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PRELIMINARY REPORT

# Seasonal Variations of Cerebral Palsy Births in Northeastern Poland

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*Background.* The objective of this report was to examine the seasonal variations on the incidence of cerebral palsy (CP) in Podlasie province, Poland in a retrospective case-control study.

*Methods.* Data were obtained from the Department of Pediatric Neurology and Rehabilitation. Selected babies were all born between January 1, 1990 and December 31, 1999; 212 children (116 boys, 96 girls) with CP were included in the study. We applied Cosinor analysis to examine the seasonality of CP births.

*Results.* The highest number of CP births occurred in spring and the lowest in winter, with intermediate values in summer and autumn. This seasonal pattern was significant for spring vs. winter. The peaks in CP births occurred in May and August. The lowest number of CP births occurred in February and December. We also demonstrated seasonal variation in CP births in girls and boys and Apgar score. Peaks in CP births in boys were noted in May and October and Apgar score in May and December, respectively. No significant relationship between mean temperature and Apgar score, low birthweight and asphyxia was found.

*Conclusions.* These data suggest the seasonal patterns of CP births. Further studies should be performed with larger numbers of patients. 

*Key Words:* Births, Cerebral palsy, Seasonal variations.

## Introduction

Cerebral palsy (CP) is non-progressive abnormal control of movement or posture. It is the most common cause of physical disability in childhood (1). Several hypotheses have been proposed to explain the origin of CP in preterm babies. It may be the result of an ischemic insult in utero leading to both preterm birth and damage to the white matter (2,3). Immature babies are particularly vulnerable to cerebral hemorrhage and ischemia (4,5). Neonatal factors such as seizures, prolonged ventilation, transfusion, ventilation, sepsis, hyponatremia, and total parenteral nutrition are associated with an increased risk of CP (6,7).

Recently published prospective studies do support that CP is also associated with prenatal risk factors in full-term infants. Twins are more likely than singletons to have antenatal periventricular leukomalacia and CP. The risk is increased if there has been an unusually short interval and/or an unusually long interval since the previous pregnancy (3–5). Spontaneous abortion, stillbirth, asphyxia, congenital malformations and birth weight $<2000$ g are associated with an increased risk of CP. Chromosomal, metabolic, or morphologic aberrations with a genetic basis are more frequently observed in CP patients (4–6).

A better understanding of the etiology of preterm CP is necessary for preventive strategies and treatments to be developed. Seasonal variations may influence disease occurrence (8,9).

If seasonal fluctuations affect birth of children with CP, this may imply that environmental factors (seasons) exert an etiological role in CP. Existing seasonal birth studies were reviewed for multiple sclerosis, Parkinson's disease (9), Down syndrome (10), schizophrenia (11), epilepsy (12), and mental retardation (13). Epilepsy appears to have the most consistent pattern, with an excess of births in winter and

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a deficit in September. Mulitple sclerosis and Parkinson's disease appear to have an excess of spring births. Studies of CP are not conclusive, although there are suggestions that there may be an excess of summer births (14).

We used the data from the Department of Pediatric Neurology and Rehabilitation in Białystok to examine the seasonal variation of CP births in Podlaskie province in this preliminary study.

## Materials and Methods

### *Regional Data*

Podlaskie province is located at latitude 53–54° north, occupies 20,000 km$^2$ and is not highly urbanized, with a population of more than 1.2 million. There are clear seasonal variations in weather conditions. The winters are usually cold and the summers are warm. Bialystok Meteorological Station (Bialystok) for the last 10 years shows mean monthly temperatures ranging across a wide band of −4.5 through +18°C.

### *Patients*

We reviewed the medical records of children with CP referred to our Department of Pediatric Neurology and Rehabilitation in Bialystok. Selected babies were all born between January 1, 1990 and December 31, 1999. The present study included 212 children with CP (116 boys, 96 girls). Details are summarized in Table 1. A group of 212 age- and sex-matched healthy children were recruited as a comparison group. Data were drawn from the hospital database. None of the children had motor impairments, mental retardation or neurological disorders. CP was classified into five clinical subtypes: spastic hemiplegia ($n = 50$), spastic diplegia ($n = 64$), spastic tetraplegia ($n = 66$), extrapyramidal ($n = 19$), mixed ($n = 13$), according to Mutch et al. (3). Inclusion criteria for CP were motor disabilities caused by non-progressive damage to the developing brain, age at study at least 3 years old. Exclusion criteria for CP included progressive damage to the developing brain, metabolic, degenerative and infectious disorders or children aged <3 years.

**Table 1.** Characteristics of subjects with CP and controls

| Variable | CP subjects ($n = 212$) | Controls ($n = 212$) | $p$ value |
|---|---|---|---|
| Gestational age | 24–43 | 26–43 | |
| | 36.80 ± 4.09 | 39.03 ± 1.95 | $p < 0.001$ |
| Girl/boy | 96/116 | 98/114 | NS |
| Number of pregnancies | 1–7 | 1–7 | NS |
| | 2.46 ± 1.57 | 2.09 ± 1.32 | |
| Number of deliveries | 1–7 | 1–7 | NS |
| | 2.23 ± 0.94 | 1.96 ±1.17 | |
| Apgar score at 1 min | 0–10 | 1–10 | $p < 0.001$ |
| | 5.29 ± 3.61 | 8.97 ± 1.89 | |
| Weight at birth | 980–4600 | 1012–4450 | $p < 0.001$ |
| | 2765 ± 831 | 3342 ± 527 | |

$p$ value from; t-test and chi-square; test between groups. NS, not significant.

### *Statistical Analysis*

Data from the 10-year period were pooled for the analyses, and each year was divided into four seasons. Winter included December, January, and February; spring included March, April, and May; summer included June, July, and August; and autumn included September, October, and November. The proportions of CP births and controls in the following months were compared using the chi-square test.

Cosinor analysis (15,16) was used to assess seasonality. This technique is reliable, provided that the data fit a single sine curve; the best fit of a cosine function curve to annual data is then calculated. In this analysis the year is taken as 360°, and the midpoint of each month of the year is assigned an angular value t for January (15°) through to December (345°). Multiple regression analysis is completed between monthly data and sine *(t)* and cos *(t)*. This analysis gives the multiple correlation coefficients ($r$) its significance ($p$) and its angular position in the year where the fitted sinusoidal regression line has its highest value. The extent of the seasonal fluctuation (amplitude A) was measured as the percentage above the mean for the sine curve (the acrophase). The term significance relates here to the presence or absence of seasonality. The 95% confidence interval of odds ratio for the occurrence of CP in spring, summer, autumn and winter compared with controls were obtained in the Statistica.

## Results

Figure 1 shows the distribution of month of birth for children with CP across the four seasons compared with controls.

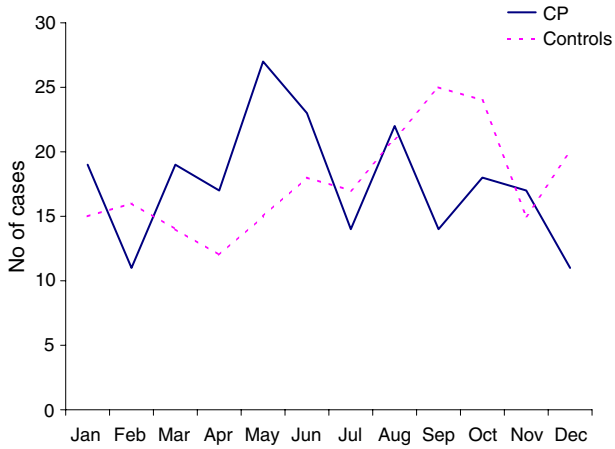


**Figure 1.** Distribution of cerebral palsy (CP) births compared with controls in Podlaskie province, Poland (1990–1999) by month of birth.