



## Scientific Review

### Fatigue in polio survivors

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**Objectives:** Fatigue is commonly reported among polio survivors. The aims of the present study were to examine the incidence of perceived fatigue among a sample of Norwegian polio survivors, and to examine the association between the level of fatigue and sociodemographic and health variables.

**Materials and methods:** A mailed questionnaire containing, among others, Fatigue Questionnaire, Fatigue Severity Scale, sociodemographic and health variables were sent to a representative group of 312 Norwegian polio survivors. 276 subjects (88%) answered the questionnaire.

**Results:** The incidence of fatigue among the polio survivors were considerably higher than in the normative data. Physical fatigue, more than mental fatigue, represented the major problems. Polio subjects who reported severe fatigue had significantly more other diseases and health problems than the normative group.

**Conclusions:** The diagnosis and treatment of other or related physical conditions should be given higher priority in the management of persons with late effects of poliomyelitis, as these conditions probably can be the reasons for fatigue more than poliomyelitis sequelae alone.

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#### Introduction

Fatigue is a nonspecific symptom and is commonly reported (15% to 20%) in the general population.<sup>1</sup> Fatigue may accompany physical diseases such as anemia, chronic infection, diabetes, cancer and cardiac diseases, use of various medications such as antihistamines and beta-blockers, and the occurrence of psychiatric illnesses such as depression, and sleep disorders. Fatigue is also a common symptom reported among persons suffering from late effects of polio.

The polio epidemics were among the greatest threats to life and health during the first half of this century. The estimated incidence of death was 10 cases per 100 000 inhabitants per year.<sup>2</sup> The clinical features of the late effect of poliomyelitis have been recognized since mid 1980s, and a number of different terms have been used to describe the condition; post polio syndrome (PPS), post polio muscular atrophy (PPMA) and post polio muscle dysfunction (PPMD).<sup>3</sup> The term PPS is most commonly used. Accepted criteria to identify the post polio syndrome include a prior history of paralytic poliomyelitis; a

period of neurologic recovery followed by an extended interval of neurological and functional stability preceding the onset of new problems; a gradual or abrupt onset of new symptoms in previously affected and/or unaffected muscles, which may or may not be accompanied by other health problems such as excessive fatigue, muscle pain, joint pain, decreased endurance, decreased function, and arthropathy; and exclusion of medical, orthopedic, and neurologic conditions that might cause the health problems listed above.<sup>4</sup> The definition of PPS acknowledges that fatigue and muscle pain are present in the syndrome, but that these features do not need to be present to meet the criteria for the syndrome.<sup>5</sup> On average, the PPS appears 30–40 years after the acute onset.<sup>3</sup> The prevalence rates of the PPS vary considerably in the literature (15% to 85%), but there is more agreement on the pathophysiology of PPS. The evidence would indicate that polio survivors have a diminished motor neuron pool, that the surviving motor neurons are performing at an increasing capacity, and that some of these motor neurons may have suffered initial injury. The main theory is that the PPS is a result of an overload of motor units with regression of terminal nerves, and muscle weakness as a consequence.<sup>3</sup>

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In former studies conducted on the late effects of polio, new fatigue is reported in 34% to 91% of cases.<sup>4</sup> Among polio survivors, fatigue is described as an increasing loss of strength during exercise, such as overwhelming exhaustion, or flu-like aching accompanied by a marked change in the level of energy, endurance and sometimes mental alertness.<sup>4</sup> It is possible that the post polio individual, in responding to questions about fatigue, interprets fatigue to mean one or a combination of the following: emotional fatigue, central nervous system fatigue, 'general fatigue', and/or peripheral neuromuscular fatigue.<sup>6</sup> Post polio fatigue can be both transitory and persistent, as lifestyle changes, resting periods and assistive devices may reduce fatigue. Fatigue lasting all day is atypical for the PPS and warrants further medical examination.<sup>4</sup> Further, fatigue is often mixed with new weaknesses and vice versa [op.cit].

Bruno *et al*<sup>7</sup> suggested that polio survivors differentiate between physical tiredness, that they associate fatigue with new muscle weakness and decreased physical endurance, and 'brain fatigue', ie problems with attention and concentration. The same group claim that Type A behaviors (being competent, hard-driving and time-conscious over-achievers) are associated with fatigue and cognitive problems in polio survivors.<sup>8,9</sup> Bruno and colleagues have suggested that mental post polio fatigue is caused by poliovirus-induced damage to the neurons of the reticular activation system (RAS), referring to post-mortem histopathology from nearly 50 years ago where brain stem centers were found to be 'involved in even mild cases' of polio.<sup>7,10</sup> In a recent MRI study hyperintensive signals in the reticular formation, putamen, medial lemniscus or white matter tracts were found in eight out of 15 polio survivors who reported severe fatigue, but not in any of the subjects who reported no or little fatigue.<sup>7</sup>

Mental fatigue has received little attention in neuropsychological research.<sup>11</sup> Studies on post polio subjects assessing cognitive functions with neuropsychological tests are few and have given divergent results.<sup>12,13</sup> In a review article, Grafman *et al*.<sup>14</sup> stated that almost all neuropsychological studies in this field suffered from significant methodological weaknesses, such as extremely small samples and/or biased subject samples, inappropriate controls, lack of control on non-PPS variables (eg other medical conditions), and/or limited cognitive testing.

Although fatigue is a common symptom reported among polio survivors, most studies conducted have not used controls, validated fatigue scales or screened for co-morbidities that also could induce fatigue. In one study, however,<sup>12</sup> exclusion criteria were established to eliminate subjects whose fatigue could have been caused by factors other than PPS, leading to an exclusion of 73% of the cases. Out of the 38 remaining volunteers, only three out of six who reported 'severe fatigue', and three out of 16 reporting 'no fatigue' or 'mild fatigue' agreed to be studied, leading to a small

sample of six subjects. Three studies on fatigue in polio survivors have used the Fatigue Severity Scale (FSS).<sup>15-18</sup> One of these studies also used the Sickness Impact Profile (SIP),<sup>19</sup> containing the subscale Alertness Behaviour (AB), assessing concentration and attention, and the subscale Sleep and Rest (SR), assessing physical fatigue.<sup>18</sup> All three studies found elevated scores in post polio survivors compared to normal controls, but the number of subjects were small; 12, 28 and 63 persons, respectively.

The aims of the present study were, firstly, to examine the incidence of perceived fatigue among a sample of Norwegian polio survivors by using validated fatigue scales, and, secondly, to examine the association between the level of fatigue and sociodemographic and health variables, especially focusing on subjects with low and high perceived fatigue, respectively.

## Material and methods

### *Material and data collection*

All registered members in Oslo of the National Society for Polio Survivors, a branch of the Norwegian Association of the Disabled, a total of 349 persons, received a mailed questionnaire in May 1999. There were 312 polio survivors among these 349 members. The response rate was 77% (240 subjects) after the first mailing, and, after a written reminder sent to all non-responders in June 1999, the response rate became 88% (276 subjects). Some questionnaires were returned with items missing. In these cases, the responders were either phoned or mailed, and the missing items completed. We could have chosen our own matched control group, but since a Norwegian population study on fatigue was recently published,<sup>20</sup> we chose this material as a comparison.

### *Measures*

For comparative reasons, many of the measures from the recently published study on fatigue in the Norwegian population<sup>20</sup> were included in the present investigation, such as the Fatigue Questionnaire (FQ), the health variables and the sociodemographic items. In addition, the questionnaire in the present study consisted of other measures of fatigue and polio-related data.

*Sociodemographic items* The questionnaire included items on age and gender, marital status, occupational status and education.

*Health variables* The questionnaire included items on past and current diseases (five items) and current health problems (eight items). Past or current diseases included hypertension, myocardial infarction, heart failure, cancer and diabetes. Current health problems included chronic allergy, arthritis, low back pain, visual

impairment, chronic skin problems, chronic lung problems, deafness or hearing problems, and other health problems. Based on the answers, identical with the study by Loge *et al.*,<sup>20</sup> the sample was divided into four (1=no disease or current health problems, 2=disease but no current health problems, 3=no disease but current health problems, 4=disease and current health problems). In addition, we asked for functional impairments due to polio; in upper and lower extremities, back, abdomen and respiration.

*Fatigue Questionnaire* (FQ) was originally developed for a hospital study of Chronic Fatigue Syndrome,<sup>21,22</sup> and was later refined in a validation study.<sup>23</sup> The FQ measures fatigue specifically and the questionnaire is intended for the detection of fatigue cases in epidemiological studies.<sup>23,24</sup> The FQ asks for fatigue symptoms experienced during the last months compared with how the subject felt when last feeling well. The responses are 'less than usual', 'same as usual/not more than usual', 'more than usual' and 'much more than usual'. The 11 items measure physical and mental features of fatigue. Additionally, two items ask for the duration and extent of fatigue. According to the study by Loge *et al.*, the responses were scored on both Likert (0, 1, 2, 3) and dichotomized (0, 0, 1, 1) scales. Based on the results from the validation study, 'substantial fatigue' was defined by total dichotomized scores of  $\geq 4$ , and fatigue 'caseness' was defined by total dichotomized scores of  $\geq 4$  and a duration of  $> 6$  months.<sup>23</sup> The FQ measures Total Fatigue (TF, all items, maximum score 33), with two underlying constructs Physical Fatigue (PF, seven items, maximum score 21) and Mental Fatigue (MF, four items, maximum score 12).

*Fatigue Severity Scale* (FSS) was originally designed to measure fatigue experienced by persons with sclerosis multiplex,<sup>15</sup> including a list of nine statements assessing perceived fatigue. Each statement (eg 'I am easily fatigued') is rated on a scale from 1='strong disagreement' to 7='strong agreement'. The individual score is the mean of the numerical responses to the nine statements, ie a maximum score of 7 can be achieved. By a mistake, only 8 of the 9 items were used in our questionnaire, ie the question 'fatigue interferes with carrying out certain duties and responsibilities' was missing.

*Sickness Impact Profile* (SIP) is a behavior-based self-assessment of function in activities of daily living.<sup>19,25</sup> The 136 items are grouped into 12 subscales, and an Overall Dysfunction score is calculated. Three subscales are also aggregated into a Physical Dysfunction score, and four into a Psychosocial Dysfunction score. In this study, only the two subscales AB (cognitive problems) and SR (physical fatigue), were used. Scores are calculated in percent, with a maximum score of 100 for both scales, indicating maximum perceived fatigue.

*The SF-36 Short-Form Health Survey* (SF-36) is constructed to produce a brief general measure of health status in general population surveys, in clinical research, in daily clinical practice, and other applications in various populations.<sup>26</sup> The 36 items are grouped into different eight multi-item scales measuring physical functioning, role limitations due to physical problems, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health. In this study, only the items covering Vitality were used (ie question 9 a (Pep/Life), 9 e (Energy), 9 g (Worn out) and 9 i (Tired)). The sum score is the mean of the numerical responses to the four statements, with a maximum score of 6, indicating lowest vitality.

#### *Statistical analysis*

Data are presented with means and standard deviations. Group comparisons were analysed using chi-square, Student's *t*-test for independent samples, and ANOVA's with Scheffé *post hoc* pairwise group comparisons. Associations between variables were analysed by means of Pearsons and Spearman correlation analyses, multiple classification analysis and Point-biserial correlation. Level of significance were set at the 0.05 level. All statistical analyses were performed using SPSS for Windows, version 7.0. The study was approved by the Regional Committee for Medical Ethics in Norway.

## **Results**

#### *Demographic characteristics*

The demographic characteristics of the responders are presented in Table 1, compared with normative data. The 36 out of 312 persons who did not return the questionnaire, had the same gender and age distribution as the participants. The study group were older than the normative population and consisted of a larger population of women.

As to sex differences among polio survivors, the women were older than the men (mean 60 years, SD=10, among women, *versus* 57 years, SD=10, among men,  $P=0.01$ ), while the men reported longer duration of education than the women ( $P=0.004$ ). There were also differences in marital status, mainly because more women than men were widows/widowers (16 *versus* 3%,  $P=0.02$ ). A larger proportion of women had disablement benefit (52 *versus* 45%) or old age pension (27 *versus* 16%,  $P=0.003$ ).

#### *Medical characteristics*

Medical characteristics are presented in Table 2, compared with health condition in the normative data by Loge *et al.*<sup>20</sup> Polio survivors had more diseases and current health problems in addition to their polio than the normal population.

**Table 1** Characteristics of polio respondents ( $n=276$ ) compared to normative data from the Norwegian population<sup>a</sup>

	<i>Polio survivors</i> ( $n=276$ )	<i>Normative data</i> ( $n=2323$ )
Age (yrs) [mean (SD) range]	59 (10) 24–86	50 (17) 19–80
Age groups [ $n$ (%)]		
$\leq 29$ years	2 (1)	510 (22)
30–39 years	5 (2)	487 (21)
40–49 years	26 (9)	446 (19)
50–59 years	121 (44)	363 (16)
$\geq 60$ years	122 (44)	517 (22)
Gender [ $n$ (%)]		
Female	200 (72)	1192 (51)
Male	76 (28)	1131 (49)
Marital status [ $n$ (%)] <sup>b</sup>		
Single	48 (17)	473 (20)
Married/cohabitant	146 (53)	1609 (70)
Separated/divorced	33 (12)	117 (5)
Widow/widower	49 (18)	115 (5)
Educational status [ $n$ (%)] <sup>c</sup>		
Second level, first stage (lower)	76 (28)	621 (27)
Second level, second stage (medium)	107 (39)	1036 (45)
Third level (university)	93 (34)	643 (28)
Work/source of income [ $n$ (%)] <sup>d</sup>		
Paying job	56 (20)	1308 (57)
Self-employed	5 (2)	190 (8)
Whole time at home	4 (1)	99 (4)
Studying or in military service	7 (3)	179 (8)
Unemployed	1 (0.4)	54 (2)
Disablement benefit	138 (50)	157 (7)
Old-age pension	65 (24)	232 (14)

<sup>a</sup>Loge *et al* 1998.<sup>20</sup>; <sup>b</sup>Missing normative data = 9 (0.4%); <sup>c</sup>Missing normative data = 23 (1%); <sup>d</sup>Missing normative data = 13 (0.6%)

As to sex differences in the study group, a higher percentage of men than women had diabetes (10.5 *versus* 2.5%,  $P < 0.005$ ) and chronic skin problems (22.4 *versus* 12.5%,  $P = 0.04$ ), but more women (25.0%) than men (11.8%) suffered from chronic allergy ( $P = 0.02$ ). More female polio survivors than male used analgetics and sleep medication regularly (17.5 *versus* 3.9%,  $P = < 0.01$ , 12.0 *versus* 1.3%,  $P = 0.01$ , respectively).

### Fatigue

Table 3 presents data on fatigue in the study group compared to the normative data. The study group were significantly more fatigued on all measures ( $P < 0.001$ ), but large standard deviations must be considered. The difference in mean score on Mental Fatigue between polio survivors and the Norwegian population was not clinically significant (4.9 in the polio group *versus* 4.3 in the normative group). Regarding sex differences among polio survivors, no significant differences were found

**Table 2** Medical characteristics of polio respondents ( $n=276$ ). Disease and health problems are compared to normative data in the Norwegian population<sup>a</sup>

	<i>Polio survivors</i> ( $n=276$ )	<i>Normative data</i> ( $n=2323$ )
Age at polio onset <sup>b</sup> (yrs) [mean (SD)]	8.4 (7.8)	
Years since polio onset <sup>b</sup> (yrs) [mean (SD)]	51.1 (8.0)	
Body parts affected by polio [ $n$ (%)]		
Right arm	88 (32)	
Left arm	92 (33)	
Right leg	185 (67)	
Left leg	170 (62)	
Back and abdomen	153 (55)	
Respiratory muscles	65 (24)	
Health condition [ $n$ (%)]		
No disease/current health problem	47 (17)	876 (38)
Past or current disease	27 (10)	191 (8)
Current health problem only	111 (41)	862 (37)
Disease and current health problem	90 (33)	384 (17)
Diseases [ $n$ (%)]		
Hypertension	81 (29)	384 (17)
Cardiac failure	19 (7)	119 (5)
Cardiac infarction	17 (6)	67 (3)
Cancer	22 (8)	100 (4)
Diabetes	13 (5)	52 (2)
Health problems [ $n$ (%)]		
Chronic allergy	59 (21)	299 (13)
Arthritis	17 (6)	97 (4)
Low back pain	134 (49)	502 (22)
Visual impairment	30 (11)	139 (6)
Chronic lung problems	35 (13)	123 (5)
Chronic skin problems	42 (15)	151 (7)
Deafness or hearing problems	40 (15)	190 (8)
Other health problems	24 (9)	353 (15)
Medication regularly [ $n$ (%)]		
Analgetica	38 (14)	
Sedativa	19 (7)	
Hypnotica	25 (9)	
Heart medication	17 (6)	
Antihypertensiva	64 (23)	
Other medication	96 (35)	

<sup>a</sup>Loge *et al* 1998.<sup>20</sup>; <sup>b</sup>Missing data = 1 (0.4%)

on the Fatigue Severity Scale or Sleep and Rest and Alertness Behavior.

Table 4 shows scores on Fatigue Questionnaire, ie mean values on Total Fatigue, Physical Fatigue, Mental Fatigue and Caseness in relation to age and gender in the polio survivors compared to the normative data of the Norwegian population.<sup>20</sup> Compared to the normative data, polio survivors had significantly elevated scores on Total Fatigue, Physical Fatigue and Caseness ( $P < 0.001$ ). No significant differences were found between male polio survivors and the normative male population in Mental Fatigue, but females aged 40–49 years and above 60 years reported significantly more Mental

Fatigue than the normative group ( $P=0.01$ ). As to Caseness between age groups among polio survivors, significantly more cases were reported above 60 years ( $P<0.05$ ). No significant differences were found between fatigue scores in different age groups in the polio population.

As to items on duration of fatigue covered in the FQ, 9.8% of the respondents reported no fatigue, while 68% reported fatigue lasting more than 6 months. As to extent of fatigue, 9.1% reported no

fatigue, and 20% reported to be fatigued all the time. There were no significant age or sex differences in these items.

The mean score of SF-36 on the items assessing fatigue was 4.2 (maximum score 6), indicating a high perceived rating of fatigue also on this scale. No significant age or sex differences were found on SF-36. No comparative normative data is available.

Table 5 combines two items from Fatigue Questionnaire regarding extent and duration of fatigue. To focus on subjects with low and high perceived fatigue, respectively, subjects reporting not feeling tired at all on both questions were labelled the No fatigue group ( $n=21$ ) and compared with those feeling tired all day with a duration of 6 months or more (Severe fatigue group,  $n=51$ ). A significantly higher percentage in the No fatigue group were holding a job (38.1 versus 9.8%,  $P<0.01$ ). Significantly more members of the Severe fatigue group were affected by polio in the respiratory muscles (31.4 versus 4.8%,  $P<0.01$ ), and they also had considerably more health problems, such as chronic allergy, low back pain, visual impairment, chronic lung problems and chronic skin problems.

Table 6 presents characteristics of polio survivors reporting extreme scores in the lower and upper range on both Fatigue Severity Scale and Fatigue Questionnaire. A higher proportion of the Mild fatigue group had no other diseases or health problems (30.8% versus none,  $P<0.007$ ). No significant differences between the groups were found in the other variables, except for marital status, where more members of the Mild fatigue group were single (46.2 versus 7.1%,  $P<0.05$ ). The proportions of persons in paid work was more than twice higher in the Mild fatigue group, and the proportion of persons with

**Table 3** Results on Fatigue Questionnaire ( $n=274$ ), Fatigue Severity Scale ( $n=274$ ) and Sleep and Rest and Alertness behavior ( $n=276$ ) in polio survivors compared to normative data<sup>a b c</sup>. Higher scores means more fatigue

	Polio survivors	Normative data/ controls	$P^d$
Fatigue Severity Scale (1–7) [mean (SD)]	5.2 (1.5)	<sup>a</sup> 2.3 (0.7)	***
Sickness Impact Profile (%)			
Sleep and Rest	20.3 (13.7)	<sup>b</sup> 10.3 (14.7)	***
Alertness Behaviour	14.9 (17.6)	5.0 (9.9)	***
Fatigue Questionnaire [mean (SD)]			
Total Fatigue (0–33)	16.9 (5.1)	<sup>c</sup> 12.2 (4.0)	***
Physical Fatigue (0–21)	12.0 (4.0)	7.9 (3.1)	***
Mental Fatigue (0–12)	4.9 (1.8)	4.3 (1.4)	***
Substantial Fatigue (%)	67.9	22.0	***
Caseness (%)	53.3	11.4	***

<sup>a</sup>Normative data by Krupp 1989<sup>15</sup> ( $n=20$ , mean age 39.7 years); <sup>b</sup>Normative data by Sigurdsson 1983<sup>33</sup> ( $n=112$ , women mean age 26–72 years); <sup>c</sup>Normative data by Loge *et al* 1998 ( $n=2287$ , mean age 50 years); <sup>d</sup> $P$  values based on chi-square and Student's  $t$ -test; \*\*\* =  $P<0.001$

**Table 4** Fatigue Questionnaire: mean values of Total Fatigue, Physical Fatigue, Mental Fatigue and Caseness in relation to age and gender in polio survivors compared to normative data of the Norwegian population.<sup>a</sup> Age groups <40 years cannot be compared to norms due to few cases (<29 years  $n=2$ , 30–39 years,  $n=5$ )

Fatigue Questionnaire (men/women)	Total		40–49 years		50–59 years		>60 years		Differences between age groups among polio survivors
	Polio $n=274$ (74/200)	Norms $n=2287$ (1112/1175)	Polio $n=26$ (14/12)	Norms $n=440$ (216/224)	Polio $n=119$ (33/86)	Norms $n=361$ (180/181)	Polio $n=122$ (25/97)	Norms $n=501$ (238/263)	
Total fatigue: mean	16.9		16.9		16.5		17.3		n.s.
male	16.6	11.9 ***	15.6	11.7 ***	16.7	12.6 ***	16.7	12.9 ***	n.s.
female	17.0	12.6 ***	18.0	12.2 ***	16.4	12.2 ***	17.4	13.4 ***	n.s.
Physical Fatigue: mean	12.0		11.9		11.5		12.4		n.s.
male	11.6	7.6 ***	11.1	7.4 ***	11.7	8.1 ***	11.7	8.4 ***	n.s.
female	12.1	8.2 ***	12.6	7.9 ***	11.4	7.8 ***	12.6	9.0 ***	n.s.
Mental Fatigue: mean	4.9		5.0		5.0		4.9		n.s.
male	4.9	4.3 ***	4.5	4.3 n.s.	4.9	4.5 n.s.	5.0	4.5 n.s.	n.s.
female	4.9	4.4 ***	5.4	4.3 **	5.0	4.3 n.s.	4.9	4.4 **	n.s.
Caseness (%)	53.3		46.2		45.4		62.3		*
male	52.7	10.1 ***	41.7	9.6 ***	51.5	12.2 ***	60.0	16.8 ***	n.s.
female	53.5	12.6 ***	50.0	13.8 ***	43.0	10.5 ***	62.9	21.7 ***	*

<sup>a</sup>Normative data by Loge *et al* 1998<sup>20</sup>. \*\*\* =  $P<0.001$ , \*\* =  $P<0.01$ , \* =  $P<0.05$ , n.s. = not significant

**Table 5** Polio survivors reported no or severe fatigue, respectively, in relation to demographic and health variables

	No fatigue 'Not tired at all' (n=21)	Severe fatigue 'Tired all day' >6 months (n=51)	P <sup>b</sup>
Age (yrs) [mean (SD)]	57.2 (8.09)	60.8 (8.0)	n.s.
Age at polio onset (yrs) [mean (SD)]	5.4 (6.5)	8.4 (7.2)	n.s.
Female (%)	71.4	76.5	n.s.
Male (%)	28.6	23.5	
Marital status (%)			
Single	33.3	13.7	n.s.
Married/cohabitant	38.1	56.9	
Widow/widower	9.5	15.7	
Separated/divorced	19.0	13.7	
Educational level (%)			
Lower	23.8	33.3	n.s.
Medium	33.3	41.2	
University	42.9	25.5	
Work/source of income (%)			
Paying job	38.1	9.8	P<0.01
Disablement benefit	52.4	60.8	
Old-age pension	9.5	29.4	
Body parts affected by polio (%)			
Upper extremities	47.6	52.4	n.s.
Lower extremities	90.5	94.1	n.s.
Back and abdomen	42.9	57.1	n.s.
Respiratory muscles	4.8	31.4	P<0.05
Diseases (%)			
Hypertension	23.8	29.4	n.s.
Myocardial infarction	4.8	15.7	n.s.
Heart failure	4.8	9.8	n.s.
Diabetes	4.8	5.9	n.s.
Cancer	0	11.8	n.s.
Health problems (%)			
Chronic allergy	4.8	33.3	P<0.01
Arthritis	0	5.9	n.s.
Low back pain	28.6	58.8	P<0.05
Visual impairment	0	19.6	P<0.05
Chronic lung problems	0	19.6	P<0.05
Chronic skin problems	0	23.5	P<0.05
Deafness/hearing problems	9.5	15.7	n.s.
Other health problems	4.8	7.8	n.s.

<sup>a</sup>Results are based on the following questions on Fatigue Questionnaire: 'If you feel tired these days, for how long have you been tired?' and 'If you feel tired these days, how much of the time do you feel tired?'. <sup>b</sup>P values are based on chi-square and Student's *t*-test, n.s.=not significant at the 0.05 level

parases in the respiratory muscles was more than three times higher in the Severe fatigue group.

Table 7 presents characteristics of polio responders who reported no disease or health problems trichotomized according to scores on Fatigue Severity Scale. Average score in FSS was 4.6 (1.6) among these polio survivors. The three groups showed no significant differences in age, gender, marital status, educational

**Table 6** Characteristics of polio respondents reporting scores at the extreme lower and upper range on both Fatigue Severity Scale (FSS) and Fatigue Questionnaire (total fatigue, TF)<sup>a</sup>

	Mild fatigue (n=13)	Severe fatigue (n=14)	P <sup>b</sup>
Age (yrs) [mean (SD)]	59.0 (13.5)	58.0 (12.0)	n.s.
Age at polio onset (yrs) [mean (SD)] <sup>c</sup>	8.9 (10.0)	9.0 (9.2)	n.s.
Gender (%)			
Female	52.9	47.1	n.s.
Male	40.0	60.0	
Marital status (%)			
Single	46.2	7.1	P<0.05
Married	38.5	64.3	
Widow/widower	15.4	7.1	
Separated/divorced	–	21.4	
Educational status (%)			
Lower	38.5	28.6	n.s.
Medium	23.1	42.9	
University	38.5	28.6	
Work/source of income (%)			
Working	15.4	7.1	n.s.
Disablement benefit	53.8	64.3	
Old-age pension	23.1	21.4	
Other	7.7	7.1	
Body part affected by polio (%)			
Upper extremities	46.2	42.9	n.s.
Lower extremities	100.0	92.9	n.s.
Back and abdomen	30.8	50.0	n.s.
Respiratory muscles	7.7	28.6	n.s.
Diseases/health problems (%)			
No disease	30.8	–	P<0.007
Disease/no health problems	30.8	7.1	
Health problems/no disease	38.5	50.0	
Disease and health problems	–	42.9	

<sup>a</sup>Mild fatigue: FSS 0–18% of the population=score <3.1, TF 0–10% of the population=score <12. (18% was chosen as cut-off on FSS as no scores were reported at 10%, only on 5%). Severe fatigue: FSS 0–10% of the population=score 7, TF 0–10% of the population=score >23; <sup>b</sup>P values based on chi-square and *t*-test; <sup>c</sup>Missing data n=1; n.s.=not significant at the 0.05 level

status, source of income or polio affection. Analysis was also performed to trichotomize the Total Fatigue Score among subjects reporting no diseases and health problems, again 47 persons. However, 33 of these reported scores within 1 SD from the mean in the normative data, and only 7 scored above 2SD from the mean. Correlation between Fatigue Severity Scale and Total Fatigue were  $r=0.52$  in the total population studied, compared with  $r=0.44$  for the subjects without diseases or health problems. Similar correlation studies in normative groups are unknown.

Table 8 describes the effect of subject characteristics on the fatigue scales. Significant correlations were

**Table 7** Characteristics of polio responders with no disease or health problems ( $n=47$ ) in relation to scores on Fatigue Severity Scale (FSS) ( $n=47$ ). Groups are defined in relation to SD from mean in normative data<sup>a</sup>

	Mild fatigue (0–2 SD) (n=12)	Moderate fatigue (3–5 SD) (n=21)	Severe fatigue (>5 SD) (n=14)	P <sup>b</sup>
FSS [mean (SD)]	2.5 (0.8)	4.7 (0.7)	6.4 (0.4)	$P<0.001$
FSS range	1–3.5	3.8–5.8	5.9–7.0	
Age (yrs) [mean (SD)]	58.8 (10.0)	56.0 (5.6)	52.4 (9.1)	n.s.
Age at polio onset [mean (SD)]	4.7 (3.4)	6.4 (4.8)	6.3 (5.4)	n.s.
Gender (%)				
Female	66.7	76.2	85.7	n.s.
Male	33.3	23.8	14.3	
Marital status (%)				
Single	33.3	19.0	21.4	n.s.
Married/ cohabitant	50.0	66.7	57.1	
Separated/ divorced	16.7	14.3	14.3	
Widow/widower	–	–	7.1	
Educational status (%)				
Lower	33.3	9.5	35.7	n.s.
Medium	33.3	28.6	14.3	
University	33.3	61.9	50.0	
Source of income (%)				
Paying job	33.3	33.3	14.3	n.s.
Disablement benefit	50.0	57.1	78.6	
Old-age pension	16.7	9.5	7.1	
Body parts affected by polio (%)				
Upper extremities	33.3	52.4	42.9	n.s.
Lower extremities	91.7	85.7	92.9	n.s.
Back/abdomen	33.3	52.4	35.7	n.s.
Respiratory muscles	8.3	14.3	14.3	n.s.

<sup>a</sup>Krupp *et al* 1989.<sup>15</sup>; <sup>b</sup>P values based on chi-square and *t*-test; n.s. not significant at 0.05 level

found between all the fatigue scales and health problems, where Sleep and Rest, Total Fatigue, Physical Fatigue and Fatigue Severity Scale were significant at the 0.001 level. In addition, significant correlations at the 0.05 level between subject characteristics and fatigue scores were only found between the following variables: marital status and Physical Fatigue, Alertness Behavior and source of income, age when contracting polio and years since polio onset on both Alertness Behavior and Fatigue Severity Scale.

## Discussion

The study population was only for registered polio cases in Oslo City, and it might not thus be representative of the polio survivors. However, a

previous comparison between the present material and all acute polio cases notified by the national health authorities indicated that we had reached a representative part of the Norwegian polio population.<sup>27</sup>

The main finding in the present study was that the incidence of fatigue among polio survivors was considerably higher than in the normative data. Among polio survivors, 67.9% reported Substantial Fatigue (total dichotomized scores  $\geq 4$  on fatigue questionnaire), *versus* 22% in the normative group, and 53.3% of the polio survivors fulfilled the criteria for Caseness (total dichotomized scores  $\geq 4$  and duration of fatigue >6 months) *versus* 11.4% in the normative group.

The high incidence of fatigue reported among polio subjects is in accordance with the few other studies in polio survivors using validated scales for fatigue. In the present study, a total mean score of 5.2 (SD=1.5) was found on Fatigue Severity Scale. In Schanke's study<sup>18</sup> on 63 polio survivors, mean score on the same scale was 5.6 (SD=1.2). Neither of these two studies showed significant gender differences in FSS scores. In the present study, mean score was 4.6 (SD=1.6) among the polio survivors who had no other diseases or health problems. In a study by Packer *et al.*<sup>16</sup> mean score on Fatigue Severity Scale was 4.8 (SD=1.6) among 12 polio survivors with no additional medical problems or medication that could contribute to fatigue. In another study by Packer<sup>17</sup> mean fatigue score on the same scale was 5.0 (SD=1.7) among 28 polio survivors without additional medical conditions. In Schanke's study,<sup>18</sup> a positive correlation was found between fatigue and anxiety and depression ( $r=0.50$ ,  $P<0.001$  and  $r=0.36$ ,  $P<0.05$ , respectively), and a negative correlation was found between fatigue and social support ( $r=-0.36$ ,  $P<0.01$ ). Working capacity measured by maximal oxygen uptake (max  $\dot{V}O_2$ ) did not correlate significantly with self-reported fatigue, but all the subjects had max  $\dot{V}O_2$  below average values for untrained persons in the normal population.<sup>18</sup>

Secondly, according to our results on the Fatigue Questionnaire, the present study showed that physical fatigue represented the major problems for polio survivors. Thus, our study does not give great support to the hypotheses of 'brain fatigue', as reported by Bruno *et al.*<sup>7</sup> The differences in Mental Fatigue scores between polio survivors and the normative data were not significant for men. For women, significant differences were found in the age groups 40–49 years and above 60 years. However, the differences were small and hardly of clinical significance.

The polio survivors had significantly more diseases and health problems besides their polio than the normative group. When we analysed the correlations between subject characteristics versus reported fatigue, the highest correlation were found between other health problems and fatigue (Table 8). When correcting for co-morbidities among polio survivors reporting mild, moderate and severe fatigue on FSS,

**Table 8** Effects of subject characteristics on reported fatigue

	Age <sub>a</sub>	Sex <sub>b</sub>	Marital status <sub>c</sub>	Education <sub>d</sub>	Work <sub>e</sub>	Body parts affected by polio <sub>a,c</sub>	Age when polio <sub>a</sub>	Years since polio <sub>a</sub>	Health problems <sub>f,c</sub>
SF-36 total score	r = .05	r = -.09	R = .16	r = -.01	R = .15	r = .01	r = .04	r = -.04	R = 21**
Sickness Impact Profile									
Sleep and rest	r = .05	r = -.06	R = .04	r = -.01	R = .16	r = .05	r = .03	r = -.03	R = .22***
Alertness behavior	r = -.09	r = -.03	R = .10	r = .03	R = .17*	r = .10	r = .12*	r = -.12*	R = .20*
Fatigue Questionnaire									
Total Fatigue	r = .02	r = -.04	R = .12	r = -.01	R = .14	r = .05	r = .10	r = -.10	R = .26***
Physical Fatigue	r = .06	r = -.05	R = .17*	r = -.03	R = .16	r = .08	r = .08	r = -.08	R = .25***
Mental Fatigue	r = -.05	r = -.01	R = .05	r = .06	R = .11	r = -.03	r = .11	r = -.11	R = .20*
Fatigue Severity Scale	r = .03	r = -.05	R = .13	r = -.04	R = .16	r = .03	R = .13*	r = -.13*	R = .24***

<sup>a</sup>Pearson's correlation; <sup>b</sup>Point-biserial correlation; <sup>c</sup>Multiple classification analysis (R); <sup>d</sup>Spearman's correlation; <sup>e</sup>Score is number of body parts affected by polio (0–6); <sup>f</sup>Based on Loge *et al* 1998,<sup>20</sup> division: 1: no disease and current health problems, 2: disease but no current health problems, 3: no disease but current health problems and 4: disease and current health problems. \*\*\* =  $P < 0.001$ , \*\* =  $P < 0.01$ , \* =  $P < 0.05$

respectively, no significant correlations were found between these three groups and demographic variables, or *versus* body parts affected by polio. However, a tendency towards more fatigue among persons with polio in the respiratory muscles were found. In a study by Halstead and Rossi,<sup>28</sup> three variables were found to be associated with fatigue, hospitalization, ventilator use, and paralysis of all four limbs during the acute poliomyelitis illness. According to Agre,<sup>6</sup> this appears to reflect a common underlying variable, namely severity of acute poliomyelitis illness. In our study, a significantly higher percentage of subjects who reported to be tired all day for more than 6 months, were affected in the respiratory muscles (Table 5). When studying patients with low and high scores on Fatigue Severity Scale and Fatigue Questionnaire (Table 6), the same tendency was found, although not significant. When correcting for other diseases and health problems (Table 7), a modest tendency was found towards reporting fatigue among polio survivors with polio in the respiratory muscles. In the normative study the highest fatigue scores were found among the unemployed and among those receiving disablement benefit. In our study, only one subanalysis showed statistical significant correlation, namely between source of income and reported fatigue (Table 5).

Finally, fatigue among polio survivors in the present study was not found to be related to age. In the normative data, the highest Total Fatigue scores were found among the oldest in both gender. In our study, there were no differences in fatigue between men 50–59 years *versus* men above 60 years, while the age group 40–49 years reported most fatigue among women. As to Physical Fatigue, the normative data showed significant differences between age groups, where subjects above 60 years had the highest scores. In our study, no significant differences were found among different age groups in Physical Fatigue. On

the Mental Fatigue subscale, the normative data showed no statistical significant differences between age groups, and this finding was repeated in our material. However, both the normative and the present study showed a tendency towards more cases among women than men and more cases in higher age reporting mental fatigue.

In our study, psychological distress was not assessed. In a study by Tate *et al*<sup>29</sup> distressed/depressed polio survivors reported increased pain, they rated their health as poorer, and were less satisfied with life. Several studies on fatigue have documented a strong association between fatigue and psychological distress in younger subjects.<sup>1,24,30</sup> This may not hold in the elderly, among whom somatic diseases, like in our study, are far more common.

The limitation of the current study is that we have used a cross-sectional design. Cross-sectional research allows mainly for identification of physical and psychosocial changes soon after they occur. Longitudinal research, however, also makes possible the development of predictive models of various long-term outcomes. Such longitudinal research in PPS patients is scarce, but would of course be of great interest also concerning fatigue.

The present findings in the PPS patients group could be comparable with findings in ageing spinal cord injuries, but studies in long-standing spinal cord injuries focusing on fatigue are very few. In one study, tetraplegics reported significantly more fatigue than other spinal cord injured patients, and paraplegics reported significantly increased fatigue during a five-years period.<sup>31</sup>

Basmajian<sup>32</sup> states that 'fatigue is a complex phenomenon and perhaps a complex of numerous phenomena'. However, the conclusion of the present study is that polio survivors are suffering mainly from physical fatigue, primarily due to their physical

health with both polio-related problems and comorbidity. Thus, the diagnosis and treatment of these physical conditions should probably be given higher priority in the management of post polio syndrome.

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