

CONSENSUS STUDY “FACTORS INFLUENCING FUNCTIONAL RECOVERY IN CEREBRAL PALSY: A MODIFIED DELPHI CONSENSUS STUDY

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ABSTRACT

Importance: Functional recovery in cerebral palsy depends on various factors and to identify the factors that affects the recovery is essential as it would help in development of the predictive models and guiding the patient specific rehabilitation plans.

Objective: The study aims at developing a expert consensus on factors affecting recovery in children with cerebral palsy using modified Delphi method.

Study Design: Modified Delphi consensus study.

Study setting: Electronic expert survey

Participants and Interventions: Total 25 participants mainly the paediatricians, paediatric orthopaedic surgeons, physiotherapists working in the field of paediatrics having variety of experience participated in the study by filling the google form, which included the basic demographic details of the participants and various factors that could affect the recovery.

Outcome measure: Various factors like epilepsy, prenatal factors, socioeconomic factors etc. were included and the experts rated these factors that were identified by the literature review and expert opinion. Consensus was classified with high consensus >65%, medium consensus 65% to 50% and low consensus < 50%.

Results: The results identified that certain factors like maternal age at delivery, epilepsy episodes and family support have high consensus 100% and other factors like age of the child, socioeconomic condition, and age of the child at the time of onset of recovery, occupational and speech therapy interventions, orthopaedic and surgical management have medium consensus 92%.

Conclusion and Relevance: The study identified key factors having high consensus affecting recovery and these would ultimately give future insight for the clinicians for the individualized rehabilitation strategy planning.

Plain language summary: Cerebral palsy is a condition that occurs due to a non-progressive damage to the developing brain in the foetus or damage to the brain of infants. This causes the children with cerebral palsy to be dependent functionally. The recovery among these children also differs even though they are taking similar treatment and there are various factors that affect the recovery. So to understand the factors that affect the recovery becomes utmost important as it would help the clinician to identify them and plan the treatment strategies accordingly. So in this study the factors that affect the recovery in cerebral palsy were identified by from the literature search and then electronic survey was done to get the consensus from the experts in the field like paediatricians, paediatric orthopaedic surgeons, paediatric physiotherapists, physiotherapists. Then the consensus was analysed and the key factors that affected the recovery were identified. The key factors identified were the age of mother at the time of delivery, the age of the child at the onset of the treatment, the severity and type of cerebral palsy, the presence of epilepsy and socioeconomic condition of the child. Thus this would help clinician identify the children with prognosis of the condition and accordingly allocate the resources available for the use and help researchers to develop predictive models for the same.

INTRODUCTION

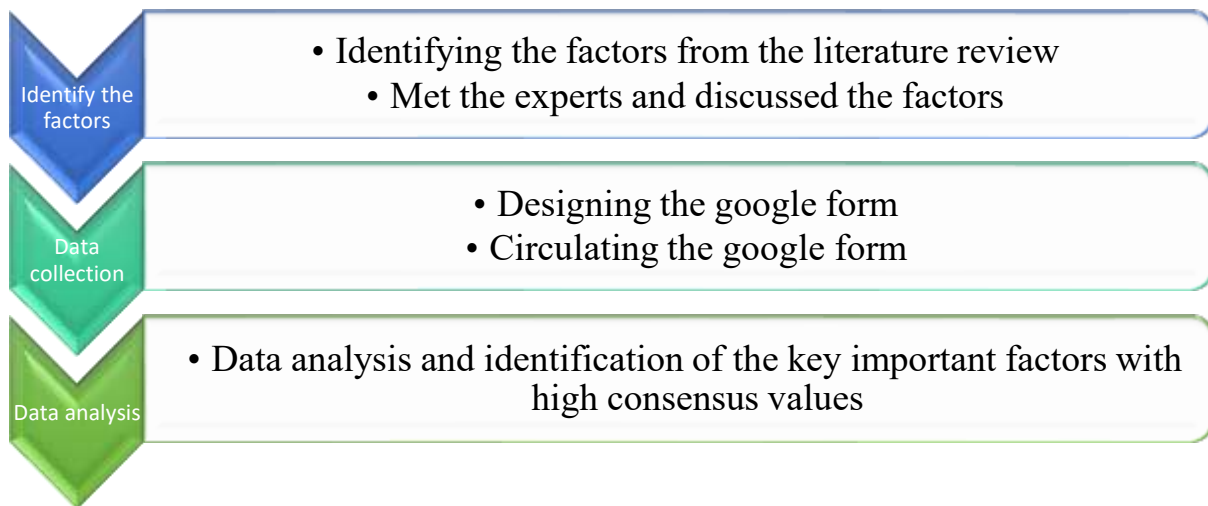
Cerebral palsy is the most type of congenital neuromuscular disorder in children. Cerebral palsy is the chronic disability of the nervous system due to damage in the immature brain. The disease is characterized by various symptoms like altered consciousness, reflexes, tone, delayed milestones and may associated abnormalities with vision, hearing and respiration.(1) There may be various prenatal, natal or postnatal causes that may lead to cerebral palsy like neonatal encephalopathy, premature delivery or low birth weight, maternal infections and intra-uterine growth retardation, epilepsy, hypothyroidism, acute catastrophic intra-partum asphyxia and neonatal hypoglycaemia. (2) A recent survey in 2024 showed that annual birth prevalence of the cerebral palsy per 1000 live birth population is 1.5 to 1.7 in high income countries and 3.0-3.9 in low & middle income countries. This was estimated for the children with cerebral palsy under 5 years. (3) Cerebral palsy is classified by various ways like depending upon the alteration in the tone of the muscle, part of the body affected and also on the functional activity done by the child. So the classification on the basis of alteration in the tone include dystonic cerebral palsy, spastic cerebral palsy and ataxic cerebral palsy. Amongst them majority of the children have spastic type of cerebral palsy. The subtypes of cerebral palsy depending upon the parts of the body involved

include quadriplegia (all four limb involvement and sometimes with trunk, face and mouth involvement), Diplegia (mostly both lower limb are more affected than both upper limb) and Hemiplegia (involvement of one side of the body). One more way was on the basis of functional activities done by the child rather than the involvement in the child. They are classified on the basis of Gross Motor Functional Classification System which has five levels of classification. Other functional classification is done on the basis of communication skills, manual ability, visual involvement which uses the scales like Communication Function Classification System (CFCS), Manual Ability Classification System (MACS) and Visual Function Classification System (VFCS) respectively. (4) According to one systematic review there are several risk factors identified which may lead to development of the cerebral palsy in children. The identified risk factors were low birth weight, male affected more, brain injury during neonatal period, intraventricular haemorrhage, and periventricular leukomalacia. (5) The diagnosis of the cerebral palsy is also difficult as it is not a single disease but large variety of group of conditions that together cause motor impairment. (6) Earlier the diagnosis of the cerebral palsy was been done at the age of 12 to 24 months based on the impairments of the movements, posture and balance. But in the recent era perinatal ultrasonography and post birth magnetic resonance imaging are used to identify the brain damage at the early age of life. The magnetic resonance imaging shows variety of abnormalities like clefts in the cerebral tissues, hydrocephalus and periventricular leukomalacia. Also along with these tools the history and physical examination also is useful in diagnosis of cerebral palsy. (7) There are various factors that may affect the recovery in children with cerebral palsy like maternal age at the time of delivery, presence of epilepsy or seizures, family support, age, gross motor function classification system level, level of spasticity, severity of brain damage and medical and surgical treatment and also some environmental factors. These factors needs to be properly identified as each factor has its own importance of affecting the recovery on cerebral palsy children. Also if the factors are identified at early stage it prevents the development of secondary complications which would improve the prognosis of the child. (8) So predicting factors affecting recovery in cerebral palsy is a challenging and very important task as accuracy in prediction is utmost needed to help proper clinical decision making, make optimal use of the available resources and help develop personalized therapeutic interventions? Consensus based approaches are now used widely to identify the variables for developing predicting models. As these method helps gathering the expert opinion from the many experts and identify the clinically meaningful factors. The consensus study helps to gather various perceptions of the experts and thus it ultimately helps to reach a fruitful and very effective outcome and result for the benefit of the patient. At the same time the decision making using Delphi study would be transparent in nature and by the collaborative approach. So these study aims to establish a consensus on factors affecting recovery in cerebral palsy. This would also help add on the evidence base for identification of the factors affecting the recovery in cerebral palsy.(9)

METHODOLOGY

The study was conducted using an online Modified Delphi method with the aim of identification of the factors affecting recovery in cerebral palsy via google forms. Only one round of the survey was done. A total of 17 experts who were mainly physiotherapist working in the field of paediatrics and also who are specifically working on cerebral palsy and paediatricians and paediatric orthopaedic surgeon with varying years of experience participated in the study. The google form for the modified Delphi survey was circulated amongst the participants and were asked to identify the factors. The factors included in the survey were identified from the current existing literature and meetings with the expert in the field. Optimal panel size remains undefined so the survey form was circulated to as many experts in the field as possible. The basic demographic details were taken to identify the expert's base and expertise in the field. The Delphi survey was done from March 2026 to May 2026 and the data was collected. (10) The main domains included in the survey form were:

1. Demographic factors
2. Perinatal factors
3. Clinical and neurological factors
4. Associated impairments
5. Rehabilitation and therapeutic factors
6. Medical and surgical interventions
7. Environmental and social factors



Data Analysis:

The responses were exported to the excel sheet and analysis was done using frequency based consensus analysis and factors were given ranking on the basis of the proportion of the experts identifying the factors. The ranking was done based on the frequency distribution as follows:

High consensus: $\geq 65\%$ agreement

Moderate consensus: 65–50% agreement

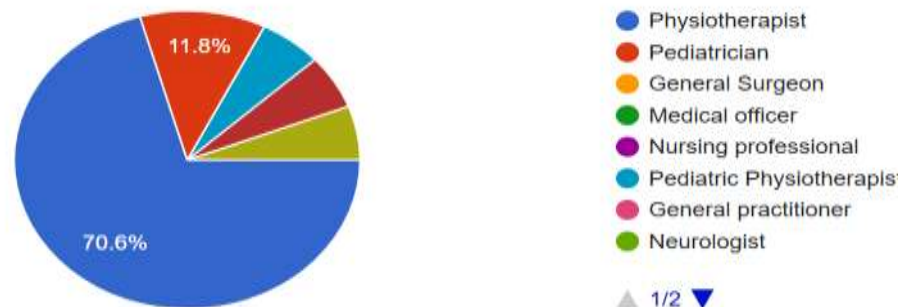
Low consensus: $<50\%$ agreement

RESULTS

The following figure is the figure representing the participants in the study

Choose your profession

17 responses



The following Table 1 and Figure 2 highlights the factors that have high consensus.

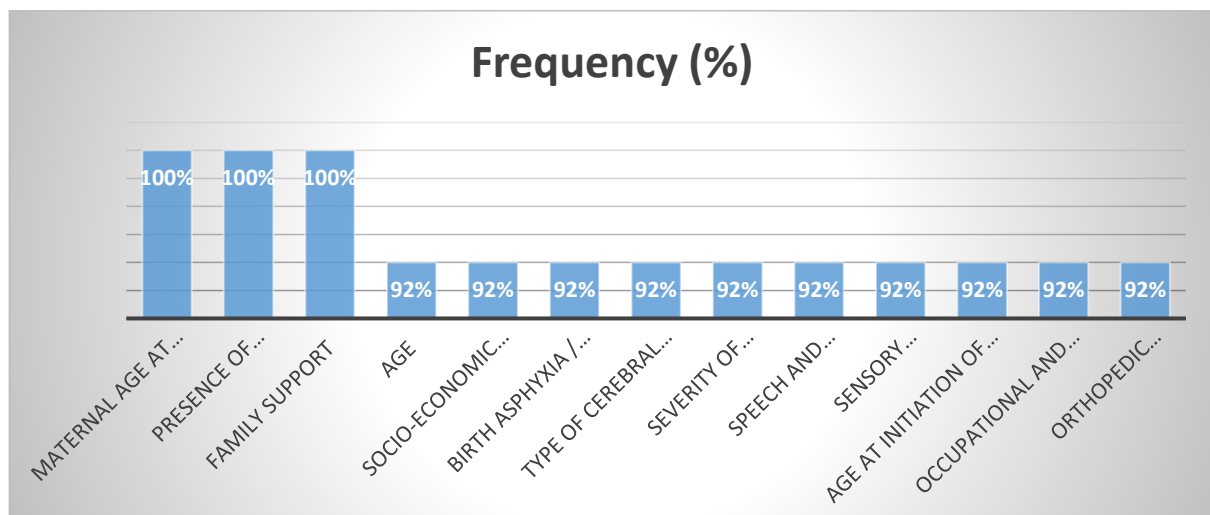


Figure 2. Factors having high consensus

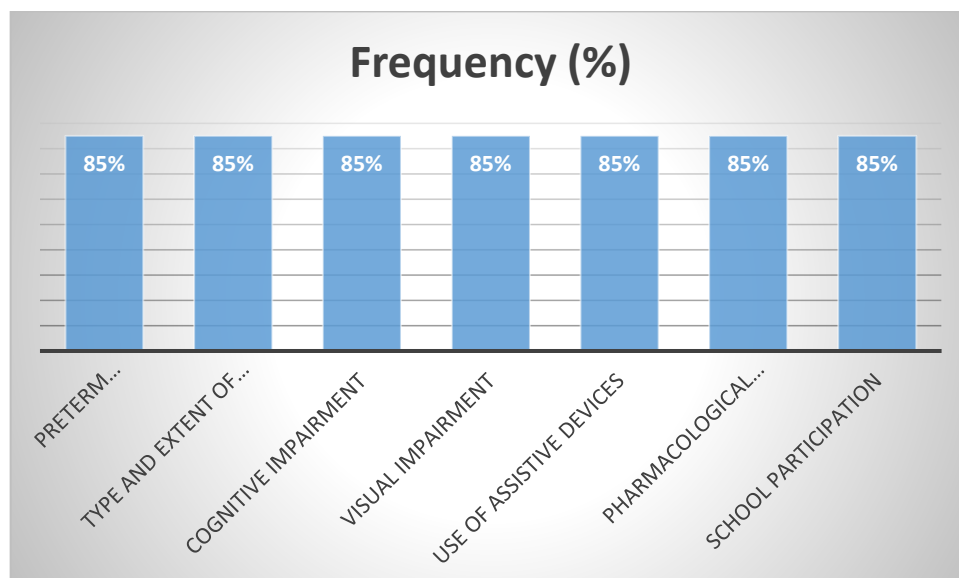
Table 1: Factors having high consensus

Factor	Frequency (%)
Maternal age at delivery	100%
Presence of epilepsy or seizures	100%
Family support	100%
Age	92%
Socio-economic condition	92%
Birth asphyxia / low Apgar score	92%
Type of cerebral palsy	92%
Severity of cerebral palsy	92%
Speech and language disorders	92%
Sensory integration deficits	92%
Age at initiation of therapy	92%
Occupational and speech therapy	92%
Orthopedic surgical interventions	92%

The table 2 and Figure 2 shows frequency of factors having medium consensus

Table 2: Factors having medium consensus

Factor	Frequency (%)
Preterm birth/gestational age	85 %
Type and extnt of injury	85 %
Cognitive impairment	85 %
Visual impairment	85 %
Use of assistive devices	85 %
Pharmacological management	85 %
School participation	85 %

**Figure 3: Factors having medium consensus**

The further detailed analysis of the factors affecting recovery in cerebral palsy. Maternal age and perinatal factors are likely to reflect the underlying pathology or damage in the brain and the Apgar score may also be low at the time of the birth of the child.(11)

Severity and type of the cerebral palsy is also one of the most influential factors. Also the spastic type of the cerebral palsy which is milder form have good chances of recovery as compared to those of the other type of cerebral palsy like mixed or athetoid or dystonic cerebral palsy.(12)

Neurological and associated impairments have almost higher consensus so that indicates one of the most powerful factor affecting the recovery in cerebral palsy. Occurrence of seizures mainly affects the neuroplasticity in the children having cerebral palsy which may ultimately lead to difficulty in recovery. Also the associated impairments in the children would hamper or limit the participation in the social and other day to day activities leading to less or affected recovery. The sensory integration also was one of the factor with higher consensus as it would also affect the motor learning and thus affect the recovery in cerebral palsy.(13)

Another factor with high consensus is the age at the onset of the therapy and type and intensity of the therapy given. Early identification and intervention of the treatment leads to a better recovery as the neuroplasticity is at the peak in early childhood. Also studies show that intensity of the physical therapy plays a major role in the recovery in terms of high intensity physical therapy. The study also defined the average dose of intensive physical therapy sessions to be 0.75 hours per day for 14 weeks.(14)

The medical and surgical interventions also had higher consensus in the analysis. The cerebral palsy is a non-curable disease so the management of cerebral palsy is purely symptomatic. The children with cerebral palsy have some associated impairments and brain damage so firstly they are always treated with non-surgical approach like physiotherapy and medicines especially to reduce spasticity and pain to prevent deformities and secondary complications. But when this fails the surgical management is advised as it may have the potential benefit of improved mobility, pain relief, reduced stiffness and improved coordination and balance. Thus this helps in improving the gross motor function hence in activities of daily living and in turn improves quality of life.(15, 16)

Environmental factors and the social support are also one of the major factors affecting cerebral palsy as they also have higher consensus values. One of the recent survey identified that access to services has a significant impact on the social and economic problems of the caregivers. The study also identified the environmental factors that could affect the most is the physical barriers in the society and the effects of the peer group. (17)

DISCUSSION

This study aimed to develop a consensus guidance on the factors affecting the recovery in cerebral palsy. The final results identified 20 factors with higher and medium consensus. The recovery in cerebral palsy is thus based on the multidimensional factors over and above motor and sensory components. The result analysis of the study currently states that one factor or two factors are not enough to predict the recovery. The experts suggested very high agreement certain factors like age of the mother at the time of delivery, epilepsy, and support from the family and suggested a moderate agreement to certain factors like type of cerebral palsy, sensory issues orthopaedic and surgical management and rehabilitation services. Also the International classification of disability uses this approach of predicting the recovery considering the multi-dimensional factors rather than one or two factors. The overall purpose was to identify the factors that affect the recovery which would ultimately help the clinicians and physiotherapist to prioritize the factors and thus work on it. It is also useful for the policy making. (18) The findings are suggest that the recovery in cerebral palsy has lot many factors affecting it and they are interdependent in nature. There is strong agreement on the type of cerebral palsy, severity of the disease, occurrence of epilepsy, overall medical and surgical management, age at which treatment started and social and environmental factors affecting the recovery in cerebral palsy. (10, 14, 15) These findings are inn strong correlation with the other previous studies which also suggested that motor impairments in dyskinetic cerebral palsy, epilepsy and the environmental factors slows down the recovery in cerebral palsy as compared to the children without having epilepsy and milder form of spastic diplegic variant of cerebral palsy.(19) The reason behind is the epilepsy affects the cortical organisation of various body parts in the brain, also affects the motor learning and neuroplasticity. The moderate consensus was given to the associated factors like vision, speech and hearing impairment by the expert. The reason being is the impairments affects the active involvement of the child in the various activities of daily living and also in the social activities which would limit the growth in the child. One of the previous study also suggested that the associated impairments have burden in the children with cerebral palsy and also refrains them from active participation and seeking of rehabilitation. (20)

Also there is a critical role of early physiotherapy intervention and the incorporation of various approaches in the rehabilitation. The age of the onset of the therapy, the duration of the therapy, speech and occupational therapy along with physiotherapy and the medical/orthopaedic interventions were consistently reported as the factors with high consensus by the experts. Early intervention would lead to good prognosis as the neuroplasticity is at its peak when the child is young and so the repetitive task therapy helps develop the new neural pathways leading to easy and fast learning. Some of the systemic reviews in the past have also identified that intensive patient specific rehabilitation leads to greater improvement in the motor impairments and thus improving the participation in the activities of daily living. (21)

The other identified important factor by the experts is the social and the economic factor. Family support was one of the factor amongst it where the experts gave the highest consent. So the caregiver and the other family members play an important role in the recovery of cerebral palsy as they are the people who would be responsible for the timely and regular adherence to the treatment of the child, helps in home programme exercises, and helping in participation in the social activities. Some of the other factors like financial constraints, limited resources availability, and lack of transport facilities also had a moderate consensus as the rehabilitation process is the long term process. Some of the previous study identified that socioeconomic condition had a direct impact on the severity of the cerebral palsy and thus the recovery in cerebral palsy. (22)

The strength of the study is the identification of the various factors affecting the recovery in cerebral palsy in a systemic way using the consensus given by the experts in the field. So the identification of the factors by the expert and the literature

review done would increase the reliability of the factors identified for the development of the future predictive models. There are other predictive models made to identify the recovery in the cerebral palsy but they are mainly including only one or two components for predication which would not be able to justify the predictive model as the recovery is based on various factors and components.

Also a single round was conducted in the study but as this is a modified Delphi study the study starts with the predominant identified factors identified by the literature review. Also the consensus obtained for the factors were very high in the first round itself and no new factors were identified in the survey. So the second round would not give much changes. The study also aimed at identifying the factors rather than prioritizing them.

The limitation of the study is the participation of majorly the physiotherapist in the study. There is the participation of paediatrician and paediatric orthopaedic surgeon but very few responses. So the further studies can include more variety of experts in the field.

The consensus study provides a structured framework for variable selection, which is a critical step in predictive modelling. This study also highlights the need for developing the models with many factors that would work with biological, clinical and environmental factors along with the gross motor recovery factors.

CONCLUSION

The study identified that recovery in cerebral palsy is determined by the combination of the factors like prenatal factors, neurological, rehabilitation, medical, and environmental factors rather than by a single clinical characteristic.

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