conditions were contracture, short limb, pain, numbness, and scoliosis and almost all polio participants

suffered from multiple musculoskeletal conditions. The findings identified the intervention targets which the healthcare provider should focus on to maximize their functional independence.

There were few studies on the stigma of people with physical disabilities. This study showed that both of the two groups had a low level of stigma. Due to the long history of disability, the participants were essentialized and had stable and positive self-evaluation²⁹. However, it should be noted that people with physical disabilities may hide their disability-related characteristics to reduce stigma³⁰. For instance, disabled people may reduce their exposure to the public and refuse to use axillary crutches, wheelchairs, or other assistive devices, which usually led to motor function decline and social participation limitation. The positive rate of moderate anxiety was significantly higher in the no-polio group. A previous study demonstrated that moderate-to-vigorous physical activity was related to the reduction of anxiety symptoms³¹ and anxiety also improved over time³², as the no-polio group had a shorter history of disability with a less active lifestyle than the polio group in this study. In addition, the prevalence of depression was reported to be 13.5% among healthy people over 55 years old³³ and a survey of disabled people in England found that the positive rate of depression was 19.5%³⁴ which was similar to the overall positive rate of depression in this study. It was recommended that depressive symptoms should be taken into consideration when making policies related to senior adults³⁵.

Clinical Implication

A rational fall prediction model was established in this study, where the cause of disability, gender, grade of disability, and functional gain assessment were the four significant indicators. The disabled people with a high risk of falling can be identified through roughly 10 minutes of screening and calculating. This study also showed the intervention targets for the musculoskeletal conditions in people with physical disabilities, such as contracture, short limb, scoliosis, numbness, and pain, especially in the polio group. Considering the high positive rates of anxiety and depression among the physically disabled, policymakers should take some low-cost and efficient interventions into account.

Conclusion

The tendency of falls in physically disabled individuals can be effectively diagnosed via the collection of basic demographic information and functional gait assessment. Those who were with polio, female, and of high-level disability were prone to fall. Compared to no-polio disabled people, the polio people had a longer disability period, more musculoskeletal conditions, worse mobility, and a higher rate of recurrent falls. Positive rates of anxiety and depression in the disabled people were relatively high and the anxiety symptoms of the no-polio group were more severe than the polio group.

Declarations

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Authors' contributions

Q.D. and N.C. conceived and supervised the study, and led the drafting. Z.C., L.M., and Y.L. recruited the participants, analyzed the data, and were involved in the drafting. All authors have read and approved the manuscript.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Xinhua Hospital Affiliated to Shanghai Jiao Tong University School of Medicine (approval number: XHEC-C-2021-116-1) and was in accordance with the Declaration of Helsinki. Before the commencement of the study, all participants received a participant information sheet, had opportunities to ask questions, and then signed informed consent for participation.

Consent for publication

All participants in this study provided written informed consent for study publication.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1
Physical and psychological outcomes in 146 participants

Outcome Measures	Mean	SD
Functional Gait Assessment	14.0	6.1
Time up and Go (seconds)	14.9	6.3
Self-Maintaining and Instrumental Activities of Daily Living Scale	12.8	1.5
International Physical Activity Questionnaire - Short Form	2712.6	1861.1
Sedentary Time (minute/week)	454.8	197.2
Stigma Scale for Chronic Illness-8	9.8	3.8
Self-Rating Anxiety Scale	39.7	9.5
Self-Rating Depression Scale	41.1	11.7

Table 2
Results of multivariate logistic regression ^a

	B	p	OR	95% CI for OR	
				Lower	Upper
Cause of Disability	-1.368	0.001	0.255	0.114	0.566
Gender	0.955	0.021	2.6	1.157	5.839
Grade of Disability		0.011			
Grade of Disability (1) ^b	1.899	0.089	6.677	0.748	59.606
Grade of Disability (2) ^c	1.119	0.007	3.062	1.359	6.902
FGA	-0.078	0.028	0.925	0.862	0.991
Constant	0.615				
Note:					
a. Nagelkerke R ² = 0.320, and Hosmer and Lemeshow test: p = 0.393					
b. Comparing Level 2 to Level 4					
c. Comparing Level 3 to Level 4					

Figures

Figure 1

Receiver Operating Characteristic (ROC) Curve for fall diagnosis. The shadowed part of the figure is the area under the curve

Supplementary Files

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- [SupplementaryTABLES.docx](#)