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# Analysis of Risk Factors in Children with Suspected Developmental Delays on the Denver Developmental Screening Test*

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= Abstract =

**Purpose:** This study was conducted to estimate the prevalence of questionable development according to developmental screening testing for children, and to explore biological and environmental risk factors of developmental delays. **Method:** The study participants were 153 children under two years of age. A questionnaire and Home Observation for measurement of the Environment (HOME) inventory were used to collect data, and Korean Denver II was administered. **Results:** The overall prevalence of questionable development was 11.1%. Significant differences in biological factors between the normal development group and questionable development group were the rate of prematurity, twins, the educational level of mother and father's and the presence of an illness in the mother ($p<.10$). Maternal acceptance in HOME was significantly different between the two groups. The factors related to questionable development that were significant in the logistic regression analysis were prematurity (OR=3.56, p=.026), and maternal acceptance in HOME score (OR=.629, p=.028). **Conclusion:** Early developmental screening tests seem necessary for all children, especially for prematurely born children. Also, child rearing environments were identified as significant factors in the development of all children. These findings suggest that the HOME scores might be useful in identifying children at risk for developmental delays, and that interventions for these children will probably be more effective if their mothers are helped to provide a more appropriate social environment.

Key words : Development, Developmental disabilities, Parents, Risk factors
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# Introduction

Child development is an important determinant of health over the course of life. The early years of life are a period of considerable opportunity for growth, or vulnerability to harm (Anderson et al., 2003). Therefore, it is of great importance that children with developmental delays are identified as early as possible. Developmental screening is one of several strategies in the prevention and amelioration of developmental disabilities and their sequela (Sonnander & Claesson, 1999). In the United States and European countries, developmental screening is an essential part of health care, and nurses are recognized as an important member of interdisciplinary team for the care of children and families (Stepans, Thompson, & Buchanan, 2002). However, the importance of developmental screening had not been valued until recently in Korea. Only some public health centers started preliminary developmental screening project just a few years ago (Bang, Kim, Park, & Lee, 2002; Han, Bang, & Yun, 2001).

The rate of developmental delays has been increasing with the increment of premature births and their survival rates. According to a recent estimate, 12% to 16% of American children have developmental or behavioral disorders (American Academy of Pediatrics, 2001). But in Korea, precise incidence rate of developmental delays is still unclear, and only the premature birth rate is estimated about 8% (Committee on the data collection and statistical analysis, The Korean Society of Neonatology, 2005). Recently, prematures have been registered at public health centers, but systematic analysis or follow up care has not been performed yet (Oh, Lee, & Lee, 2004).

To identify developmental problems earlier and prevent complications, the predictions of risk factors are very important. Complex relationships between biological and environmental factors are known to influence developmental courses and outcomes (Sonnander & Claesson, 1999). As biological factors, premature birth, congenital anomalies, perinatal brain injuries, pregnancy and delivery related complications were reported (Hollomon, Dobbins, & Scott, 1998), and as environmental risk factors, maternal education levels, socioeconomic status, maternal depression, relationship with caregivers, home environment, family functioning, social support, and so forth were reported in previous researches (Beck, 1999; Bradley & Corwyn, 2002; Liaw & Brooks-Gunn, 1993; To, Cadarette, & Liu, 2001). Among various environmental factors, the quality of parenting is crucial for child development, and research has found that what goes on in the early years can have a vital influence on later outcomes (Burston, Puckering, & Kearney, 2005). However, studies on overall risk factors affecting child development are still very limited in Korea.

Therefore, it was attempted in this study that finding questionable developmental delays in Denver developmental screening test, and determining the risk factors for developmental delays by comparing biological, and environmental characteristics between normal development group and questionable development group. In short, the purpose of this study was to estimate the prevalence of developmental delays, and to find the risk of a poor developmental outcome associated with exposure to various biological and environmental risk factors. The results of this study can be used to plan prevention of developmental disorders and intervention services.

# Methods

## Research design

This study was exploratory research to determine the biological and environmental risk factors of developmental delays in children under age two years.

## Subjects

The subjects were 153 children under 24 months-old, consisting of 46 prematures and 107 full-terms residing in two cities in the Kyung-gi province.

## Instrument

- Developmental screening test

Korean Denver II (Shin, Han, Oh, Oh, & Ha, 2002) was administered for developmental screening. This instrument is applicable to children under 6 years, and test result is divided as normal development, questionable development, and untestable. Up to 24 months of age, if the child was born prematurely, correct the age by subtracting the number of weeks of missed gestation from present age. There are 4 subscales of personal-social, fine motor-adaptive, language, and

motor development. The sensitivity and specificity of Korean Denver II were 0.82 and 0.62 (Shin, Kwon, & Lim, 2005). Total items consisted of 110 and about 25-30 items are tested for one developmental screening. The average screening time was about 30 minutes.

● General characteristics

Information was collected on the following general characteristics: child's gender, birth order, and age, mother's job, family type, mother' and father's age.

● Obstetrical related characteristics

Obstetrical related characteristics included maternal smoking and drinking habits in pregnancy, delivery type, complication.

● Biological factors

Biological factors were child's prematurity, birth weight, twin, disease and mother's disease.

● Environmental factors

Environmental assessed factors included parent's education level, family income, living region, family type. Home Observation for Measurement of the Environment (HOME), mother's depression, family functioning, and social support were also measured.

• Home Observation for Measurement of the Environment (HOME) inventory

HOME inventory (Caldwell & Bradley, 1984) was used to assess the quality of children's immediate home environment during a home visit. This inventory has been widely used in studies of children's health and development not only in America but also in Korea. It consisted of 45 binary-choice items clustered into a HOME total score and six separate subscales; 11 items of responsiveness, 8 items of acceptance, 6 items of organization, 9 items of learning materials, 6 items of involvement, and 5 items of variety. A high score meant psychological stimulation and cognitive support available in the home environment. Cronbach's α was .72 in this study.

• Mother's depression

Mothers' depression was assessed using the Beck Depression Inventory (BDI). This instrument was 4 point 21-items Likert scale (Rhee et al., 1995), and Cronbach's α in this study was .79. Greater than 21 point was classified as having depression.

• Child-rearing burden

Child-rearing burden was measured with Han's inventory which was 4 point 20-items Likert scale, and validity and reliability of the inventory was reported (Han, 1997). Cronbach's α in this study was .89. A high score meant the mother felt high level of child-rearing burden.

• Family functioning

Family functioning was assessed using the Lee's Korean family function instrument (Lee et al., 2002) that was 4 point 24 items Likert scale, and subscales are consisted of affective bonding, external relationship, family norm, roles and responsibilities, communication, and financial resources. The higher the score, the better the family functioned. Construct validity was confirmed and Cronbach's α was .87 in Lee's study, and .88 in this study.

• Social support

Social support was measured by Park's (1985) instrument, 4 point 25 items Likert scale, and subscales are consisted of emotional support, informational support, material support, and evaluative support. Construct validity was confirmed (Park, 1985) and a high score meant the mothers received high support from significant others. Cronbach's α in this study was .96.

## Procedures

Data was collected from September 2004 to March 2005. In two public health centers in two other cities, prematures under 24 months old were listed. Researcher called them on the telephone and visited their home if they agreed to participate, and there were 46 prematures and their mothers. For full term babies, researcher contacted mothers who visited public health centers, and 107 mothers agreed to participate. Denver II screening tests and questionnaire were performed at the public health centers or at their home. Two nurses of public health centers enrolled Koran Denver II training courses, and at the Researcher made an appointment for home visiting, and HOME was scored by researcher or a research assistant. Before starting HOME scoring, an education on the measurement for research assistant was performed and an

inter-rater agreement of 90% between the researcher and the research assistant in HOME was established.

### Data analysis

The data was analyzed using SPSS Win 12.0 program. Comparison of normal development group and questionable development group was analyzed by $\chi^2$-test and t-test. Logistic regression was used to analyze the odds ratio to detect significant predictive risk factors for developmental delays. The significant level was p<.10 because the number of questionable development group was so small that not to lose possible differences of these two groups.

## Results

### Results of developmental screening

Developmental screening was performed using Korean Denver II, and 136 (88.9%) subjects classified as normal development, and 17 (11.1%) classified as questionable development. Among full-term children, the rate of questionable development was only 6.5% whereas the rate for prematurely born children was 21.7% <Table 1>.

<Table 1> Result of developmental screening using Korean Denver II (N=153)

| Categories | Full-term n(%) | Premature n(%) | Total n(%) |
|---|---|---|---|
| Normal development | 100(93.5%) | 36(78.3%) | 136(88.9%) |
| Questionable development | 7( 6.5%) | 10(21.7%) | 17(11.1%) |

### Comparison of characteristics between normal and questionable development group

● General characteristics for two groups

General characteristics such as gender, birth order, education level and mother's job, living region, family type, and child's and parent's age between normal development group and questionable development group were compared. There were no significant differences in general characteristics between these two groups <Table 2>.

● Obstetrical related characteristics for two groups

Mother's obstetrical related complications, experience of smoking and drinking during pregnancy of these two groups were compared, and significant differences between these two groups were not found <Table 3>.

● Biological characteristics for two groups

Prematurely born children (p=.006) and twins (p=.003) showed significantly high rates of questionable development at the significant level of p<.05. Also, when mothers had diseases such as anemia, ecclampsia, diabetes, or heart disease, the rates of questionable development of their children were significantly higher than those of healthy mothers (p=.080) at the significant level of p<.10 <Table 4>.

<Table 2> Comparison of general characteristics for normal and questionable development groups

| Variables | Categories | n(%) or M±SD: Normal development (n=136) | n(%) or M±SD: Questionable development (n=17) | $\chi^2$ or t | p |
|---|---|---|---|---|---|
| Gender | Male | 67(85.9) | 11(14.1) | 1.442 | .230 |
| | Female | 69(92.0) | 6( 8.0) | | |
| Birth order | First | 78(90.7) | 8( 9.3) | .651 | .420 |
| | >Second | 58(86.6) | 9(13.4) | | |
| Mother's job | None | 108(88.5) | 14(11.5) | - | >.999[a] |
| | Have | 28(90.3) | 3( 9.7) | | |
| Living region | Cities | 122(89.7) | 14(10.3) | - | .407[a] |
| | Rural | 14(82.4) | 3(17.6) | | |
| Family type | Nuclear | 125(88.7) | 16(11.3) | - | >.999[a] |
| | Expanded | 11(91.7) | 1( 8.3) | | |
| Child's age(month) | | 11.06±6.34 | 13.12±4.71 | -1.292 | .198 |
| Father's age(year) | | 33.74±3.94 | 34.47±2.96 | -.742 | .459 |
| Mother's age(year) | | 31.24±3.40 | 31.29±3.63 | -.067 | .947 |

[a] Fisher's exact test

<Table 3> Comparison of obstetrical related characteristics for normal and questionable development groups

| Variables | Categories | n(%) or M±SD | | $\chi^2$ or t | p |
|---|---|---|---|---|---|
| | | Normal development (n=136) | Questionable development (n=17) | | |
| Delivery type | Normal delivery | 72(90.0) | 8(10.0) | .210 | .647 |
| | Cesarean section | 64(87.7) | 9(12.3) | | |
| Pregnancy complication | None | 112(82.4) | 13(76.5) | - | .517[a] |
| | Have | 24(17.6) | 4(23.5) | | |
| Smoking during pregnancy | None | 132(97.1) | 16(94.1) | - | .450[a] |
| | Have | 4( 2.9) | 1( 5.9) | | |
| Drinking during pregnancy | No | 120(92.3) | 14(87.5) | - | .622[a] |
| | Yes | 10( 7.7) | 2(12.5) | | |

[a] Fisher's exact test

<Table 4> Comparison of biological characteristics for normal and questionable development groups

| Variables | Categories | n(%) or M±SD | | $\chi^2$ or t | p |
|---|---|---|---|---|---|
| | | Normal development (n=136) | Questionable development (n=17) | | |
| Prematurity | Full-term | 100(93.5) | 7( 6.5) | 7.523 | .006 |
| | Premature | 36(78.3) | 10(21.7) | | |
| Single or twin baby | Single | 128(90.8) | 13( 9.2) | - | .030[a] |
| | Twin | 8(66.7) | 4(33.3) | | |
| Mother's disease | None | 93(68.4) | 8(47.1) | 3.062 | .080 |
| | Have | 43(31.6) | 9(52.9) | | |
| Baby's ventilation | Didn't use | 124(91.2) | 15(88.2) | - | .656[a] |
| | Used | 12( 8.8) | 2(11.8) | | |
| Baby's disease | None | 102(75.0) | 13(76.5) | - | >.999[a] |
| | Have | 34(25.0) | 4(23.5) | | |
| Birth weight(kg) | | 2.92±7.49 | 2.45±8.34 | 1.820 | .071 |

[a] Fisher's exact test

● Environmental characteristics for two groups

Mother and father's education levels were significantly associated with an increased risk for developmental problems at the significant level of p<.10. In the group of parent's education level that were high school or below, 16.2% of children classified as questionable development whereas 7.1% were classified as questionable development in the group of higher education. Because mothers are the primary environment for their children, mother's child rearing burden and depression were included as environmental characteristics. Also, family functioning and social support were included as environmental variables. HOME total score was 31.83 for normal development group and 30.18 for questionable development group, but the difference was not statistically significant. But in HOME subscale, maternal acceptance of children for normal development group of 5.71 is significantly higher than that of questionable development group of 4.88 (t=2.742, p=.007). Child rearing burden, mother's depression, family function, and social support were not significantly different between two groups <Table 5>

## Risk factors of developmental delays

In order to examine the association between biological and environmental factors and child development, logistic regression analyses were performed. Significant affecting factors at the significant level of p<.10 were prematurity, twin, birth weight, mother and father's education level, presence of mother's disease, and maternal acceptance in HOME score. In logistic regression, too many independent variables make it difficult to find significant predictive factors. In this study, among these factors, prematurity, twin, and birth weight are highly correlated, so only prematurity was included for the independent variable in logistic regression. Also, mother and father's education levels were highly correlated, so only mother's education level was included. Therefore, logistic

<Table 5> Comparison of environmental characteristics for normal and questionable development groups

| Variables | | n(%) or M±SD Normal (n=136) | Questionable (n=17) | t | p |
|---|---|---|---|---|---|
| Mother's education | <High school | 57(83.8) | 11(16.2) | 3.180 | .075 |
| | >Junior college | 79(92.9) | 6( 7.1) | | |
| Father's education | <High school | 43(82.7) | 9(17.3) | 3.062 | .080 |
| | >Junior college | 93(92.1) | 8( 7.9) | | |
| Family income (million won) | | 32.22±12.59 | 30.12±12.32 | .651 | .516 |
| HOME total | | 31.83 ±4.74 | 30.18± 4.30 | 1.368 | .173 |
| Organization | | 4.44± 1.01 | 4.05± .97 | 1.479 | .141 |
| Learning materials | | 5.03± 2.46 | 5.35± 2.32 | -.515 | .608 |
| Variety | | 3.48± 1.10 | 3.24± 1.09 | .862 | .390 |
| Involvement | | 3.96± 1.38 | 3.53± 1.17 | 1.222 | .224 |
| Acceptance | | 5.71± 1.13 | 4.88± 1.54 | 2.742 | .007 |
| Responsiveness | | 9.21± 1.33 | 9.12 ±.99 | .286 | .775 |
| Child rearing burden | | 47.28± 9.11 | 44.81± 9.80 | 1.014 | .312 |
| Mother's depression | | 8.91± 5.52 | 8.00± 5.36 | .639 | .524 |
| Family functioning | | 76.43± 8.93 | 76.12± 8.35 | .135 | .892 |
| Social support | | 79.56±11.37 | 79.94±11.50 | -.132 | .895 |

HOME; Home Observation for Measurement of the Environment

<Table 6> Logistic regression analyses for variables predicting developmental delays

| Variables | Criteria | B | SE | Wald | p | OR | 95% CI |
|---|---|---|---|---|---|---|---|
| Prematurity | (0: Full-term) | 1.243 | .559 | 4.939 | .026 | 3.467 | 1.158-10.376 |
| Mother's education | (0: <High school) | -.783 | .570 | 1.885 | .170 | .457 | .149- 1.398 |
| Mother's disease | (0; None) | .655 | .558 | 1.376 | .241 | 1.924 | .645- 5.743 |
| HOME-acceptance | | -.453 | .206 | 4.843 | .028 | .636 | .424 -.952 |
| Model Chi-square 15.457(df=4) p=.004 | | | | | | | |

regression with enter type was performed with Denver II as a dependent variable, and prematurity, mother's education level, presence of mother's disease, and acceptance in HOME as independent variables. The rates of developmental delays and odds ratios (OR) and 95% confidence intervals (C.I.) are presented in <Table 6>. As Table 6 shows, the possibility of questionable development was markedly higher in prematures than full term babies (OR=3.467, p=.026). It was decreased to .629 according to maternal acceptance in HOME score. Relative risk was 1.89 times higher in mothers with disease, but it was not a significant predictive variable <Table 6>.

## Discussion

Early childhood development is influenced by characteristics of the child, the family, and the broader environment. This study was performed to provide insight into the early detection and early intervention for child development by analysing risk factors for developmental delays. Influencing factors on the child development are biological and environmental conditions, and these affect children in a complicated way.

This current study showed that prematurity was significantly associated with increased risk for developmental problems. Studies on the later developmental consequences of prematures were performed extensively in other countries, and prematurity was reported as a primary risk factor for developmental delays. Stoelhorst et al. (2003) followed prematures under 32 weeks gestation at the corrected age of 18 months and 24 months, and reported 40% of the children at both age showed moderate to severely delayed development, and suggested early developmental screening. Winter, Autry and Boyle (2002) also reported 32% of low birth weight under 1,500gm showed cerebral palsy in their follow up study. In Taiwan, 15.4% of the low birth weight babies under 2,000g and 2.5% of the full term babies showed developmental delays at age two, and significant correlations of developmental outcomes for the cases were birth weight, gestational age, and maternal education (Wang, Wang, Huang, & Lin, 1998).

According to Vohr and Garcia-Coll's study (1985), extremely low birth weight (ELBW) infants were classified as normal,

suspect, and abnormal based on 1-year neurological assessment, and compared the neurological findings at 7 years of age. Seventy seven percent of the normal group, 58% of the suspect group, and 100% of the abnormal group remained in the same neurologic category at 7 years of age. Therefore, developmental screening for early detection and continuous monitoring are necessary for high risk groups such as prematures.

Not only biological risk factors like prematurity, but also social risk factors, such as low socioeconomic status of the parents, may have negative effects on children's development (Bradley & Corwyn, 2002). In this study, maternal education and presence of maternal disease were different between normal and questionable developmental groups. Sonnander and Claesson(1999) performed development tests at 18 months and observed school performance later, and also concluded that optimality score of prenatal and postnatal condition and maternal education constituted the best predictors of school achievement problems.

In addition, it was determined that the physical, cognitive, and emotional home environment (HOME) were affecting factors for development. HOME was reported as a major factor for child development in Korea(Bang, 2000; Han et al., 2001), and in other countries (Tong, Baghurst, Vimpani, & McMichael, 2007). In this study, although the total score of HOME was not significantly different in two groups, one subscale of HOME, maternal acceptance of child's behaviors was higher in the normal development group than that of the questionable development group, and it was confirmed as a significant predictive factor in logistic regression. This means that emotional environment, especially the mother's child rearing attitude, is more important than physical or cognitive stimulation in child development.

Beck (1999) and Burchinal, Roberts, Hooper, and Zeisel (2000) reported mother's depression, stress, and mother's involvement as significant factors for children's development. But in this study, significant variables affecting child development among mother's burden, depression, family function, and social support were not found, so this study did not support previous researches.

Mothers with developmental problems can be unhealthy due to heavy burden and stress, and as a result, the quality of child care can be threatened (Oh, 1997). Tak and Lee (1997) reported that families with disabilities experienced higher level of stress and had more problems in family adaptation if they perceived a lack of social support. But in this study, these emotional factors were not significantly different between the normal and questionable development groups. It is assumed that there is no difference in the two groups, because most of the subjects who permitted a home visit and participated in this study did not have severe problems in depression, family functioning, and social support.

As a result of this study, it is confirmed that prematurity is a major risk factor, and environmental factors such as maternal acceptance can also be a relating factor for child development. Although children have biological risk factors already, it can be intervened by nursing services. It is suggested that developmental screening is used in a routine health check ups for children in Korea, especially for the vulnerable group of children under the age of three in order to detect developmental problems earlier, and provide proper interventions.

## Conclusions

This study is meaningful because it considers complex biological and environmental variables simultaneously, and analyzes risk factors for developmental delays, and also because this kind of study is still very limited in Korea. These findings from this study indicate that prematurity and the mother's acceptance score in HOME were the most significant predictive factors for child development. These findings suggest that prematurity has a lasting adverse effect on early development, and developmental screening is necessary for all children, especially for prematures. Also, nursing interventions need to be developed and applied for facilitating the child rearing environment. Replication study with bigger samples and prospective studies may be needed to confirm our findings, because some of the variables could not be analyzed as significant factors due to the small number of children with questionable development subjects in this study.

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