Lifestyle and late effects after poliomyelitis. A risk factor study of two populations.


Background – Patients with polio often experience new symptoms (muscle weakness, pain, fatigue and respiratory problems) many years after the acute disease. This study examined possible interactions between lifestyle factors (overweight, physical inactivity, smoking) and late polio with new symptoms. Methods – A total of 148 patients hospitalized for acute polio in 1950–1954 at Haukeland University Hospital, Norway and 128 patients, hospitalized for acute polio in 1958 at Tartu University Hospital, Estonia responded to a mailed questionnaire regarding lifestyle and late polio with new symptoms. Multiple regression analysis, two samples t-test and chi-square analysis were undertaken. Results – Mean body mass index (BMI) and percentage of smokers did not differ in the two cohorts, while polio patients were physically less active in Estonia. The physically active patients in both cohorts had significantly lower odds for experiencing polio-related late muscle pain (OR = 0.21; 95% CI = 0.08–0.55) and fatigue (OR = 0.32; 95% CI = 0.14–0.75). With increasing age the patients had significantly higher odds for experiencing new muscle weakness (OR = 1.03; 95% CI = 1.00–1.07), fatigue (OR = 1.04; 95% CI = 1.01–1.07) and breath shortness (OR = 1.04; 95% CI = 1.00–1.07). Conclusion – Physically inactive patients are at a higher risk for late polio-related symptoms. An active lifestyle should be recommended for patients with polio sequels.

Poliomyelitis (polio) was a common disease until the introduction of vaccination in the 1950s. Before the vaccination era, the disease occurred in epidemics worldwide resulting in millions of patients with significant functional limitations. At the turn of the new century, the eradication of polio is one of the main tasks for WHO. The number of patients contracting polio has declined rapidly and is today below 1000 registered annual cases (1).

The patients who suffered from acute polio now experience new manifestations many years after the acute disease and after long lasting stable health (2–6). Such symptoms include progressive muscle weakness with or without increasing atrophy, generalized fatigue, joint and muscle pain, sometimes respiratory insufficiency and dysphagia. The exact pathogenesis of the late polio with new manifestations is unknown, but hypotheses about ongoing motor neuron degeneration combined with the normal aging process and motor neuron overuse are prevailing. An immune-mediated destructive process and also persistent poliovirus infection has been suggested, but is less likely (7–9). Clinical trials with immunosuppressive and antiviral substances that influence these processes have been negative (10, 11). As there so far is no cure for late polio deterioration, the search for preventive measures should be an interest in research.

There are few epidemiological studies on risk factors that influence the development of late polio with new symptoms. However, lifestyle changes are often recommended because beneficial effects of exercise programs and weight loss on the late polio with new symptoms have been reported (12–15). We have examined lifestyle factors that may influence the development of new symptoms many years after the acute polio based on comparative data from two cohorts; 276 polio patients
either from the epidemics in Norway or a 1958 epidemic in Estonia. Population studies have revealed several differences on lifestyle in the Baltic countries compared with Western Europe (16–18), differences that may negatively influence health status. We investigated the occurrence of overweight, physical inactivity and smoking among patients with polio in Estonia and Norway and the impact of these factors on development of new symptoms in the late course of polio.

Methods

Patients

Based on information from the patient files from 1950–1954, data for 243 patients hospitalized with acute polio at Haukeland University Hospital, Norway and for 334 patients hospitalized in 1958 at Tartu University Hospital, Estonia were found. In 1998, 371 of these patients (175 Norwegians and 196 Estonians) were alive and possible to identify. All these patients were contacted and one reminder was mailed to the non-responders. A total of 276 (74.4%) of them answered the questionnaire; 65.3% in Estonia and 84.6% in Norway. Thus, 148 Norwegian and 128 Estonian patients were examined (19). More Estonian than Norwegian patients had only transitory findings in the acute phase; 63 with transitory acute findings and 44 with persistent paresis compared to 84 patients with transitory acute findings and 85 with persistent paresis in Norway ($P < 0.001$). The transitory group consisted of patients hospitalized with aseptic meningitis from a geographic area with known recent paralytic cases and/or with peripheral paresis, apparently completely recovered at discharge from hospital.

Questionnaire

All patients were examined by an extensive questionnaire. The late polio symptoms were defined according to Halstead and Rossi (3). The questionnaire aimed to identify development of new muscular weakness, muscle pain, general fatigue, and breath shortness in recent years (yes/no response), and with registration of the year when the symptom first occurred. Information about non-polio diseases (cardiovascular, rheumatologic, respiratory, neurological and childhood diseases) were registered as described before (20). The occupational status (employed, unemployed, disability or age pensions) and the use of assistive devices was registered.

For calculation of the body mass index (BMI), height and weight were recorded. BMI was registered both as a continuous variable and grouped in four categories; $<18.5$ kg/m$^2$ regarded as underweight, 18.5–24.9 as normal, 25–29.9 as overweight, and $\geq30$ as obese (21). Data about physical exercise at leisure were recorded in three categories: 1) never: no physical exercise at leisure; 2) intermittently: occasional exercise; 3) regularly: at least weekly exercise at leisure. Data for current daily smoking (yes/no) were collected.

Patient’s age in 1998 was registered as a continuous variable and gender as a categorical variable.

Statistical analysis

The two samples $t$-test was applied when comparing mean values of continuous variables. Chi-square analysis and Fishers test were performed for analysis of categorical variables.

The odds for new late symptoms were calculated in a multiple logistic regression analysis for each potential risk factor of interest; BMI (continuous variable), smoking and exercise. Adjustment was made for gender, age, and persistent paresis vs acute transitory findings. In addition, the data were adjusted for reported respiratory, cardiovascular, neurological and rheumatologic diseases and for country (Norway vs Estonia). To examine whether the relative difference in odds for a particular symptom between the two populations differed because of variation in amount of physical activity, an interaction term was included in the statistical model.

Ethics

The regional ethical committees in both countries approved the study.

Results

Compared with Norwegian patients those from Estonia differed by higher percentages of transitory acute findings and unemployment (Table 1). About 30% of Estonian patients and 17% of Norwegian patients received disability pensions ($P < 0.0001$) as reported before (19). The distribution of various professions among the polio patients were similar with the largest group (35% of Norwegian and 39% of Estonian patients) employed in trade and office. Twenty-six Norwegian and 28 Estonian patients used orthopaedic devices; six Norwegians and eight Estonians used wheelchair and four Norwegians and ten Estonians.
had an orthosis. Thirteen Norwegian and 13 Estonian patients reported use of walking aid. None of the patients used assisted ventilation or lived in institutions.

New muscle pain was reported more frequently by Norwegian than Estonian patients; 49% vs 35% (P = 0.02) (Table 2). Otherwise the occurrence of late symptoms did not differ in the two populations. The most frequent new symptom was muscle weakness. Mean age at developing new late symptoms was 42–46 years, whereas the age range for first developing such symptoms was as wide as 14–87 years.

Nearly half of all patients (49%) reported physical inactivity at leisure; in Norway less (40%) than in Estonia (59%) (Table 1). Only six Estonian patients (5%) reported regular physical exercise at leisure whereas 28 (19%) Norwegians exercised regularly (P < 0.001). Physically active patients were similarly distributed between the groups with transitory findings and persistent paresis and between males and females. The physically active patients in both countries had significantly lower odds for new muscle pain (P < 0.05) and general fatigue (P < 0.001) when compared with the groups with no and intermittent activity (Table 3). There were few observations in the group with regular physical activity; the confidence intervals were wide and not statistically significant.

The mean BMI did not differ between the two populations; 24.7 (SD ± 4.4) for the Norwegian and 24.9 (SD ± 5.0) for the Estonian patients. Four Norwegians (3%) and seven Estonians (6%) were underweight (Table 1). The distribution of BMI was similar among patients with persistent paresis and transitory findings in both countries. More men than women were overweight (BMI between 25 and 30) (41% vs 26%) whereas obesity was equally distributed between genders; 9% of men and 11% of women. The occurrence of new late muscle weakness and new muscle pain did not differ among patients with low, normal, high or very high BMI nor did they differ in a separate analysis for each country. However, the patients with high BMI were more likely to experience breath shortness (P < 0.001; Table 3).

Twenty-nine percentage of all patients were daily smokers; 34% of Norwegians and 24% of Estonians, with no difference between the patients with transitory and persistent paresis. Fewer women than men smoked (25% vs 35%; P = 0.03). No effect of smoking on new late symptoms was observed (Table 3).

There was no gender difference for odds for experiencing new muscle weakness, muscle pain and fatigue, but the OR for experiencing new breath shortness was significantly higher for women than men (P < 0.005; Table 3). The OR for experiencing new muscle weakness (P < 0.001), generalized fatigue (P < 0.001) and breath shortness (P < 0.01) increased with increasing age. Persistent paresis increased significantly the odds for experiencing new weakness (OR = 3.16; 95% CI = 1.78–5.61), muscle pain (OR = 2.11; 95% CI = 1.20–3.70) and generalized fatigue (OR = 2.45; 95% CI = 1.37–4.38). Non-polio disease did not influence new late symptoms, except rheumatological diseases, which increased the odds ratio for breath shortness (OR 2.60; 95% CI = 1.06–6.46).

**Discussion**

New polio-related symptoms occurred frequently in patients with previous polio both in Estonia and Norway. This deterioration occurred for the
first time usually between 40 and 50 years of age in both populations, but with wide variation and was reported even before the age of 20 years. The differences in social and medical conditions in Estonia and Norway both in general and regarding polio rehabilitation do not seem to have influenced late polio with new symptoms (19). Previous studies have reported a frequency in range from 28 to 64% for the new symptoms related to prior poliomyelitis (6, 9, 22), in line with our data.

Physical activity and training at leisure differed among Estonian and Norwegian patients. A previous study on the Norwegian general population has demonstrated that 15% of the women and 14% of the men were physically inactive (23). A similar study on the Baltic general population showed that 43% of Estonians participated only in sedentary activities during their leisure time (18). Our findings mirror the general differences in the physical activity between two countries. However, this difference did not result in less new symptoms in the late course of polio in the Norwegian patients or a later debut of such complications. Physical activity and training at leisure differed among Estonian and Norwegian patients. A previous study on the Norwegian general population has demonstrated that 15% of the women and 14% of the men were physically inactive (23). A similar study on the Baltic general population showed that 43% of Estonians participated only in sedentary activities during their leisure time (18). Our findings mirror the general differences in the physical activity between two countries. However, this difference did not result in less new symptoms in the late course of polio in the Norwegian patients or a later debut of such complications. Thus, our findings do not support the previously published hypothesis that physical activity counteracts late polio symptoms (14, 24). However, the more sedate patients in both countries experienced more pain and fatigue. The cause–effect relationship is not clear as new symptoms may force patients to physical inactivity. Low muscle strength in overexerted muscle is not suitable for physical exercise. However, the exercise may result in better physical performance in motor units that are not much affected in size after polio. The symptoms because of muscle weakness may be reduced in this subpopulation. Further clinical studies are needed for exploring the causes of frequent late symptoms in inactive patients.

Weight reduction has been recommended as a preventive measure to avoid development of late polio symptoms (9). One-third of the patients in the present study were overweight with no difference between Estonian and Norwegian patients. The patients with high BMI complained of new breath shortness, but new muscle weakness, pain and fatigue did not correlate with BMI. Our study could not confirm overweight as a risk factor for new late polio symptoms, in contrast with the results of a previous study (25). However, the statistical power of our study was rather low with wide confidence intervals and therefore larger cohort studies are needed to confirm our negative findings.

The risk analysis did not reveal any connection between smoking and new late polio symptoms, and smoking does, therefore, not seem to be a major factor for the late polio-related respiratory deterioration, as has been suggested previously (9). The percentage of smokers among Estonian and Norwegian patients was similar to the national average (26).

Both Estonian and Norwegian polio patients frequently reported late muscle weakness, fatigue and breathe shortness with increasing age. The role of age for late polio deterioration has been debated (7, 27). One theory explaining new progression many years after acute polio implies a slow ongoing motor neuron dropout because of the combination of previous neuronal damage and normal aging (28, 29). Thus, new deterioration should be expected to increase with age. Stålberg with coworkers demonstrated that motor neuron loss increases with age in polio patients and more than in normal aging (30). This is supported by an epidemiological study that demonstrated age as a risk factor (6). However, some of our patients reported new symptoms already in their teens. The

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Possible risk factors for new late symptoms of polio expressed as odds ratios (OR)*</th>
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<tbody>
<tr>
<td></td>
<td>Muscle weakness OR (95% CI)</td>
</tr>
<tr>
<td>BMI (per kg/m²)</td>
<td>1.00 (0.93–1.07)</td>
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<tr>
<td>Physical exercise</td>
<td></td>
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<tr>
<td>Never</td>
<td>1.00</td>
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<tr>
<td>Intermittently</td>
<td>1.29 (0.57–2.92)</td>
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<tr>
<td>Regularly</td>
<td>0.64 (0.10–4.18)</td>
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<tr>
<td>Smoking status</td>
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<tr>
<td>No</td>
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<tr>
<td>Yes</td>
<td>0.93 (0.50–1.74)</td>
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<tr>
<td>Age (per year)</td>
<td>1.03 (1.00–1.07)</td>
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<tr>
<td>Gender</td>
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</tr>
<tr>
<td>Male</td>
<td>1.00</td>
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<tr>
<td>Female</td>
<td>1.59 (0.91–2.77)</td>
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</tbody>
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* Based on multiple logistic regression analysis adjusted for cardiovascular, respiratory, rheumatological and neurological diseases, residency (Norway/Estonia), and transitory vs persistent findings.
physiological age-related motor neuron loss emerges in the third decade of life with approximately 1% annual loss of motor neurons (31). Uncompensated muscle weakness does not develop until at least 30% of motor neurons have been lost. Thus, the aging alone cannot explain the new polio-related late symptoms.

A previous study stated female sex as a risk factor for new late polio effects (22). Less well defined fatigue syndromes such as post-viral fatigue and whiplash injuries occur more frequently in women (32, 33). This study shows that this is not true for fatigue and pain after polio. However, women had higher odds for experiencing new breath shortness. Breath shortness is unspecific and an uncommon symptom (9). Several previous studies are in line with ours showing no gender factor for post-polio symptoms (6, 25).

Coexisting rheumatologic disorders, rheumatoid arthritis in particular, influenced the reporting of late polio symptoms. This finding illustrates that many of the late polio symptoms are unspecific. Studies on late polio effects should always include information about other diagnoses that may explain the symptoms reported by the patients.

In conclusion, this study shows that physical inactive patients are at considerably higher risk for late polio-related symptoms. An active lifestyle should be recommended for patients with polio sequels.

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References
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