



## Original Research—CME

# Relationship Between Physical Activity, Knee Muscle Strength, and Gait Performance in Persons With Late Effects of Polio

Cecilia Winberg, RPT, MSc, Ulla-Britt Flansbjerg, RPT, PhD,  
James H. Rimmer, PhD, Jan Lexell, MD, PhD

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## Abstract

**Objective:** To examine the relationship between physical activity (assessed subjectively and objectively), knee muscle strength, gait performance, age, gender, and body mass index (BMI) in persons with late effects of polio.

**Design:** Cross-sectional.

**Setting:** A university hospital outpatient clinic.

**Participants:** Seventy-seven community-dwelling ambulant persons with late effects of polio (42 men and 35 women; mean age 67 years [standard deviation 6, range 54-80]).

**Main Outcome Measures:** Physical activity was described by the Physical Activity and Disability Survey and by a pedometer (number of steps/day). Isokinetic concentric knee extensor and flexor muscle strength was measured at 60°/s. Gait performance was assessed by the Timed "Up and Go" test, the Comfortable Gait Speed and Fast Gait Speed tests, and the 6-Minute Walk test.

**Results:** The Physical Activity and Disability Survey leisure subscale was significantly correlated with all knee muscle strength measurements ( $P < .01$ ), the Comfortable Gait Speed test ( $P < .05$ ), and the 6-Minute Walk test ( $P < .05$ ), and the number of steps per day was significantly correlated with all knee muscle strength measurements and all gait performance tests ( $P < .01$ ). In the linear regression analyses, knee muscle strength and gait performance explained 1% to 8% of the variance in the leisure subscale, and when the personal attributes (age, gender, and BMI) were added, they explained up to 14% of the variance. Knee muscle strength explained 16% and gait performance explained 15% to 31% of the variance in the number of steps per day, and when personal attributes (age, gender, and BMI) were added, they contributed at most an additional 3% of the variance.

**Conclusions:** In ambulatory persons with late effects of polio, knee muscle strength and gait performance explain only a small portion of physical activity. Further studies are needed to increase our understanding of how other impairments, activity limitations, environmental factors, and personal factors are associated with physical activity in persons with late effects of polio.

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## Introduction

Physical activity (PA) is equally beneficial for people with or without disability [1]. Regular PA promotes overall health, can be used to prevent and treat various diseases, and contributes to maintenance of functional independence, general well-being, and life satisfaction [2-4]. Despite this knowledge, about one third of the adult population does not attain public health guidelines of at least 150 minutes per week [4], and activity levels are even lower in older adults and in persons with disabilities [5]. Adults with disabilities are twice as likely to be physically inactive compared with persons who have no disability [6]. Health status and personal factors, such as self-efficacy, mood, and motivational readiness, as well as age, gender, income, education,

and cost of and access to facilities, are associated with PA in both disabled and nondisabled persons [3,7], but the evidence on determinants of PA participation is inconclusive for persons with disabilities [1,8]. One key to an effective health promotion program for persons with disabilities is to understand the diversity of factors that are associated with successful participation in PA [3,9].

Late effects of polio is a neurologic condition leading to a lifelong disability. This condition can occur several decades after an acute poliomyelitis infection and is characterized by new symptoms or impairments such as muscle weakness and muscle fatigue [10,11]. These impairments can lead to activity limitations [12], many of which are related to gait performance [13]. Activity limitations, in turn, can have an impact on perceived

participation [14], as defined by the International Classification of Functioning, Disability and Health [15], and also on life satisfaction [16]. Late effects of polio have a slowly progressive course [11]. Management comprises an interdisciplinary goal-oriented approach to reduce disability and encourage a healthy and active lifestyle [11,17]. Many persons with late effects of polio have difficulty or are unable to increase the amount of exercise necessary to achieve desired levels of moderate PA because of their impairments and activity limitations. This lack of sufficient exercise may affect their overall physical and psychological health, life satisfaction, and bone and muscle mass. It also may increase the risk for falls and fractures, as well as chronic diseases such as cardiovascular and metabolic conditions, many of which are common among middle-aged and older people. Therefore, it is necessary to adapt and individualize health promotion programs for this population, which requires an understanding of how their impairments and activity limitations affect their rates of PA participation.

Late effects of polio is characterized by different impairments and activity limitations. Among them, muscle weakness is very commonly reported [18], and activities related to the ability to ambulate are most often reported as being difficult to perform by persons with late effects of polio [13]. Thus both muscle strength and gait performance could be related to PA participation in persons with late effects of polio, as is the case in persons with stroke, multiple sclerosis, and spinal cord injury [8,19,20]. In persons with late effects of polio, muscle weakness in the lower limbs is one of the most common impairments, and knee muscle strength, in particular, is a predictor for gait performance in this population [21]. However, only 2 studies have assessed the associations between PA and muscle strength in this population [22,23]; greater muscle strength was associated with higher activity levels [22] and daily step counts [23]. To the best of our knowledge, no study has assessed the relationship between PA and gait performance in persons with late effects of polio. Age, gender, and body mass index (BMI) are associated with rates of PA [7] in persons with disabilities and therefore should also be included in any research model examining variables associated with PA participation.

The aim of this study was to assess the relationship between PA (assessed subjectively and objectively), knee muscle strength, gait performance, age, gender, and BMI in persons with late effects of polio.

## Methods

### Participants

Community-dwelling ambulatory persons with mild to moderate late effects of polio were selected from the

database at a post-polio rehabilitation clinic in a university hospital. The database has existed since 2003, and at the time of recruitment (January 2012), it included 300 persons (130 men and 170 women) with a confirmed history of acute poliomyelitis who met the following inclusion criteria: 50 to 80 years of age; new symptoms after a period of functional stability; an electromyogram in the upper and lower limbs as verification of prior polio; ambulatory with or without mobility devices; living in standard housing; able to understand verbal and written instructions in Swedish; and being able to walk at least 300 m with or without mobility devices and/or orthotics. Exclusion criteria were the presence of other conditions such as severe joint problems, cardiovascular or pulmonary diseases, or respiratory insufficiency due to late effects of polio that could affect mobility and PA and using a wheelchair as the main mode of transportation. A total of 300 persons matched these inclusion and exclusion criteria. Based on our own previous studies in this population, we anticipated a response rate of at least 70%. We then randomly selected and invited 102 persons to participate in the present study, and 77 persons (42 men and 35 women) accepted the invitation (response rate, 76%). This sample size would allow a sufficient number of independent variables, consistent with the recommendations of 10 persons per variable [24]. There was no significant difference regarding age between the 77 participants and the 25 nonparticipants and the other 198 eligible persons, respectively.

Following the National Rehabilitation Hospital Post-Polio Limb Classification [25] and the individuals' own perception of their post-polio condition, one lower limb was defined as "more affected" and the other as "less affected." Prior to testing, all participants were medically checked by the responsible physician.

Before inclusion, oral and written information about the purpose of the study was provided and each participant provided written informed consent. The Regional Ethical Review Board in Lund, Sweden, approved the study (Dnr 2013/427).

### Assessments

#### Physical Activity

PA was measured with the Swedish version of the Physical Activity and Disability Survey (PADS-S) [26] and a pedometer (Yamax SW 200, Tokyo, Japan).

The PADS is a 31-item self-report questionnaire developed to provide a measure of the day-to-day level of PA in people with disabilities [27]. The original PADS has shown good psychometric properties [27,28] and has been used in populations with disabilities such as multiple sclerosis, arthritis, and stroke [28-30]. In the present study, the participants were asked about their PA behavior in the following 4 subscales: (1) structured exercise (ie, exercising at a specific time of day on a

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