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Original Research Article

To Observe the Prevalence of Clinical Manifestations in Post-Polio Syndrome Individuals using an Index of Post-Polio Sequelae

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ABSTRACT

Background: Post-Polio Health International estimated that 12-20 million people worldwide experience the aftereffects of poliomyelitis. A significant proportion of polio survivors experience muscle weakness, muscle atrophy, new muscle weakness, and fatigue. The objective of this study is to determine the prevalence of manifestations among patients with post-polio syndrome.

Aim: To observe the prevalence of clinical manifestations in post-polio syndrome individuals using An Index of Post-Polio Sequelae.

Methodology: In this observational study, 90 participants were enrolled following a thorough evaluation of inclusion and exclusion criteria. Consent was secured before the assessment. We assess the presence and severity of post-polio manifestations by an Index of post-polio sequelae. Data was analysed using Microsoft Excel.

Study design: An observational study.

Result: Study revealed that muscle weakness in involved muscle (100%) and muscle atrophy (100%) were the most prominent manifestations among total participants, contractures were observed in 94.40% individuals, muscle weakness in uninvolved muscle (55.6%), 56.6% experienced muscle pain, 42.2% reported joint pain, 30% suffered fatigue, 27.7% participants had breathing problems, 13.3% faced sleep disturbance, difficulty in swallowing (2.2%) and carpal tunnel syndrome (1.11%) identified as the least prevalent manifestations. In this study, we also observed that among the three factors- pain, atrophy, and bulbar, the severity of the atrophy factor was the highest amongst individuals with Post Polio Syndrome.

Conclusion: The study highlights the predominant musculoskeletal and systemic manifestations, including muscle weakness, atrophy, and contractures which significantly impair mobility and quality of life. Progressive weakening of uninvolved muscles and limbs, pain, and fatigue hinder daily activities, leading to social hesitation.

KEY WORDS: Poliomyelitis, Index of Post-Polio Sequelae, Anterior Horn Cell, Neurological conditions, post-polio syndrome, PPRP.

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INTRODUCTION

Post-polio syndrome (PPS) is a common neurological disorder that persists through out life, it is the late progressive deterioration suffered by survivors of poliomyelitis. The prevalence of post-polio syndrome in patients with previous poliomyelitis ranges from 28.5-64% [1]. Poliomyelitis, commonly known

as polio is a viral infection caused by poliovirus. This virus is an enterovirus that belongs to the family of Picornaviridae and comprises Type 1, 2, and 3, and type 1 is most frequently responsible for illness. It is mostly seen in children under 5 years and is considered a Paediatric disease. It was a significant cause of childhood mortality and morbidity with 35000 deaths reported in 1988 [2].

Picornaviridae has the potential to enter the bloodstream and subsequently invade the anterior horn cells of the spinal cord, causing significant damage to the central nervous system, virus reaches the central nervous system by crossing the blood-brain barrier or via retrograde axonal transport along peripheral nerves leading to flaccid paralysis which is a hallmark of poliomyelitis [3].

It is crucial to remember that motor neuron pools are impacted throughout the spinal cord and that the infection extends to the cerebral cortex in the region where axons project to motor neurons [4].

Approximately 1 out of 100 infections lead to paralysis due to the affection of anterior horn cells in the spinal cord [5].

Studies indicate that muscle deterioration in post-polio syndrome patients progresses more rapidly than in the general population with muscle weakness primarily stemming from overuse of muscle that compensates for lost function in affected areas [6].

Peripheral or muscular fatigue or muscle weakness is the inability of skeletal muscle to generate or maintain high levels of strength. This fatigue is associated with the depletion of energy substrates and the accumulation of metabolites, leading to impaired muscle contraction, factors such as calcium release issues, and defects in excitation-contraction coupling.Additionally, neuromuscular transmission defects and ineffective reinnervation contribute to fatigue in PPS patients [7].

Central fatigue arises in the neural structures involved in physical activity, and leads to changes in motor axon recruitment and neurotransmission. It is associated with prolonged or intense efforts and involves failures in nerve impulse conduction,affecting motor unit activation and neurotransmitter levels, such as acetylcholine. Central fatigue is characterized by sudden, generalized exhaustion, often aggravated by minor activities, the underlying mechanisms may involve polio viral lesions in brain areas such as the hypothalamus and reticular formation contributing to cognitive difficulties, attention issues, and fatigue in post-polio syndrome patients [7].

Post-polio muscular atrophy is marked by delayed-onset muscle weakness in individuals previously affected by poliomyelitis, during the initial polio infection motoneurons are variably damaged or destroyed leading to muscle impairment. However, after approximately 15 years, the capacity of these neurons to maintain their expanded connection diminished, resulting in progressive muscle weakening and atrophy [8]. Joint pain in persons with post-polio syndrome is often caused by overuse and postural changes due to unbalanced muscle strength. Muscle pain, on the other hand, can result from muscle cramps, fasciculations, and overuse, which are associated with joint instability. The pain is influenced by daily activities, uneven limb size, poor posture, the development of scoliosis, and impaired body mechanisms [9]. Dysphagia which means difficulty in swallowing, appears a decade after initial poliomyelitis and arises when an acute polio infection affects the medulla and VII-XII cranial nerves which supply the bulbar muscles [6], the most frequently observed swallowing deficit includes delayed pharyngeal transit and food getting stuck in the throat [10].

Breathing and swallowing problems are barely present in patients with post-polio syndrome, respiratory insufficiency is usually caused by respiratory muscles or bulbar muscle dysfunction. Presently, an estimated 27-36% of polio survivors experience respiratory insufficiency [11]. Cold intolerance, is characterized by a usual sensitivity to low-temperature environment. This intolerance stems from insufficient muscle function to support the vasoconstriction of blood vessels, a necessary process to reduce the flow of warm blood to the skin and thus retain body heat, insufficient muscle support is due to muscle atrophy which is a result

of damaged peripheral nerves caused by poliovirus during acute phase poliomyelitis [6]. Carpal tunnel syndrome is also a problem faced by patients with post-polio syndrome, especially those with lower extremity weakness, as they rely heavily on their upper limbs for mobility, daily activities, and employment [12].

Study aimed to examine and check the prevalence of various manifestations and their distribution in post-polio syndrome patients above 16 years with the help of an Index of Post-Polio sequelae.

MATERIAL AND METHODOLOGY

In this observational study, we recruited 90 individuals diagnosed with post-polio syndrome, the study was conducted in Chhatrapati Sambhajinagar (Aurangabad), Maharashtra, India. All participants attended the District Civil hospital, Chhatrapati Sambhajinagar (Aurangabad) to obtain either disability certificate or a fitness certificate. We included willing participants 16 years and above with a confirmed diagnosis of poliomyelitis. Written informed consent was obtained from all the participants in the regional language. An Index of Post-Polio Sequelae Questionnaire was administered to assess the prevalence of post-polio manifestations.

The questionnaire addressed three primary factors: pain, atrophy, and bulbar. Pain factors encompassed six domains: muscle weakness (uninvolved muscle), joint pain, muscle pain, sleep problems, contracture, and carpal tunnel syndrome. Atrophy factor comprises three domains: muscle weakness (involved muscle), muscle atrophy, and Fatigue. Bulbar factor included two domains Breathing problems and Swallowing Problems. Each domain was rated 1 to 5 on a severity scale, where 1 represented slight severity and 5 indicated extremely severe.

RESULTS

In this study, we evaluate 90 participants using An Index of Post-Polio Sequelae. The mean age of the participants was 43.54±10.83, while the male: female ratio among participants was 2.9:1, this mentioned data can be seen in the Table. no.1.

Table 1: General Characteristics of the Participants.

Age (in years)	43.54±10.83
Gender (Male: Female)	2.9:1

We observed that muscle weakness and atrophy were the most prevalent manifestations within our population, while carpal tunnel syndrome and swallowing problems were the least common. Also, muscle weakness and atrophy exhibited the highest mean and standard deviations. Prevalence percentage, as well as the mean and standard deviation of domains of pain, atrophy, and bulbar factor are presented in Table no. 2

Table 2: Mean and Standard deviations and Percentage of Prevalence of individuals with Post-Polio Syndrome.

Factors	Domains	Mean±Standard Deviation	Percentage
Pain Factor	Muscle weakness (Uninvolved muscles)	1.48±0.4472	55.60%
	Joint Pain	1.39±0.68	42.40%
	Muscle Pain	1.60±0.63	56.66%
	Sleep Problem	1.16±0.38	13.33%
	Contracture	2.45±0.73	94.40%
	Carpal Tunnel Syndrome	2±0	1.11%
Atrophy Factor	Muscle weakness (Involved muscles)	2.92±0.65	100%
	Muscle Atrophy	2.36±0.78	100%
	Fatigue/Low energy	1.55±0.64	30%
Bulbar Factor	Breathing Problem	1.64± 0.63	27.70%
	Swallowing Problem	1± 0	2.20%

Table 3: Mean and Standard Deviation of Total of Severity Rating of Pain Factor, Atrophy Factor and Bulbar Factor.

Factors	Pain Factor	Atrophy Factor	Bulbar Factor
Mean ± standard deviation	4.17± 2.29	5.73± 1.51	0.47± 0.87

Charts 1, 2 and 3 illustrate prevalence of post-polio manifestations in the domain of pain, atrophy and bulbar factor respectively.

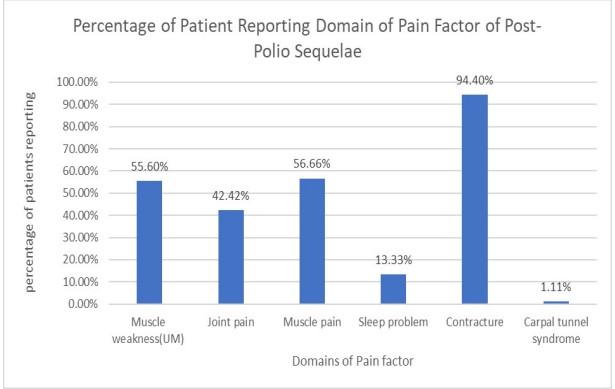

Chart no. 1: Percentage of Patients Reporting Domains of Pain Factor of Index of Post-Polio Sequelae.

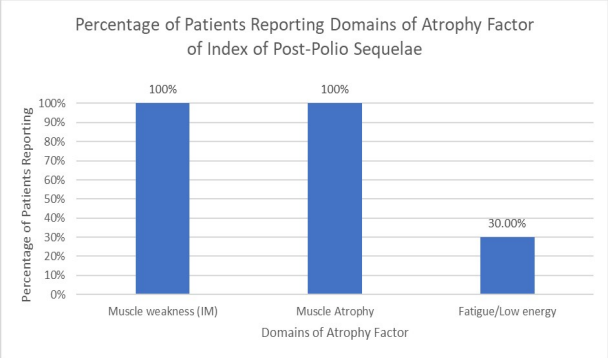

Chart no. 2: Percentage of patients Reporting Domains of Atrophy Factor of Index of Post-Polio Sequelae.

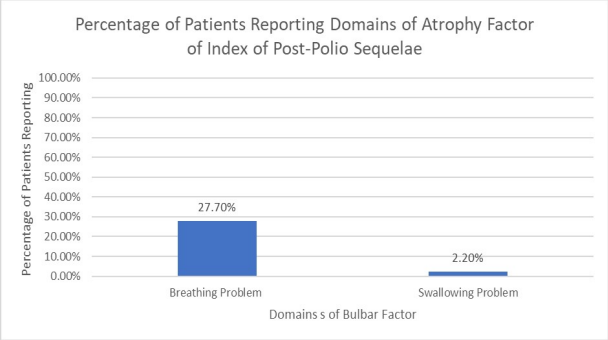

Chart No.3: Percentage of Patients Reporting Domains of Bulbar Factor of Index of Post-Polio Sequelae.

DISCUSSION

The objective of this study was to identify the predominant manifestations affecting the majority of individuals with post-polio syndrome. A total of 90 participants from Chhatrapati Sambhaji Nagar, Maharashtra, with a history of poliomyelitis were recruited. The average age of participants was 43.54±10.83 years, with 74% males and 26% females. Likewise, research conducted by Yuval Pinto et.al. (2022) aimed to analyse the clinical and demographic characteristics of the post-polio syndrome among polio survivors in Jerusalem. They carried out a case-control study involving 194 participants, revealing that 79% of participants were diagnosed with post-polio syndrome, of whom 51% were male and 49% female showing more percentage of males than females [13].

Muscle weakness and muscle atrophy are always a predominant manifestation in post-polio syndrome. The exact cause of new weakness in post-polio syndrome remains uncertain. However, the most commonly accepted theory attributes these symptoms to the degeneration of distal axons within the significantly enlarged motor units formed during recovery from acute paralytic poliomyelitis. Initially, many of the denervated fibers are reinnervated by nearby axons, but as this process becomes imbalanced, permanent denervation sets in, leading to further muscle weakness [14]. As anterior horn cells are affected in poliomyelitis it shows characteristics of Lower Motor Neuron Lesions such as hypotonia, flaccidity, hyporeflexia, fasciculations, ipsilateral weakness, neurogenic atrophy occurs as motor nerve supply from the anterior horn cell to the muscle reduced or stopped due to the lesion because of that muscle contraction and muscle activities decreased leading to severe muscle wasting [15].

In our study, we observed that nearly all patients exhibited both muscle weakness and muscle atrophy, with severity being pronounced in some cases and mild in others. Correspondingly, in an analysis performed by Isabella Schwartz and colleagues in 2014, in that cross-sectional study Among the participants, 94.3% reported muscle weakness in the affected limb while 77.3% reported muscle atrophy [16]. Similarly, a study by Claire Z. Kalpakjian and colleagues in 2005, found that 95.3% of participants reported muscle weakness in the affected limb, and 77.7% experienced muscle atrophy [17].

Muscle contracture is characterized by a shortening of muscle length due to the loss of sarcomeres, which increases resistance to passive stretch, and remodelling of connective tissue. Due to muscle shortening, stiffness increases, and joint range of motion activities are compromised leading to joint contracture [18]. In our study we observed that contracture was the third most common manifestation experienced by our participants, after evaluating 90 participants we found out that every ninth patient out of 10 had contractures (94.4%), making it one of the major challenges faced by individuals with post-polio syndrome. Comparably analysis conducted by Isabella Schwartz and colleagues performed a cross-sectional study and found that 68% of the participants had contractures [16].

In our study, after evaluating 90 participants we found that more than half of participants

(55.60%) had weakness in muscle that was previously unaffected. In a case report published in 2022, Kengo Maeda and colleagues studied a 73-year-old Japanese man with post-polio syndrome, four years later, the patient noticed progressive weakness in his right arm which was previously not affected, as well as in previously unaffected muscles [19]. This study underscores the progressive nature of post-polio syndrome and highlights that previously uninvolved muscles also develop weakness over time.

There is an established link between muscle pain and weakness, which is thought to result from either excessive use or prolonged inactivity creating a persistent vicious cycle. Excessive strain on musculoskeletal structure leads to pain. That can be alleviated through rest and immobilization. However, this often results in reduced muscle engagement, leading to disuse atrophy and further weakening consequently even moderate muscle activity can trigger pain perpetuating the cycle of disuse [20]. In this study, we observed that pain is common in post-polio syndrome patients, from total participants more than half of the patients had muscle pain (56.66%) which was exceeding joint pain (42.4%). Relatively, an evaluation carried out by Megha Sheth and colleagues in 2013, in this cross-sectional survey of 72 participants involved with post-polio syndrome in Gujrat, India. Findings revealed that muscle pain (39%) was more prevalent than joint pain (24%) among the participants [20].

In this study, we observed that less than half of the participants (30%) experienced fatigue. Also, we found that the majority of those who reported fatigue during daily activities were either females or males above the age of 50. Comparatively, research carried out by Arzu Yagiz and colleagues published in 2006, concluded that fatigue was a prominent factor in the impairment of quality of life, fatigue was significantly higher in the post-polio syndrome group (76.9%) [21].

Respiratory insufficiency in individuals with post-polio syndrome is primarily attributed to respiratory muscle weakness or bulbar muscle dysfunction. It is also strongly associated with a high prevalence of secondary complications such as scoliosis, obesity, and sleep apnoea. Currently, an estimated 27-36% of polio survivors experience respiratory insufficiency. In our study, breathing problems a component of the bulbar factor in an index of post-polio sequelae did not have a significant impact on our population, in our sample 27.7% of participants reported breathing problems. Analogously, a study conducted by Elisabeth and colleagues in 1991 sought to investigate lung function in individuals with a history of poliomyelitis. The researchers examined 74 participants, dividing them into two groups: Group I comprised 60 participants and Group II, with 14 participants. The finding revealed that in Group I, only 14 individuals (18%) reported experiencing shortness of breath, whereas in Group II, 10 individuals (71%) reported similar symptom [22].

Various studies conclude that post-polio patients experience a lower quality of sleep compared to the general population, when we assessed participants about sleep problems, we observed that approximately 13.3% had sleep problems. In contrast to that, an investigation undertaken by Klass W. Van Kralingen and colleagues in 1996 concluded that up to half the post-polio patients reported experiencing a sleep problem [23].

In post-polio syndrome patients with lower extremity involvement Use of canes, crutches, and wheelchairs creates pressure over the wrist and may put the patient at risk of carpal tunnel syndrome. In our population, we observed, that almost none of the patients had carpal tunnel syndrome (1.11%). But in contrast, a study undertaken by Robert Werner and colleagues in 1989 examined the prevalence of risk factors of median mononeuropathy at the wrist in post-polio patients and revealed that approximately 22% of the patients had carpal tunnel syndrome [24].

As mentioned in the introduction dysphagia, difficulty in swallowing is one of the manifestations of post-polio syndrome, which arises when polio infection affects the medulla and VII-XII cranial nerve. In our study, we noticed that swallowing problems were experienced

by minimal participants (2.20%) of our population. In a study, executed by M.P. Sainz and colleagues in 2019, they found that dysphagia is impacting only 11.7% participants out of 310 participants, in another study Soderholm S. Lehtinen noted that 15 participants out of 51 reported daily problems with voice production and swallowing, Oluwaseyi Jacob Oluwasami in review of living experiences of patients reports that approximately 18% polio survivors has been estimated incidence of dysphagia [6].

CONCLUSION

The study underscores the predominant musculoskeletal and systemic manifestations observed in participants, with muscle weakness, atrophy, and contractures being notably prevalent. These conditions significantly impair patient's mobility and severely compromise their quality of life, often leading to social withdrawal due to increased hesitation in engaging with others. Over time, we observed the onset of weakness in unaffected muscles and limbs, pain, and fatigue, further hindering the patient's ability to perform daily activities. This progressive weakening requires urgent attention. Future research should focus on developing comprehensive management strategies aimed at preserving the strength of intact muscles and limbs, as well as implementing interventions to enhance patients' overall quality of life.

Conflicts of interest: **None**

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