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Running title: Determinants of falls and fear of falling in persons with prior polio

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Abstract

Background: Falls and fear of falling (FOF) are common in persons with late effects of polio but there is limited knowledge of associated factors.

Objective: To determine how knee muscle strength, dynamic balance and gait performance (adjusted for gender, age and BMI) are associated with falls and FOF in persons with late effects of polio.

Design: A cross-sectional study.

Setting: A university hospital outpatient clinic.

Participants: Eighty-one ambulatory persons with verified late effects of polio (43 men; mean age 67 years).

Main Outcome Measurements: Number of falls the past year, Falls Efficacy Scale – International (FES-I) to assess FOF, a Biodex dynamometer to measure knee muscle strength, the Timed Up and Go (TUG) test to assess dynamic balance and the Six Minute Walk test (6MWT) to assess gait performance. Univariate and multivariate logistic regression analyses were used for falls (categorical data) and linear regression analyses for FOF (continuous data) as dependent variables.

Results: Fifty-nine % reported at least one fall during the past year and 79% experienced FOF. Reduced knee muscle strength in the more affected limb and gait performance were determinants of falls. An increase of 10 Nm in knee flexor and knee extensor strength reduced the OR between 0.70 and 0.83 (P=.01), and an increase of 100 meter in 6MWT reduced the OR to 0.41 (P=.001). All factors were determinants of FOF; reduced knee muscle strength in the more and less affected limbs explained 17% to 25% of the variance in FOF, dynamic balance 30% and gait performance 41%. Gender, age and BMI only marginally influenced the results.

Conclusions: Reduced gait performance, knee muscle strength and dynamic balance are to a varying degree determinants of falls and FOF in ambulatory persons with late effects of polio. Future studies need to evaluate if rehabilitation programs targeting these factors can reduce falls and FOF in this population.

Key words: Accidental falls; postural balance; muscle strength; postpoliomyelitis syndrome; walking

Introduction

Decades after an acute poliomyelitis infection, many people experience new symptoms and impairments, referred to as late effects of polio or post-polio syndrome [1]. These impairments, i.e. reduced muscle strength, muscle fatigue, general fatigue and musculo-skeletal pain [2-5], can lead to decreased balance, walking limitations [6-9] and increase the risk of falls [10]. Studies have shown that between 50% and 84% of persons affected by late effects of polio report at least one fall during a year [10-16]. This is considerably higher than in non-disabled elderly people, where the fall frequency is about 20% to 40% [17]. The occurrence of falls in persons with late effects of polio is most commonly reported outdoors [10, 16] and when walking [10, 12, 16]. Many sustain an injury because of the falls and up to 35% a limb fracture [10, 11, 13, 14, 16].

The experience of falls can also lead to fear of falling (FOF). It has been shown that up to 95% of persons with late effects of polio express FOF when performing daily activities [10, 11, 14, 15, 18], especially activities related to walking [10, 15]. This, in turn, can affect their quality of life negatively [18].

Even if falls and FOF are common in persons with late effects of polio, there is overall limited knowledge which factors are associated with falls and FOF in this population. Factors shown to be associated with falls are reduced ankle dorsiflexor muscle strength [11, 19], decreased postural control [14, 19], FOF [14] and leg-length discrepancy [16]. Muscle weakness in the knee extensors in the most affected leg was associated with falls in one study [14], but this could not be confirmed in another [16]. Thus, the limited knowledge of how knee muscle strength and gait performance are associated with falls in persons with late effects of polio underscore the need for further studies. Moreover, to the best of our knowledge, no study has comprehensively evaluated factors that are determinants of FOF in this population.

In a previous study of 325 persons with late effects of polio [10] we showed that self-reported impairments, self-perceived walking limitations and FOF were greater among the fallers than the non-fallers. A subgroup of 81 participants from that study [10] was also assessed with regard to knee muscle strength, dynamic balance and gait performance. The aim of the present study is to determine the association between these factors. Our hypothesis was that reduced muscle strength, dynamic balance and gait performance (adjusted for gender, age and BMI) are determinants of falls and FOF in ambulatory persons with late effects of polio.

Materials and Methods

Participants

From our previous cohort of 325 participants with late effects of polio [10], 102 persons were randomly invited to participate in the present study. Eighty-one persons accepted the invitation (response rate 79%) and met the following inclusion criteria: (i) a confirmed history of acute poliomyelitis affecting their lower limbs; (ii) a period of recovery and functional stability of at least 15 years; (iii) clinically verified post-polio including new symptoms that had persisted for at least a year, such as muscle weakness and/or loss of functioning, in one or both lower limbs; (iv) between 50-80 years of age; and (v) ability to walk 300 meters with or without an assistant device. The exclusion criteria were: (i) other diseases (such as stroke, Parkinson's disease, severe osteoarthritis, or cardiovascular or pulmonary diseases due to late effects of polio) that could impact on their mobility and/or risk of falling. The participants had previously participated in another study about the relationship between physical activity and self-reported impairments, walking limitations, fear of falling, and incidence of falls [15].

All participants had undergone an electromyogram (EMG) examination of their upper and lower limbs, as part of the initial routine clinical examination and verification of prior polio. They all had EMG findings indicative of prior polio in at least one lower limb and no other neurological disorders or medical reasons that could explain their increased or new problems. Following the individuals' own perception, one lower limb was defined as the "less affected" and the other as the "more affected".

Ethics

Before inclusion, oral and written information about the purpose of the study was provided and each participant gave their written informed consent. The principles of the Declaration of Helsinki were followed and the study was approved by the Ethics Research Committee of Lund University, Lund, Sweden (Dnr 2011/582).

Questionnaires

The participants responded to questions about their current medical and physical situation, living situation, use of mobility aids and orthotic devices, incidence of falls during the past year and FOF.

A fall was defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level [20]. Fall incidence was dichotomized as "yes" (one or more falls during the past year) or "no" (no falls during the past year).

Fear of falling (i.e. an ongoing concern about falling that ultimately limits the performance of daily living) [21] was assessed with the Falls Efficacy Scale-International (FES-I). The scale was developed by the Prevention of Falls Network Europe (ProFaNE) group and asks how concerned persons are about falling [22] when performing the following 16 daily activities: cleaning the house, getting dressed or undressed, preparing simple meals, taking a bath or shower, going to the shop, getting in or out of a chair, going up or down stairs, walking around in the neighborhood, reaching for something above the head or on the ground, going to answer the telephone before it stops ringing, walking up or down a slope, on uneven or slippery surface, visiting a friend or relative or going out to a social event. The response options in FES-I range from 1 (not at all concerned) to 4 (very concerned). The score for each item is summarized, yielding a total score of 16 to 64 points; a greater score indicates that the person is more concerned about falling. The FES-I score can also be categorized as low FOF (16-19 points), moderate FOF (20-27 points) or high FOF (28-64 points) [23, 24]. The FES-I has shown good psychometric properties [25] and is commonly used in persons with different neurological and neuromuscular diseases [10, 14, 15, 24, 26, 27].

Assessments of knee muscle strength

Isokinetic knee extensor and flexor muscle strength was measured with a Biodex® Multi-Joint System 3 PRO dynamometer using a standard protocol shown to be reliable for persons with late effects of polio [28]. The participants were seated without shoes or orthotics in an adjustable chair, firmly stabilized with straps across the shoulders, waist and thigh. The ankle cuff of the lever arm was strapped 3 cm proximal to the malleoli of the tested leg. After a structured warm-up, each subject performed, in successions, three maximal concentric knee extensor and flexor contractions at 60°/s and the highest peak torques were recorded (Newton meter; Nm). Consistent verbal encouragement was given throughout. Before each measurement, the range of motion was set and the Biodex software applied the gravity correction. All measurements started with the less affected lower limb followed by the more affected lower limb.

Because of muscle weakness in the more affected lower limb, five participants

were unable to perform isokinetic knee extension and six were unable to perform isokinetic knee flexion. Muscle strength for these measurements was recorded as "0" to allow for a complete statistical analysis.

Assessments of dynamic balance and gait performance

Dynamic balance was assessed by the Timed "Up & Go" test (TUG) [9, 29] and gait performance by the 6-Minute Walk Test (6MWT), according to a standardized test protocol [7]. Both tests are shown to be reliable in ambulatory persons with late effects of polio [7].

For the TUG, the participants sat in a chair placed at the end of a marked 3-m walkway. They were instructed to sit with their back against the chair, and on the word "go", stand up, walk at a comfortable speed and pass the 3-m mark, turn around, walk back and sit down in the chair. Each participant did one trial to become familiar with the test, and then performed the TUG twice with a one-minute rest between each trial. The time from the start until the participant sat down in the chair with back support was measured and the mean of the two tests was recorded.

For the 6MWT, the participants were instructed to walk 30 meters between two marks on the floor. After passing the mark, they were told to turn and walk back. They were instructed to cover as much ground as possible and to walk as far as possible during six minutes. The 6MWT was performed once and the number of 30 m-lengths was counted. Every meter was marked on a wall so the distance walked could be measured.

Data analysis

Demographic data and clinical characteristics are presented as mean ± SD (range) or proportions (%). Differences between fallers and non-fallers were analyzed with the independent sample t-test or the Mann-Whitney U test. Associations between fear of falling (categorized as low, moderate or high FOF) and demographics and clinical characteristics were analyzed with the non-parametric Jonckheere-Terpstra Test.

To determine how falls and FOF were related to knee muscle strength of the more and less affected limb, dynamic balance and gait performance (adjusted for gender, age and BMI), we conducted univariable and multivariable regression analyses. In these analyses knee muscle strength was calculated in intervals of 10 Nm and gait performance in intervals of 100 meters. A logistic regression analysis was used for falls (categorical data) as the dependent variable, whereas a linear regression analysis was used for FOF as the dependent

variable (continuous data). As an initial step in the model building, correlations between the independent variables were analyzed using the Spearman rank correlation coefficient (rho). As knee muscle strength (knee extension and knee flexion) in both the more and the less affected lower limbs as well as dynamic balance and gait performance were highly correlated (rho: -0.74 to 0.74), four regression models were established (see Table 3 and 4). In the univariable analyses, each of the six variables was entered separately. Thereafter, in the multivariable regression analyses gender, age and BMI were added together. Additionally, in the linear regression analysis with FOF as dependent variable, we adjusted for falls (yes/no).

The fits of the linear regressions were checked by graphic presentations of the residuals. Data were analyzed using the IBM SPSS Statistics version 22 (IBM Corporation, Armonk, New York, United States). Significance level was set at $P < .05$.

Results

Of the 81 participants, 43 were men and 38 were women. Their mean age was 67 ± 6 years (range 54 to 80 years), their mean BMI 27 ± 4 (18 to 38) and the mean time since onset of new symptoms was 16 ± 9 years (range 1 to 46 years). A total of 33% lived alone, 20% used a mobility device (such as a cane, a crutch or a rollator) and 21% used an ankle foot orthosis (AFO) when walking. Forty-eight of the participants (59%) reported at least one fall during the past year and 79% experienced moderate or high FOF (>20 points on FES-I).

Differences between fallers and non-fallers

In Table 1, the demographics and clinical characteristics of the fallers and non-fallers are presented. There were no significant differences between the groups regarding demographics, but in clinical characteristics. The fallers had significantly lower knee extensor and knee flexor muscle strength (P=.002) of the more affected limb than the non-fallers and significantly reduced dynamic balance (P<.05) and gait performance (P=.001). The fallers were also significantly more afraid of falling when performing daily activities than the non-fallers (P<.001).

Insert Table 1 about here

Differences with regard to fear of falling

In Table 2, the demographics and clinical characteristics of the participants with low, moderate and high FOF are presented (n=81). There were no significant differences between the three groups in demographics, but for all clinical characteristics (P<.001). Higher FOF was associated with significantly lower muscle strength in the knee extensors and knee flexors in both lower limbs, and significantly more reduced balance and gait performance. The proportion of fallers was also significantly higher among those with higher FOF.

Insert Table 2 about here

Factors associated with falls

In Table 3, the results from the univariable and multivariable logistic regression analyses are presented. Knee muscle strength in the more affected limb was significantly associated with falls. An increase of 10 Nm in knee extensor muscle strength decreased the odds of falling (OR) to 0.83 (95% CI: 0.74 to 0.94; P=.003), and an increase of 10 Nm in knee flexor muscle strength decreased the OR to 0.70 (95% CI: 0.56 to 0.88; P=.002). When we adjusted for gender, age, BMI in the multivariable analyses the results only changed marginally.

A decreased dynamic balance tended to increase the odds of falling, but the association was not significant (P=.07). Gait performance was significantly associated with falls; an increase of 100 meter in 6MWT decreased the OR to 0.41 (95% CI: 0.24 to 0.71; P=.001). When we adjusted for gender, age, BMI in the multivariable analyses for both dynamic balance and gait performance the results only changed marginally.

Insert Table 3 about here

Factors associated with fear of falling

In Table 4, the results from the univariable and multivariable linear regression analyses are presented. Muscle strength in both the more and less affected limbs was significantly associated with FOF. For the more affected limb, an increase of 10 Nm in knee extensor muscle strength decreased the B coefficient to -1.12 (95% CI: -1.55 to -0.70; P=.001), and an increase of 10 Nm in knee flexor muscle strength decreased B to -1.68 (95% CI: -2.49 to -0.87; P=.001). For the less affected limb, an increase of 10 Nm in knee extensor muscle strength decreased B to -1.08 (95% CI: -1.48 to -0.67; P=.001), and an increase of 10 Nm in

knee flexor muscle strength reduced B to -1.90 (95% CI: -2.64 to -1.17; *P*=.001). The knee muscle strength in the more and less affected limb, respectively explained 17% to 25% of the variance in FOF. When we adjusted for falls, gender, age and BMI in the multivariate analyses, the variance increased with 5% to 12% (where falls represented 5% to 11%).

A decreased dynamic balance significantly increased B to 1.44 (95% CI: 0.96 to 1.92; *P*=.001). Dynamic balance explained 30% of the variance in FOF and when we adjusted for falls, gender, age and BMI the variance increased with an additional 6% (where falls represented the increase alone).

Gait performance was also significantly associated with FOF; an increase of 100 meter in 6MWT decreased B to -5.84 (95% CI: -7.39 to -4.29; *P*=.001). Gait performance explained 41% of the variance in FOF. When we adjusted for falls, gender, age and BMI the variance was unchanged.

Insert Table 4 about here

Discussion

This is, to the best of our knowledge, the first study that has determined how knee muscle strength, dynamic balance and gait performance, adjusted for gender, age and BMI, are associated with both falls and FOF in ambulatory persons with late effects of polio. Our hypothesis that these factors are determinants of falls and FOF was partly confirmed. We found that reduced knee muscle strength in the more affected limb and gait performance were determinants of falls, whereas all factors were determinants of FOF.

Falls

More than half of the participants (59%) had experienced falls during the past year, which is in agreement with other studies in persons with late effects of polio [10-14, 16]. When analyzing differences in clinical characteristics between the fallers and the non-fallers, we found that the fallers were more disabled and more afraid of falling compared to the non-fallers (see Table 1). In the logistic regression analyses, reduced knee muscle strength in the more affected limb (both knee extensors and knee flexors) and gait performance were determinants of falls. Somewhat unexpectedly, decreased dynamic balance was not associated and the influence of gender, age, and BMI was very limited. Our findings are partly in agreement with other studies. It has been shown that muscle weakness in the knee extensors in the more affected limb [14] and difficulties to maintain balance [14, 19] are

associated with falls in persons with late effects of polio. However, Bickerstaffe et al [14], did not find that walking ability was a predictor of single nor recurrent falls, and younger age was only associated with recurrent falls. Moreover, Nam et al [16] did not find that balance, knee muscle strength, gender or age were associated with falls. Plausible explanations for the divergent results could be differences in the outcome measures used or in the study populations. However, our result that reduced gait performance is a determinant of falls has been found in elderly non-disabled persons [30] and in persons with other neurological conditions [10, 31, 32].

Fear of falling

A majority of the participants in our study (79%) experienced FOF, which is in agreement with other studies [10, 11, 14, 18]. We found that those with a high FOF had greater disability, and the proportion of fallers was also highest among those with higher FOF (cf Table 2). We have previously described that persons with late effects of polio are most concerned about falling when performing activities related to walking [10]. This is also reported in the study by Bickerstaffe et al [14], who found that the participants had reduced their walking distance because of FOF. Moreover, Legters et al [18] described that their participants were most afraid of falling when being tired (34%) and outdoors (21%).

In our linear regression analyses we found that reduced knee muscle strength in both lower limbs, dynamic balance and gait performance were determinants of FOF. Of the factors included, gait performance had the strongest explanation to the variance in FOF (41%), followed by dynamic balance (30%). Furthermore, not only reduced knee extensor strength but also reduced knee flexor strength was a determinant of FOF, explaining up to 24% of the variance. The multivariable analyses also revealed that experience of falling contributed up to 11% of the variance in FOF, whereas gender, age and BMI influenced the results only marginally. As this is the first study using multivariable analyses to investigate determinants of FOF in persons with late effects of polio, our results are difficult to compare with others. However, in persons with other neurological diseases, such as stroke and Parkinson's disease (PD), decreased balance [33], muscle weakness in the lower limbs [27] and walking limitations [24, 34] have been shown to be associated with FOF.

Clinical implications

Our study contributes with new and important knowledge about factors associated with falls and FOF in persons with late effects of polio. However, our results together with previous

studies raise the question if and how the incidence of falls and FOF can be reduced. As many persons in this population experience falls, are concerned about falling, have osteoporosis and thereby an increased risk for fractures [13], targeted rehabilitation intervention or falls management programs are needed. In elderly persons, there is evidence that individually tailored exercise training and multifactorial interventions (such as reducing home hazards, vision impairment, inappropriate footwear, use of drugs, cognitive impairments and education about risk factors) can reduce falls [17, 35]. Moreover, in persons with stroke [31] and PD [36] task-specific exercise programs aiming to improve balance and walking ability seem to reduce the number of falls. However, much less is known about the effects of interventions to reduce FOF. A Cochrane review in elderly [37] concluded that exercise training may, to some extent, reduce FOF immediately after the intervention, but further studies are warranted to make conclusions about the long-term effects of such interventions.

There are reasons to believe that exercise training and other multifactorial interventions may also reduce the number of falls and FOF in persons with late effects of polio. Focused interventions, such as balance training and strength training for the less affected limb, may be feasible and beneficial for persons that are mildly to moderately affected by their prior polio. In a previous study [38] we showed that knee muscle strength, in particular knee flexor strength, was associated with gait performance (especially the 6MWT) in persons with late effects of polio. Therefore, interventions aiming at maintaining, or even increasing, muscle strength and improving gait performance can potentially decrease the incidence of falls and FOF. However, as falls are of multifactorial nature that can lead to physical and psychosocial consequences, interdisciplinary interventions should also target self-efficacy, activity limitations and participation restrictions as well as environmental factors in order to increase a person's overall functioning and life satisfaction. Future randomized controlled studies should therefore focus on evaluating the effects of a comprehensive interdisciplinary goal-oriented falls management program in persons with late effects of polio, both in a short-term and long-term perspective. Qualitative studies are also warranted to obtain a deeper understanding how the experiences of falls can influence a person's everyday life.

Strengths and Limitations

A strength of the present study is that new determinants of falls and FOF were evaluated for ambulatory persons with late effects of polio. However, as the measurements of knee muscle

strength (knee extension and knee flexion for both lower limbs) as well as dynamic balance and gait performance were highly correlated they could not be included in one regression model. Instead, we had to build different regression models in which the variables were entered separately. The analyses revealed that all variables contributed to falls and FOF to a varying extent and that not only knee extensor strength but also knee flexor strength and gait performance are important to consider in the rehabilitation of these persons. Furthermore, another strength of the present study is that we used reliable outcome measures for the targeted study population. By using the 6MWT, which is shown to be highly correlated with outdoor walking in persons with late effects of polio [39], it may also be possible to estimate if a person has an increased risk for falls 'in real life'. We included a relatively large study population given that the measurements of muscle strength, balance and gait performance are quite time-consuming. However, despite the relatively large sample size, the number of potentially associated factors to falls and FOF had to be limited. Therefore, it cannot be excluded that other factors also may be of importance, for example poor vision, fatigue, reduced self-efficacy, depression, poor concentration, bladder incontinence as well as weakness in other muscle groups in the lower limbs. Moreover, as only ambulatory persons with mild to moderate late effects of polio were included in the study the results cannot be generalized to the entire population of polio survivors.

Conclusion

This study showed that reduced gait performance, knee muscle strength and dynamic balance are, to a varying degree, determinants of falls and fear of falling in ambulatory persons with late effects of polio. Future studies need to evaluate if rehabilitation programs targeting these factors can reduce falls and fear of falling in this population.

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Table 1. Demographics and clinical characteristics of the 81 participants with late effects of polio, divided into fallers and non-fallers.

	Fallers (n=48)	Non-fallers (n=33)	*P*-value
Age: mean years ± SD (range)	67.5 ± 6.0 (56-80)	65.1 ± 7.5 (35-74)	.13
Gender: (men/women), n	22/26	19/14	.30
Body Mass Index: mean ± SD (range)	27.5 ± 4.1 (18-38)	26.0 ± 3.3 (21-35)	.08
Strength measurements (60º/s)			
More affected limb			
Knee extension (Nm): mean ± SD (range)	54.2 ± 37.6 (0-168.5)	84.5 ± 44.4 (0-161.8)	.25
Knee flexion (Nm): mean ± SD (range)	28.4 ± 18.0 (0-61.7)	45.9 ± 26.9 (0-103.2)	.002
Less affected limb			
Knee extension: mean ± SD (range)	98.2 ± 46.1 (5.1-196.5)	109.8 ± 42.8 (23.2-210.5)	.15
Knee flexion: mean ± SD (range)	53.5 ± 25.2 (0.8-131.0)	61.6 ± 24.0 (7.1-112.2)	.002
Dynamic balance			
Timed Up & Go (sec): mean ± SD (range)	11.3 ± 4.3 (6.9-32.8)	9.7 ± 2.2 (7.2-17.9)	.03
Gait performance test			
6-Minute Walk test (m): mean ± SD (range)	396 ± 93 (140-590)	477 ± 103 (250-720)	.001
Fear of falling			
FES-I (points): mean ± SD (range)	30.9 ± 8.8 (18-54)	23.4 ± 8.6 (16-46)	<.001

Fallers= those that reported at least one fall during the last year; Non-fallers= those that did not report any falls during the last year. Continuous variables were analyzed with the independent sample t-test and categorical variables with the Mann-Whitney's U-test test. Nm=Newton meters; sec=seconds; m=meters

Table 2. Demographics and clinical characteristics of the 81 participants with late effects of polio, divided into those with low, moderate or high fear of falling (FOF).

	Low FOF (n=17)	Moderate FOF (n=26)	High FOF (n=38)	*P*-value
Age: mean years ± SD (range)	64.9 ± 8.9 (35-74)	68.0 ± 5.0 (59-78)	66.3 ± 6.5 (54-80)	.66
Gender: (men/women), n	11/6	14/12	16/22	.11
Body Mass Index: mean ± SD (range)	25.7 ± 2.5 (22-30)	26.2 ± 3.9 (18-36)	27.8 ± 4.1 (21-38)	.70
Strength measurements (60º/s)				
More affected limb				
Knee extension (Nm); mean ± SD (range)	100.3 ± 46.7 (11.9- 168.5)	77.4 ± 35.9 (0-139.6)	43.9 ± 32.2 (0- 121.4)	<.001
Knee flexion (Nm); mean ± SD (range)	55.3 ± 29.1 (7.0- 103.2)	37.8 ± 19.2 (0-78.3)	25.1 ± 17.0 (0-63.2)	<.001
Less affected limb				
Knee extension (Nm); mean ± SD (range)	136.9 ± 24.8 (82.0- 210.5)	112.7 ± 41.5 (46.6- 196.5)	81.0 ± 39.7 (5.1- 167.0)	<.001
Knee flexion (Nm); mean ± SD (range)	73.4 ± 22.8 (37.9- 112.2)	63.5 ± 23.9 (31.0-131.0)	44.7 ± 20.5 (0.8- 99.4)	<.001
Dynamic balance				
Timed Up & Go (sec); mean ± SD (range)	8.6 ± 1.4 (6.9- 11.5)	9.9 ± 1.9 (7.5- 17.5)	12.1 ± 4.6 (8.4- 32.8)	<.001
Gait performance test				
6-Minute Walk test (m); mean ± SD (range)	532 ± 88 (376-720)	452 ± 77 (261-590)	368 ± 84 (140- 518)	<.001
Proportion of fallers (%)	18	61	76	<.001

Low FOF= 16-19 points; Moderate FOF= 20-27 points; High FOF= 28-64 points. Nm=Newton meters; sec=seconds; m=meters. Differences between the groups were analyzed with the non-parametric Jonckheere-Terpstra Test.

Table 3. The association between falls, knee muscle strength, dynamic balance and gait performance for the 81 participants with late effects of polio.

Regression model	Unadjusted			Adjusted for gender, age, BMI		
	OR	95% CI	*P*-value	OR	95% CI	*P*-value
1. Strength more affected limb						
Knee extension 60º/s (10 Nm)	0.83	0.74 to 0.94	.003	0.80	0.70 to 0.92	.002
Knee flexion 60º/s (10 Nm)	0.70	0.56 to 0.88	.002	0.66	0.51 to 0.87	.003
2. Strength less affected limb						
Knee extension 60º/s (10 Nm)	0.94	0.85 to 1.04	.25	0.96	0.85 to 1.08	.51
Knee flexion 60º/s (10 Nm)	0.87	0.73 to 1.05	.15	0.92	0.72 to 1.18	.53
3. Dynamic balance						
Timed Up & Go (sec)	1.22	0.98 to 1.51	.07	1.14	0.92 to 1.40	.23
4. Gait performance						
6-Minute Walk test (100 m)	0.41	0.24 to 0.71	.001	0.46	0.26 to 0.82	.009

Results were obtained by univariable and multivariable logistic regression analyses. OR=Odds Ratio; 95% CI= 95% Confidence Interval; BMI= Body Mass Index. Nm= Newton meter. Muscle strength is calculated in intervals of 10 Nm and gait performance in intervals of 100 meter. Nm=Newton meters; sec=seconds; m=meters. An OR above 1.0 indicates an increased likelihood of falling whereas an OR below 1.0 indicates a reduced likelihood of falling.

Table 4. The association between fear of falling (FOF), knee muscle strength, dynamic balance and gait performance for the 81 participants with late effects of polio.

Regression model	FOF Unadjusted				FOF Adjusted for falls, gender, age, BMI			
	B	95% CI	*P*-value	R^2	B	95% CI	*P*-value	R^2
1. Strength more affected limb								
Knee extension 60º/s (10 Nm)	-1.12	-1.55 to -0.70	.001	0.25	-1.07	-1.53 to -0.60	.001	0.32
Knee flexion 60º/s (10 Nm)	-1.68	-2.49 to -0.87	.001	0.17	-1.40	-2.36 to -0.45	.005	0.22
2. Strength less affected limb								
Knee extension 60º/s (10 Nm)	-1.08	-1.48 to -0.67	.001	0.25	-1.12	-1.55 to -0.69	.001	0.36
Knee flexion 60º/s (10 Nm)	-1.90	-2.64 to -1.17	.001	0.24	-2.34	-3.23 to -1.44	.001	0.36
3. Dynamic balance								
Timed Up & Go test (sec)	1.44	0.96 to 1.92	.001	0.30	1.27	0.77 to 1.76	.001	0.36
4. Gait performance								
6-Minute Walk test (100 m)	-5.84	-7.39 to -4.29	.001	0.41	-5.21	-6.98 to -3.45	.001	0.41

Results were obtained by univariable and multivariable linear regression analyses. B= Unstandardized Beta Coefficients; 95% CI= 95% Confidence Interval; BMI= Body Mass Index. Knee muscle strength is calculated in intervals of 10 Nm and gait performance in intervals of 100 meters. Nm=Newton meters; sec=seconds; m=meters