Some statistical aspects of children with disabilities in Assam, India

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Abstract: Analysis of data plays a very important role in describing a data set from various angles of interest. It digs out different characteristics intrinsic in the data set. This paper analyses the occurrences of disability in children for gender-wise distribution, rural-urban distribution, and probes any probable relationship of mothers' age with occurrence of disability among newborns. The influence of the parameters like birth-cry, birth-weight, mother's health during pregnancy and severe health problem of the children within a short period after the birth in determining the disability types are analysed through multinomial logistic regression. Analysis of data relating to children with disability may be useful in predicting disability and taking precautionary measures.

Keywords: disability; chi-square test; multinomial logistic regression; odd ratio; autistic; mentally challenged; cerebral palsy; learning disability; delayed speech and language; birth condition; baby's health problem; health problem during pregnancy; India.

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Biographical notes: Jumi Kalita is an Assistant Professor of Statistics in the Lalit Chandra Bharali College, Guwahati, India. She has been teaching statistics to undergraduates for the last 17 years. Her area of research for doctoral studies was statistical analysis of disability data of children. Her areas of interest are reliability, non-parametric statistics, data analysis, etc.

1 Introduction

Data analysing is a very challenging and interesting statistical task. Analysing data relating to children with disability is even more challenging. Establishing relationships of the disability characteristics with pre- and post-birth conditions of the mother and the new born baby would be of great help in predicting disability and taking precautionary measures against it. According to the World Health Organization, the term disability includes all those who not only suffer physical disability but also disabilities that enforce activity limitations, participation limitations and other forms of impairment disabilities. There are more than 93 million children with disabilities in the world, most of who remain excluded from the normal community life (http://www.unicef.org/).

A World Bank study (Elwan, 1999) noted 'the proportion of disabled children in developing countries is generally higher than in developed countries. It is estimated that 6% to 10% of children in India are born disabled and that, because of low life expectancy, possibly one third of the disabled population are children'.

The Indian Census 2011 (Government of India, 2011) reports that 28.6 million persons in the Indian total population (2.21%) are disabled and 7.86 million persons within the age-group 0–19 years (0.65%) are living with disability. Of all persons with disability, 29.32% are in the 0–19 age-group. These data include persons with visual, hearing, speech, physical and mental impairments.

It was observed that the interaction of genetic, environmental, and social factors interacting in complex ways are important determinants of cognitive development and behaviour. Heredity accounts for, at most, about 50% of the variance of cognitive, behavioural, and personality traits among individuals. This information suggests that the other 50% of variability could be due in part to environmental and social factors (Schettler, 2001).

Uses of toxins including lead, mercury, alcohol, and nicotine have been linked to developmental disabilities (Schettler, 2001).

Gao and Wang (2000) made a study to examine the main causes leading to children's disabilities in Liaoning Province, China, during 1990–1992. They found the male/female sex ratio of the disabled children as 190:100. They also found that parents with congenital and genetic diseases are the leading cause of congenitally disabled children.

Nicholas et al. (2007) found the prevalence of autism spectrum disorders (ASDs) and associated characteristics among children in South Carolina, USA as 6.2 per 1,000. They also found other commonly observed features among cases: hyperactivity/attention problems (82%), delayed motor functioning (62%), abnormality in mood/affect (55%), abnormality in eating/drinking/sleeping (54%), temper tantrums (53%), argumentative/oppositional/defiant behaviour (51%). Developmental concerns were noted before 36 months in 85% of cases, with earliest evaluation with an ASD diagnosis at median 57 months and there is no racial inclination to ASD. Their study also reveals the fact that males were more commonly affected than females (2.9:1); however, females were more often cognitively impaired than males (4.1:1).

Plant and Plant (1987) studied the maternal alcohol consumption during pregnancy and birth abnormalities. They found in their extended analysis that women with alcohol problems were not distinctive in relation to the number of birth abnormalities evident amongst their offspring.

Abel (1980) also studied the effects of alcoholism during pregnancy. The most serious effect of in utero exposure to alcohol is mental retardation. Although the physical characteristics associated with the foetal alcohol syndrome (FAS, a pattern of physical malformations observed in the offspring of women who drink alcohol during pregnancy) have been attributed to the direct effects of alcohol, conditions secondary to alcohol intake (e.g., altered nutrition) cannot be eliminated as etiological factors in the impairment in cognitive function. Ornoy and Ergaz (2010) also reports that babies having mothers habituated to using ethanol during pregnancy suffer from developmental delays and a variety of behavioural changes. There is increased chance of developing specific craniofacial dysmorphic features, mental retardation, behavioural changes and a variety of major anomalies in the fetus.

Sachdeva et al. (2009) report that smoking during pregnancy may result in reduced birth weight and birth defects of heart and brain.

Ramakrishnan et al. (1999) reported that severe iodine deficiency results in increase pregnancy loss, mental retardation and cretinism. Infectious diseases in the early childhood may also cause disabilities (Khadaker et al., 2014).

Birth weight is one of the first indicators of newborn's health and future developmental risk, which is a documented on all birth certificate records. Screening infants at birth could be a viable option for early identification of developmental risks (Avchen et al., 2001).

Squarza et al. (2016) reported that children born with extremely low birth weight and extremely low gestational age are particularly vulnerable to learning disabilities at school age associated with attention and emotional difficulties.

Maternal depression and stress during pregnancy are also recognised as risk factors of cognitive development and neurodevelopment outcomes (Bernard-Bonnin, 2004; Glover, 2011).

Many other authors, e.g., Wehmer and Hafez (1995), Ross et al. (1996), Leonard et al. (2007), Field et al. (2004), Braithwaite and Mont (2008, 2009), Memisevic and Sinanovic (2009), etc., studied different aspects of data relating to disability in children.

From literature, it is found that there are studies linking different types of disabilities with a variety of probable factors. In this study, a predictive analysis has been attempted based on some expressions of effects. The objective of this study is to observe some symptoms like birth-cry, birth-weight, mother's health during pregnancy and severe health problem of the children within a short period after the birth and use them to predict disabilities in babies. This will help in early detection of disabilities in babies. Early detection will help in early treatment, thereby increasing the possibility of improvement of conditions.

2 Materials and methods

This study aims at analysing the characteristics related to disability for male-female and rural-urban proportion of disabled children, studying the effects of the parameters on type of disabled children with respect to birth-weight, birth-cry, and mother's health during pregnancy, severe problem occurring to the children just after the birth, etc., using multinomial logistic regression. For the study, 518 sets of medically approved secondary data were collected from selected institutions (namely, NIPCCD, Monbikash Kendra, Shishu Sarathi, etc.) in Guwahati, North-East of India and categorised according to disability and need. These institutions were created especially for these special children who are in distress or mentally challenged (MR). In the collected data, five types of disabilities were mainly encountered, so, analyses were done with respect to these types.

2.1 Multinomial logistic

Multinomial logistic regression is a model that is used to predict the probabilities of the different possible outcomes of a categorically distributed dependent variable (nominal), given a set of independent variables (which may be real-valued, binary-valued, categorical-valued, etc.). It is a straightforward extension of logistic models.

The following are the assumptions applied in this method (Whelan and Maitre, 2008):

- Data are case specific; that is, each independent variable has a single value for each case.
- Dependent variable cannot be perfectly predicted from the independent variables for any case.
- Independent variables may not be statistically independent.
- Independence of irrelevant alternatives which is not always desirable.

The basic principle of multinomial logistic regression is similar to that for binomial logistic regression and it is based on the probability of membership of each category of the dependent variable. The way multinomial logistic regression deals with the variables is somewhat similar to the concept of dummy variables that it compares the probability of being in each of (n – 1) categories compared to a baseline or reference category. In a way, we can say that it fits (n – 1) separate binary logistic models, where it compares category 1 to the baseline category, then category 2 to the baseline and so on. Therefore, multinomial logistic regression is basically an extension of binary logistic regression for nominal variables with more than two categories. In multinomial logistic regression, firstly, the probabilities for each category of the dependent variable are given and secondly the probabilities for each category of the independent variables within this are given.

The model is given by

$$\Pr(y_i = j) = \frac{\exp(x_i \beta_j)}{1 + \sum_{j=1}^{J} \exp(x_i \beta_j)} \tag{1}$$

where for the i^{th} individual, y_i is the observed outcome and X_i is a vector of explanatory variables. The unknown parameters β_j are estimated by the maximum likelihood estimation.

2.2 Chi-square test

For a 2 × 2 contingency table

a	*b*
c	*d*

The chi-square statistic is given by

$$\chi^2 = \Sigma \frac{\left(O_{ij} - E_{ij}\right)_j^2}{E_{ij}}$$

where O_{ij} = observed frequency, E_{ij} = expected frequency for i = 1, 2; j = 1, 2 ,where o_{11} = a, o_{12} = b, o_{21} = c, o_{22} = d and

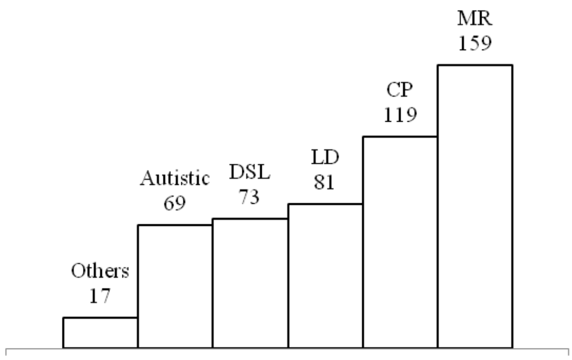
$$E_{11} = \frac{(a+b)(a+c)}{N}, E_{12} = \frac{(a+b)(b+d)}{N}, E_{21} = \frac{(a+b)(b+d)}{N},$$
$$E_{22} = \frac{(b+d)(c+d)}{N}, N = a+b+c+d.$$

The value of this chi-square statistic (calculated value) is compared with the standard value of chi-square (tabulated value) with some pre-assigned probability level of significance. If this calculated value is greater than the corresponding tabulated value than the test hypothesis is rejected at that probability level of significance otherwise it may be accepted.

3 Results and discussions

Figure 1 shows the category-wise distribution of children with disabilities in the special institutions. Table 1 and Figures 2 and 3 show the urban-rural and male-female ratios of children with disabilities of different types. Except for the cerebral palsy (CP) category, more urban children with disabilities are enrolled in the special schools and the urban-rural ratio is 1.96:1.00. This is contrary to the findings of the National Sample Survey Organization (NSSO), India, which showed that the occurrence of disability in rural areas was slightly higher than in urban areas (Government of India, 2011). So, this data implies that urban children with disability are availing special education more than the rural one. The missing enrolment of rural children in the special schools may be the result of the lack of awareness among the rural guardians, poor financial condition or inconvenience to bring these children to the institutions from far-flung rural areas. Till now the spread of special education is not satisfactory in the North-East India and there are hardly any special education institutions in small towns, let alone the rural areas. Also, the infrastructures and facilities available in the normal schools of this area are not enough for imparting inclusive education to these special children.

Figure 1 Category-wise distribution of children with disabilities



It also reveals the fact that out of total special children admitted to the institutions, number of male child is more than the female child and the ratio is 2.26:1.00. This conforms to the report of NSSO (Government of India, 2011), which states that there are more male children with disabilities than females. Some previous studies (Nicholas et al.,

2007) also show that the disability is more likely to occur in case of male child. The lower enrolment of the girl children in the special schools may be because of the lower occurrence or many of the female cases may not be reported or brought to these institutions because of the gender inequality in the area of study.

Table 1 Category-wise male-female and urban-rural ratios

Type of disability	*Ratio*	
	Male : female	*Urban : rural*
Autistic	3.31:1	1.56:1
MR	1.3:1	2.98:1
CP	1.79:1	0.76:1
LD	2.17:1	11.17:1
Delayed speech and language (DSL)	2.68:1	3.36:1
Together	2.26:1	1.96:1

Figure 2 Rural-urban divisions of all disabled children

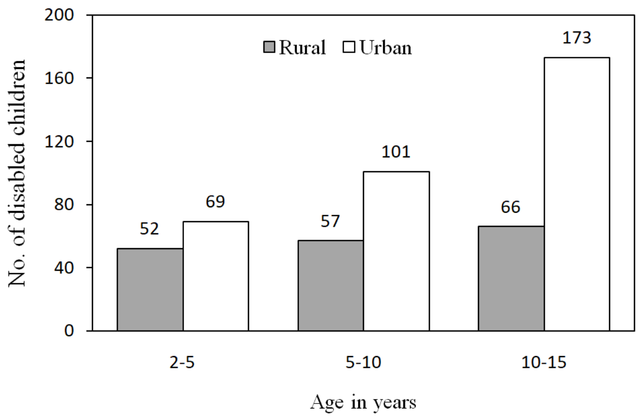
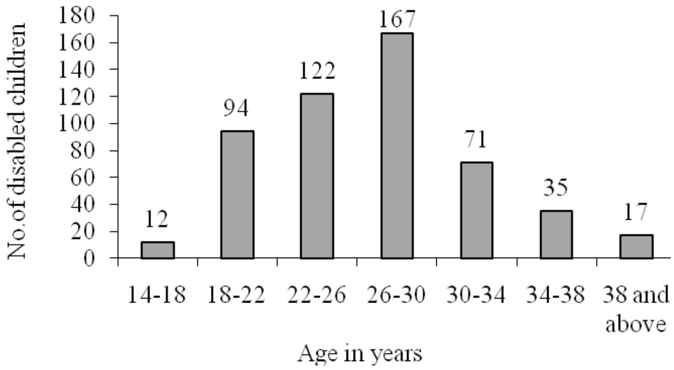


Figure 3 Male-female distributions of children with disabilities

The occurrence of disability against different age group of mother has been presented in Figure 4. A chi-square test with available data for this study provides *no relation between disability and mother's higher age*. It is seen that most of the cases come from the group of mothers' ages 26–28 and 26–30. However, it must be considered that these are the age groups when women of the region under study get married and have children. So, this group also provides the maximum number of births.

Figure 4 Number of disabled children against mother's age at the time of birth



A chi-square test is conducted to test the null hypothesis.

Ho There is no relation between mother's health during pregnancy and baby's health within a short period after birth.

This results in rejection of null hypothesis at 5% probability level of significance.

An investigation is made to see if any relationship exists between pre and post-birth conditions of the mother and baby with the disability characteristics of the child with disability. Based on such a relationship, it would be very useful in predicting disability and its type and taking precautionary and management measures. For this, multinomial logistic regression analysis is used. The different parameters, in this study, taken as symptoms of disability for a new born are:

1 absence of birth cry

2 low birth weight

3 baby's serious visible health problem within a short period of birth

4 mother's health problem including mental stress during pregnancy.

The data have been analysed using SPSS taking autistic type of disability as the reference group. The results show that the parameters considered in this study offer a good prediction of the type of child disability. The result is presented in Table 2.

a The reference category is autistic.

As far as birth cry is concerned, absence of birth cry is an important indication of subsequent CP and multiple disability conditions. Low birth weight is prominent in almost all the types of disabilities. Similarly, baby's problem at birth results in the highest odd ratio at multiple and lowest at DSL categories. Mother's health problem is observed to be the highest in MR category, also it is large at learning disabled (LD) and multiple categories and the lowest at CP category.

Table 2 Discussions of results of parameters estimates of logistic regression

Type	*Absence of birth cry (BIRTHCRY)*	*Low birth weight (BIRTHWT)*	*Baby's health problem during a short period just after birth (BPROB)*	*Mother's health problem during pregnancy (MPROB)*
MR	p-value = 0.174 no significant relations of MR with birth cry. Odd ratio = 0.357, i.e., Babies without birth cry are less likely to fall in MR category than babies with birth cry.	p-value = 0.003 implies the significant relation of MR with birth weight. Odd ratio=7.352, i.e., Babies with low birth weight are more (seven times more) likely to fall in MR category than babies with normal birth weight.	p-value = 0.069 no significant relation of MR with baby's health problem during a short period just after birth. Odd ratio = 3.397, i.e., Babies with health problem after a short period of time of birth are more (three times more) likely to fall in this category than babies with normal health.	p-value = 0.000 implies the significant relation of MR with mother's health problem during pregnancy. Odd ratio = 16.014, i.e., babies having mother with health problem during pregnancy are more (16 times more) likely to fall in MR category.
CP	p-value = 0.117 not significantly associated. Odd ratio = 3.793 i.e. Babies with absence of birth cry are more likely to fall in CP category	p-value = 0.020 significantly associated (at 5% probability level of significance). Odd ratio = 7.925, i.e., Babies with low birth weight are more likely to fall in CP category.	p-value = 0.181 not significantly associated. Odd ratio = 2.947, i.e., babies with health problem after a short period of time of birth are more likely to fall in CP category.	p-value = 0.582 not significantly associated. Odd ratio = 1.624, i.e., babies having mother with health problem during pregnancy are more likely to fall in CP category.
LD	p-value = 0.016 significantly associated (at 5% probability level of significance). Odd ratio = 0.145, i.e., Babies without birth cry are less likely to fall in LD category.	p-value = 0.007 significantly associated(at 1% probability level of significance). Odd ratio = 5.681, i.e., babies with low birth weight are more likely to fall in LD category.	p-value = 0.158 not significantly associated. Odd ratio = 2.507, i.e., babies with health problem after a short period of time of birth are more likely to fall in LD category.	p-value = 0.001 significantly associated(at 1% probability level of significance). Odd ratio = 9.719, i.e., babies having mother with health problem during pregnancy are more likely to fall in LD category.

Table 2 Discussions of results of parameters estimates of logistic regression (continued)

Type	*Absence of birth cry (BIRTHCRY)*	*Low birth weight (BIRTHWT)*	*Baby's health problem during a short period just after birth (BPROB)*	*Mother's health problem during pregnancy (MPROB)*
DSL	P-value = 0.030 significantly related.	p-value = 0.010 significantly related.	p-value = 0.985 not significantly associated.	p-value = 0.035 significantly associated.
	Odd ratio = 0.182, i.e., babies without birth cry are less likely to fall in DSL category.	Odd ratio = 5.084, i.e., babies with low birth weight are more likely to fall in DSL category.	Odd ratio = 1.013, i.e., no difference appear for babies with or without health problem after a short period of time of birth for this category.	Odd ratio = 4.092, i.e., babies having mother with health problem during pregnancy are more likely to fall in DSL category.
MULTIPLE	p-value = 0.779 not significantly associated.	p-value = 0.001 significantly associated.	p-value = 0.026 significantly associated.	p-value = 0.000 significantly associated.
	Odd ratio = 1.216, i.e., babies without birth cry are more likely to fall in MULTIPLE category.	Odd ratio = 8.448, i.e., babies with low birth weight are more likely to fall in MULTIPLE category.	Odd ratio = 4.223, i.e., babies with health problem after a short period of time of birth are more likely to fall in MULTIPLE category.	Odd ratio = 10.656, i.e., babies having mother with health problem during pregnancy are more likely to fall in MULTIPLE category.

4 Case studies

The predictions derived in Section 3 above are based on collected data. Two case studies were made by the author, which are summarised here.

Case 1

Gender – male, present age – 22 years

Type of disability – CP

Mother's age – 25 years at the time of conception. First baby.

Mother's health problem during pregnancy – in the 5th month of pregnancy, she faced breathing problem and became unconscious. She was hospitalised and given oxygen.

Birth condition – the delivery was vaginal, but forceps had to be used. There was no birth cry.

Baby's health condition after birth – at the age of six month, the baby started vomiting frequently. In the 8th month, he was diagnosed to have appendicitis and appendectomy was done.

Diagnosis of disability – the baby was diagnosed with CP at the age of nine months.

Case 2

Gender – male, present age – 14 years

Type of disability – mentally challenged, hyperactive

Mother's age – 31 years at the time of conception. 2nd baby.

Mother's health problem during pregnancy – used abortive medicine in the 2nd month of pregnancy without consulting doctor. Abortion was not successful.

Birth condition – the delivery was normal (vaginal). There was no birth cry.

Baby's health condition after birth – all psychomotor developments were delayed.

Diagnosis of disability – the baby was diagnosed to have development delay at the age of 3 months. Declared to be MR at the age of eight years.

In both the above cases, there were some distinct predictor symptoms in favour of impending disability.

5 Conclusions

The findings of this study are:

- Higher number of disability cases availing the facilities of special education is from the urban areas than the rural areas.
- The number of children with disabilities is higher in males than in females.
- Mother's age is not found to have significant affects in the birth of a baby with disabilities.
- The chi-square test shows that mother's health during pregnancy and baby's health at the time of birth is significantly related, and birth cry and CP is significantly related.
- Mother's health during pregnancy contributes significantly for the occurrence of disability in children.
- Absence of birth cry is an indication of CP and multiple disability conditions. Low birth weight may be indicative of any type of disability. Similarly baby's problem at birth is more indicative of multiple disability conditions, but it is less indicative of DSL. Mother's health problem is observed to be the highest in MR category, it is also more for LD and multiple categories, but is the least indicative of CP category.
- In the objectives of this study, four symptoms were taken up for examination of their linkage with disabilities. These four symptoms viz.

1 birth cry
2 baby's health at the time of birth
3 mother's health during pregnancy
4 low birth weights are found to be determining factors in predicting disabilities in children.

The following measures can be the recommended based on the above findings:

- Special education centres need to be setup in rural areas to meet the requirements of increasing number of population with disabilities in those areas.
- Proper care of the mothers during pregnancy is required to reduce the risk of having a baby with disability.

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