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A CROSS-SECTIONAL STUDY TO INVESTIGATE THE SOCIO-BIOLOGICAL FACTORS INFLUENCING CEREBRAL PALSY

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Abstract: *Cerebral palsy is a heterogeneous group of non-progressive motor disorders caused by brain injuries that originate in the prenatal period, perinatal period, or first few years of life. CP is classified according to the type of lesion in the brain, signs, and symptoms (spastic, ataxic, dyskinetic, and mixed CP), time of insult (prenatal, intra- natal, post- natal). Topographical involvement of limbs (hemiplegia, diplegia, or quadriplegia), changes in muscle tone (hypotonic, isotonic, hypertonic). To analyze socioeconomic factors, maternal age, and genetic predisposition in CP prevalence. A cross-sectional study was conducted with 112 pediatric CP patients in Karachi. Data were collected via interviews, questionnaires, and medical records. SES, maternal age, and consanguinity were analyzed using descriptive and inferential statistics. Low SES was significantly associated with CP (p=0.001). Maternal age showed no significant association with CP risk (P>0.05). Consanguinity correlated with a higher likelihood of CP (p= 0.002). This study highlights the significant associations between socioeconomic status and consanguinity with the risk of cerebral palsy, providing valuable insights into potential risk factors for this condition, while no significant association with mother age was found.*

Key Words: *Consanguinity, Cerebral Palsy, Maternal Age, Neurological disorder, Prevalence, socio economic status*.

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Introduction

Cerebral palsy is a heterogeneous group of non-progressive motor disorders caused by brain injuries that originate in the prenatal period, perinatal period, or first few years of life. [1]. CP is classified according to the type of lesion in the brain, signs, and symptoms (spastic, ataxic, dyskinetic and mixed CP), time of insult (pre-natal, intranatal, postnatal). Topographical involvement of limbs (hemiplegia, diplegia, or quadriplegia), changes in muscles tone (hypotonic. Isotonic, hypertonic) [2]

Global birth prevalence of cerebral palsy in high income countries is 1.6/1000 live births, and the birth prevalence estimate is 3.3/1000 live births in low and middle income countries. [3] Pakistan is a developing country that has the 5th largest population in the world, with nearly 220 million people, but unfortunately due to the unavailability of national registry, the prevalence of cerebral palsy in Pakistan is unknown [4]. However, the prevalence of CP in district Swabi, Khyber Pakhtunkhwa, Pakistan, is 1.22/1000 live births [5]. The prevalence of CP in rural areas of Sindh, Sukkar are 5.5/1000 children [6]. In Pakistan the male population is largely affected with CP than female population. [7]

Cerebral palsy (CP) is classified into the following groups based on the affected extremities and signs of neurologic impairment. The primary classifications encompass spastic CP, characterized by elevated muscle tone and hypertonia; dyskinetic (athetoid) CP, delineated by uncontrolled, involuntary writhing movements; and ataxic CP, denoted by cerebellar dysfunction resulting in disruptions of coordination and balance. The location of lesions, the underlying disease, the chronologic age, and the gestational age at delivery all affect the clinical symptoms differently [8]. The most prevalent form is spastic CP, which affects motor and postural development and which causes sensory disorders and learning disabilities [9].

One billion people globally live in countries where marriage with relative are common. Of this billion, one in three is married to a second cousin or closer relative or is the progeny of such marriage [10]. In Pakistan, half of the population marry the first or second cousin. According to Pakistan Demographic and health survey of 2017-2018, in rural areas the cousin marriage rate was 85% [11]. According to prof. Salman Kirmani, professor of pediatrics at the Aga khan university in Karachi, children who born from parents who are cousins, have two times more common genetic disorders risk as the 2-3% rate among children of non-related couples [12]. Genetic disorders include infantile cerebral palsy.

A socio-economic gradient in child health has been shown in pre-term birth, low birth weight, and traumas acquired post-natal [13]. However, a socio-economic gradient in cerebral palsy has not been well established [14]. Data are scarce about the incidence and prevalence of cerebral palsy in Pakistan, which has led to a lack of interest from the health care policy makers about this serious problem in children. Diseases have different patterns in different geographical conditions, and they also vary with time. Due to this, we rely upon the data from the West, which cannot be generalized to our socioeconomic and cultural setup. This initiative is taken to overcome the gap and to know the exact pattern of disorders and the burden of disease, which will help us in further research and health care policy making, which also helps us in prevention of cerebral palsy, and to improve the quality of life of patients and their care givers, surviving with cerebral palsy. [15]

In US, the advanced maternal age (maternal age greater than 40 years) and young maternal age (maternal age less than 20 years) are both associated risk factors for the incidence of cerebral palsy [16].

However, the data about maternal age and its association with the incidence of cerebral palsy in Pakistan is unavailable. Cerebral palsy in a major cause of disability in Pakistan. The risk factors of cerebral palsy in Pakistan have been explored in a few studies. Bangesh et.al. , identified that consanguinity and infections during pregnancy were the dominant risk factors for cerebral palsy. [17]. Keramat et.al., reported about consanguinity, jaundice, high-grade fever, maternal anemia, and vaginal delivery [18].

Khan et.al Reported about maternal anemia, low birth weight, and pregnancy-induced hypertension. [19]. Ali et.al. reported on the birth asphyxia, kernicterus, meningio-encephalitis, and prematurity. [20], but these limited studies are not representative of the national estimate for the prevalent risk factors of cerebral palsy in the country. Prevention can only be possible is the risk factors are known. Hence, data collection from all over Pakistan on urgent basis is necessary.

Methodology

Study Design and Sampling Technique: The study design was cross-sectional study and non-probability, purposive sampling technique.

Sample Size and Study Duration: Sample size calculation using Open Epi software, The calculation was based on a confidence level of 95% considering frequency proportion of children with cerebral palsy of 90.2%, [15], and an absolute precision of 5%, resulting in a minimum required sample size of 136. However, the data collected is 112 due to limited recruitment of participant. The study duration was 6th month after the approval of synopsis.

Inclusion Criteria: The study population includes pediatric patients diagnosed with cerebral palsy all over Karachi. Children with cerebral palsy and their mothers or primary caregivers were selected.

Exclusion Criteria: Children with other neurological or genetic disorders, Children with severe comorbid illnesses, Children not residing in Karachi and caregiver with language barrier were excluded from this study.

Study Parameters: Socio-economic status was assessed using B.G Prasad socioeconomic scale, while maternal age was determined through direct questioning and medical records. Consanguinity was evaluated based on direct questioning and family history analysis.

Ethical Approval: Ethical approval for this study was obtained from the Iqra University Institutional Review Board.

Data Collection Procedure: Data collection was carried out through structured or semi-structured interviews with parents or caregivers, as well as self-administered or interviewer-administered questionnaires. Written informed consent was obtained from all participants to ensure anonymity and confidentiality. Participants were fully informed about the study objectives, procedures, potential risks, and their right to withdraw from the study at any point. Medical records were also reviewed to extract relevant clinical and demographic data.

Statistical Analysis: Data was analyzed on IBM SPSS Statistics (Version 25) statistical software

program was used. Descriptive statistics -using mean and standard deviation for quantitative data and frequency and percentages for qualitative data analysis. Inferential statistics using Chi square test for associations.

Results

The participants had a mean age of 6.07 years (SD = 4.23), representing a young cohort with a broad age distribution. Mothers had an average of 2.35 previous pregnancies, indicating a predominantly multiparous group. The mean birth weight was 2.90 kg, suggesting overall normal birth weights with some low-birth-weight cases likely present. The mean age at CP diagnosis was 1.17 years, demonstrating that early identification is essential for timely intervention and management. (Table 1)

Table 1
Demographics of participants

Variables	Mean	Standard Deviation
Age of the Participant (years)	6.07	4.23
Number of Previous Pregnancies	2.35	1.98
Birth Weight of the Child (kg)	2.90	.849
Age of the Child Diagnosed with Cerebral Palsy	1.17	1.11

The study showed no statistically significant associations between maternal age and any studied variables. The Chi-square test results (all $p > 0.05$) indicate that maternal age is not significantly related to prenatal care type ($p = 0.805$), pregnancy complications ($p = 0.906$), mode of delivery ($p = 0.581$), family history of neurological disorders ($p = 0.863$), type of cerebral palsy ($p = 0.445$), or CP severity ($p = 0.168$).

Table 2

Association of maternal age with various predispositions

Variables	Maternal Age					P-Value
	Below 20 years		20 - 30 Years	31 - 40 Years	Above 40 Years	
Access to Healthcare	No checkups	6	6	2	0	0.805
	Occasional checkups	17	37	4	2	
	Regular prenatal checkups	10	22	4	1	
Complications	None	21	44	6	1	0.906
	Diabetes	1	4	0	0	
	Hypertension	6	7	2	1	
	Anemia	5	8	2	1	
	Depression	0	2	0	0	
Mode of delivery	Cesarean section	11	20	2	0	0.581
	Normal Vaginal Delivery	22	45	8	3	
H/O CP or Other Neurological Disorder	Yes	8	12	2	1	0.863
		25	53	8	2	
Type of Cerebral Palsy	Ataxic	2	6	2	1	0.445
	Dyskinetic	0	2	0	0	
	Mixed	2	3	2	0	
	Spastic	29	54	6	2	
Severity of Condition	Mild	17	33	6	1	0.168
	Moderate	16	29	2	2	
	Severe	0	3	2	0	

These findings suggest that maternal age does not substantially influence healthcare access, pregnancy outcomes, or CP characteristics in this population, implying that other factors such as socioeconomic conditions, obstetric factors, or perinatal events may play a more critical role. (Table 2) Pregnancy complications ($p = 0.001$), mode of delivery ($p = 0.001$), family history of CP or neurological disorders ($p = 0.009$), and type of cerebral palsy ($p = 0.001$) were all significantly related to socioeconomic status, with lower-income families experiencing higher rates of complications and cesarean deliveries. However, income and healthcare availability ($p = 0.077$) and CP severity ($p = 0.487$) showed no

significant association. These findings suggest that socioeconomic disparities play a key role in influencing maternal and child health outcomes related to CP.

Discussion

However, CP severity (p = 0.487) was not associated with SES, suggesting other influences such as genetics or perinatal factors. In contrast to Zhou et al., who reported advanced maternal age as a CP risk factor, this study found no significant associations between maternal age and any variables (all p > 0.05). This suggests that in this population, maternal age is not a decisive factor, and socioeconomic or systemic healthcare factors may play a more dominant role [17].

Consistent with Niaz and Ali (2021) and Başaran et al. (2023), parental consanguinity showed significant associations with healthcare access (p = 0.045), pregnancy complications (p = 0.041), family history of CP (p = 0.002), and CP type (p = 0.011), supporting its genetic contribution to CP risk [18]. However, there was no significant relationship with birth type (p = 0.835) or CP severity (p = 0.516), indicating that while consanguinity increases genetic susceptibility, environmental and neonatal care factors likely influence disease severity [19]. Overall, the study highlights socioeconomic disparities and consanguinity as key determinants of CP in this population, emphasizing the need for targeted public health interventions, improved prenatal care, and genetic counseling to reduce CP risk and improve outcomes.

Limitations of Study: This study has certain limitations. First, the sample may not fully represent the diverse socioeconomic, cultural, and healthcare contexts of other regions, limiting the generalizability of the findings. Second, potential confounding factors such as neonatal risks (e.g., preterm birth, birth asphyxia) and environmental exposures were not accounted for, which may have influenced the observed associations. Future studies should address these variables to enhance the validity and comprehensiveness of the results.

Strength of Study: This study explores the under examined links between socioeconomic status**,** maternal age**,** and consanguinity in relation to cerebral palsy risk, offering valuable insights into population-specific risk factors. Its findings fill a gap in existing literature and provide actionable guidance for genetic counseling**,** prenatal care**,** and health policy, supporting targeted interventions to reduce CP prevalence in high-risk groups.

Conclusion

This study found that socioeconomic status and consanguinity are significant risk factors for cerebral palsy (CP), while maternal age showed no meaningful association. Low socioeconomic status was linked to pregnancy complications, family history of neurological conditions, and CP type, though it did not affect CP severity.

Consanguinity correlated with limited healthcare access, increased pregnancy complications, and genetic predisposition to specific CP types, but not with delivery mode or severity. These findings emphasize CP's multifactorial nature, shaped by socioeconomic, biological, and genetic factors. The study underscores the need for public health interventions including awareness of consanguinity risks,

improved prenatal care, and maternal education to reduce CP prevalence and enhance child health outcomes. Recommendations for further research studies longitudinal studies and multivariate modeling will further clarify the complex interplay of these factors, elucidate the causal mechanisms and refine preventive strategies.

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