

A STUDY ON THE RELATIONSHIP BETWEEN BIRTH WEIGHT OF CHILDREN AND ADOLESCENTS WITH DISABILITIES AND THE CURRENT INCIDENCE OF DISEASES IN INFORMATION SYSTEMS

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ABSTRACT

Against the backdrop of increase in low birth weight babies recently in Korea, this study aimed to examine their health problems after growing up compared to those at the same age born with normal weight and to provide basic data in information systems for preventive measures. Particularly, the study tried to identify the effect of the weight at birth of children and youths with disability on their current health condition in information systems. The study was conducted for 2 months from May 6 to July 16, 2009 with children with disability, and chose 10 schools where teachers and parents gave consent, out of 50% of schools for children with disability selected randomly. Questionnaires were distributed to 2,163 students in elementary, middle, and high schools among children and youth with intellectual, physical, and both intellectual and physical disabilities nationally, and the survey was conducted. Respondents also included 949 parents of those students who agreed to participate. The survey consisted of structured 19 questions. As a dependent variable, the parents were asked to answer whether their children currently had diseases and if so, to name the diseases diagnosed at hospitals. As an independent variable, they were asked to write whether their children were born with low weight and how much they actually weighed at birth. General characteristics of study subjects were analyzed with a technical statistical analysis, and χ^2 test and one-way ANOVA were applied to variables of general characteristics. The risk rate of diseases related to the birth weight was analyzed using multilevel logistic regression. In conclusion, those born as premature showed a higher risk of disease in school age and puberty and also a higher incidence of heart disease and other diseases than those born with normal weight.

Keywords: , *Information Systems, Relationship, Birth Weight, Disability, Incidence Of Disease*

1. INTRODUCTION

Birth weight not only correlates with mortality in infancy and early childhood, but is also known to influence physical and mental health. Many studies report that birth weight has an influence not just in infancy, but even in early childhood and post-childhood. With respect to birth weight, the mortality of infants born at less than 2,000g was found to be the highest at 126.6, and as birth weight increased, infant mortality showed a tendency to decrease, coinciding with most preceding research.¹ Additionally, it was found that a normal-weight baby has a high probability of survival even in infancy², and Xu et al. (1998) have reported that mortality risks before the age of 15 were significantly higher for low birth weight infants of

1,500-2,499g than for infants weighing more than 2,500g, or normal birth weight infants.³ According to research on preschool children's social maturity and birth weight, the over-2,500g birth weight group scored significantly higher in a string of items such as average social age, social index, and so on than the under-2,500g birth weight group; consequently, low birth weight had a negative influence on preschool children's social maturity and behavioral development. Thus, it is believed that birth weight is linked with body formation during the fetal period, and it even influences the functioning of the brain and other viscera, ultimately having a relation to health during one's life-cycle; accordingly, the importance of mother-child health care during the gestational period can be recognized.⁴ The birth rate of premature babies

is determined by social and economic factors and the circumstances of a specific time period. As clarified by a number of researchers, the ratio of low birth weight to normal birth weight infants is paradoxically increasing, despite socioeconomic development.^{5, 6} According to recent trends of change in population dynamics in Brazil, the mortality rate of premature babies has decreased, whereas the mortality rate of low birth weight babies is ever increasing, in the midst of a period characterized by change in age structure, decrease in infant mortality, decrease in childbirth, and population aging.⁷

According to the 1993 infant death survey data of total births in Korea by study⁸ the most common cause of infant death was found to be fetal growth disorders in premature babies, or low birth weight infants. Additionally, according to the 1966 census data on infant death in Korea, the birth weight group with the highest infant mortality rate was found to be those infants with a birth weight of less than 1,500g, with a mortality rate of 445.0. The group with the lowest infant mortality rate was found to be those with a birth weight of over 3,500g, with a mortality rate of 2.0. Risk of death during early childhood was 5.42 times (95% CI 1.80-10.49) greater for the under-1,500g birth weight group than the over-3,500g birth weight group. In addition, infant mortality with respect to birth weight in 1996 in Korea was found to be 254.6 in the under-1,500g group, 26.7 in the 1,500-2,499g group, and 1.2 in the 2,500-3,499g group; thus, with increase in birth weight, infant mortality drastically decreased. Overseas research shows characteristics similar to Korea; for example, Vanlandingham et al. (1988) analyzed death levels among 104,511 white births in six states in the US, finding that newborn mortality was 433.7 in the under-1,500g birth weight group and 2.0 in the 2,500-3,999g group.¹

Furthermore, even with respect to health condition during the child's growth period, low birth weight infants were surveyed to have a higher incidence and prevalence of a number of diseases than normal birth weight infants, and the WHO has classified low birth weight as a risk factor in heart diseases.¹ As a result of continuous, intensive observation for 25 years since the 1980s, the WHO has also reported that low birth weight has a correlation with diseases such as high blood pressure, angina, diabetes, and so on during or after one's maturation.⁹⁻¹²

In the US alone, more than half a million premature babies are born every year, which is

coming to the fore as a serious health problem at the national level.¹³ According to reports prepared by 440 institutions in 2003 related to diseases among 34,500 people comprising 65% of very low birth weight (VLBW) infants, a large number of infants in this category died after six to seven years, or were hospitalized due to a string of diseases. Among VLBW infants, births with weight less than 1,000g showed the highest disease state. In addition, according to research reports on a similar subject prepared by a number of research institutes in the US, the ratio of risk for extremely low birth weight (ELBW) infants greatly increases due to their low levels of health and underdeveloped nervous system.¹⁴

Bogin's (1999) results showed a high prevalence of chronic diseases in such ELBW infants when they entered childhood and adolescence in about eight to nine years, while low birth weight infants also showed the same symptoms as ELBW infants after they grew up.¹⁵

According to recent statistics on Korea, the number of low birth weight infants below 2,5kg has shown a gradually increasing trend, with 4.0% in 2003, 4.2% in 2004, 4.3% in 2005, and 4.3% in 2006⁸; as yet there has been no report concerning what health difficulties low birth weight infants might suffer as they grow into school-age children and adolescents. Moreover, it is difficult to find existing research on children and adolescents with disorders. Thus, this study intended to research the birth status of disabled children and adolescents (premature or otherwise), the difference in disease risk ratio due to the weight of a low birth weight infant, and the sorts of diseases such infants suffer.

2. THEORETICAL BACKGROUND

Table 1. Definitions of birth weight categories and preterm birth.¹⁶

Category	Defenition
Normal Birth Weight	> 2500 and < 4000g
Low Birth Weight	< 2500g
Very Low Birth Weight	< 1500g

It emerged from a workshop, entitled The Fault Is Not in Our Stars but May Be in Our Embryos – Glomerular Number in Low Birth Weight Babies, held at the Clinical Research Center for Rare Diseases Aldo e Cele Dacco, IRCCS – Mario Negri Institute for Pharmacological Research, Bergamo,

Italy, on April 2, 2016, including eminent internationally recognized experts in the field of obstetrics, neonatology, and nephrology.

All nephron-counting studies have been performed on autopsy samples. From 7 studies with nearly 500 subjects, we know that the average nephron number is ~ 1,000,000 per kidney.¹⁷ Human nephron number is highly variable, however, ranging from 210,000 to 1 2.7 million.¹⁷ This 13-fold variability likely contributes to individual susceptibility to hypertension and kidney disease.¹⁸ Significant variability is already present at birth, highlighting the importance of early nephrogenesis. Nearly 60% of nephrons are developed in the third trimester of pregnancy.¹⁹ In preterm infants, nephrogenesis may occur for up to 40 days after birth, but may be abnormal.¹⁹⁻²⁰ Nephron numbers have been found to be reduced in infants who were born preterm or of LBW.¹⁹ Importantly, however, it has been observed in some animal models that low nephron numbers may also occur with normal birth weight, so the burden or risk of renal programming may be underestimated if birth weight is the only surrogate marker considered.²¹

The goal of the workshop through multidisciplinary engagement was to highlight the association between fetal and childhood development and an increased risk of adult diseases, focusing on hypertension, and to suggest possible practical solutions for the future. Low birth weight (LBW), growth restriction, and preterm birth are the most consistent clinical surrogates for low nephron numbers and are associated with an increased risk of hypertension, proteinuria, and kidney disease later in life. This relationship is amplified by the development of acute kidney injury (AKI) in preterm infants, which may further reduce nephron numbers soon after birth, as well as by rapid catch-up growth or overfeeding during infancy or childhood in children born small, which may further augment the risk of hypertension and predispose to obesity and type 2 diabetes later in life. Many questions about the developmental origins of chronic renal disease, possible nutritional and pharmacologic interventions, as well as strategies for optimal follow-up and management of vascular, metabolic, and renal functions remain unanswered.²²

The first observations that adults who were born with LBW (defined as a birth weight <2.5 kg) were at a higher risk of premature cardiovascular death, increasingly compelling epidemiologic and experimental evidence has highlighted the

“programming” impact of intrauterine and early childhood stresses on organ development and long-term organ functions.^{8,23} LBW, growth restriction, and preterm birth (defined in Table 1) have been the most accessible surrogate markers for intrauterine stress so far. Although programming associations between LBW, growth restriction, preterm birth, and hypertension have been studied the most, evidence pointing to associations between LBW and CKD, CVD, obesity, glucose intolerance, type 2 diabetes, and preeclampsia is also quite convincing.^{8,23,24} Until recently, research has largely focused on LBW and preterm birth as markers for developmental programming of hypertension and renal disease.¹⁶ Building on early epidemiologic evidence linking LBW and adult CVD, Brenner et al.²⁵ hypothesized that developmental programming in the kidney may result in a reduction in nephron number, which in turn may be a factor contributing to higher blood pressure and increased risk of chronic kidney disease (CKD). The authors hypothesized that a reduction in whole kidney glomerular surface area resulting from a programmed reduction in nephron number would enhance susceptibility to hypertension by limiting sodium (salt) excretory capacity and increase susceptibility to CKD through a reduced capacity to compensate for renal injury. Consistent with this possibility, LBW, hypertension, and CKD.²⁶ In animal studies early on, feeding pregnant rats a low protein diet induced LBW in the offspring, which subsequently developed spontaneous hypertension that increased with age, chronic renal injury, and premature death.²⁷ The rat offspring also had smaller kidneys and reduced nephron numbers, which strongly supports the nephron number hypothesis. Although the magnitude of programming effects observed often differs between males and females²⁸ and between experimental conditions, many diverse animal studies also strongly support the association between adverse intrauterine conditions and a higher risk of hypertension and renal dysfunction with age, as reviewed elsewhere.²⁹ It is important to recognize that many babies who are born yearly with birth weights above 2.5 kg (technically not LBW) still experienced intrauterine growth restriction (IUGR) and may be inappropriately small for gestational age (SGA) (Fig. 1).

LBW and preterm birth are both associated with an increased risk of elevated blood pressure in later life. Meta-analyses have shown that systolic blood pressure levels were higher in preterm or VLBW adolescents than in controls born at term (mean increase of 2.5 mm Hg; 95% confidence interval, CI, 1.7–3.3 mm Hg from 10 studies) and in subjects with birth weights <2.5 kg compared with ≥2.5 kg (mean increase 2.28 mm Hg; 95% CI, 1.24–3.33 from 9 studies). In the latter study, the odds ratio (OR) of overt hypertension was 1.21 (95% CI, 1.13–1.3) for those with birth weights <2.5 kg compared with ≥ 2.5 kg.²⁴ A systematic review of the impact of HBW on blood pressure, however, also found a risk ratio of 1.18 (95% CI, 1.05–1.32 from 6 studies) for hypertension in children who had birth weights ≥ 4 kg compared with birth weights <4 kg, but this effect did not persist in adults.³⁰ In a further meta-analysis of 13 studies including 1,115 children aged 2–20 years exposed to diabetes during gestation, systolic blood pressure levels were found to be higher compared to controls (mean difference 1.88 mm Hg; 95% CI, 0.47–3.28); however, this effect appeared to predominate in males.³¹ Similarly, a systematic review found that systolic blood pressure levels were 2.39 mm Hg (95% CI, 1.74–3.05 from 18 studies) higher among young adults who had been exposed to preeclampsia.³²

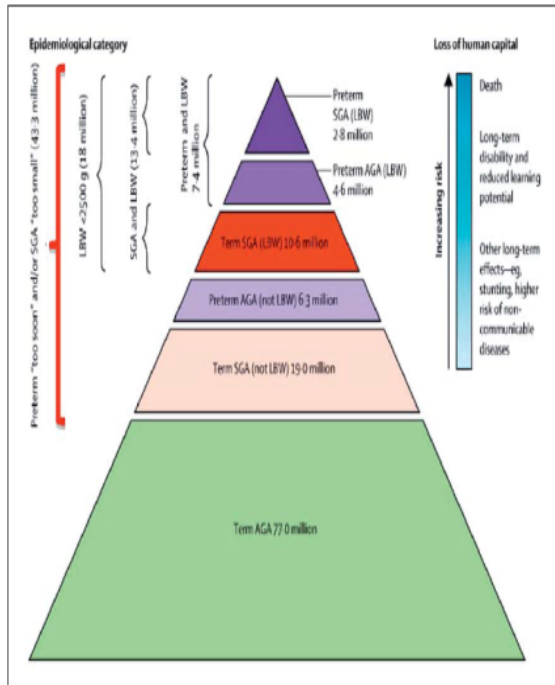


Fig 1. Number of infants born small with low birth weight, and premature birth in low and middle income countries.³³

Worldwide, the incidence rates of LBW and preterm birth lie at around 15–20% and 11%, respectively.³⁴ Research has largely focused on LBW and preterm birth as markers for developmental programming of hypertension and renal disease.¹⁶ It is important to recognize that many babies who are born yearly with birth weights above 2.5 kg (technically not LBW) still experienced intrauterine growth restriction (IUGR) and may be inappropriately small for gestational age (SGA) (Fig. 1).

In addition, preterm infants may also have either an appropriate, although low, birth weight for gestational age (AGA) or may be SGA if they experienced superimposed growth restriction (Fig. 1).

Worldwide, the incidence rates of LBW and preterm birth lie at around 15–20% and 11%, respectively [33, 34]. There is, however, significant overlap between LBW, preterm birth, and SGA, with the total reaching around 36% of live births in LMIC in 2010.³³

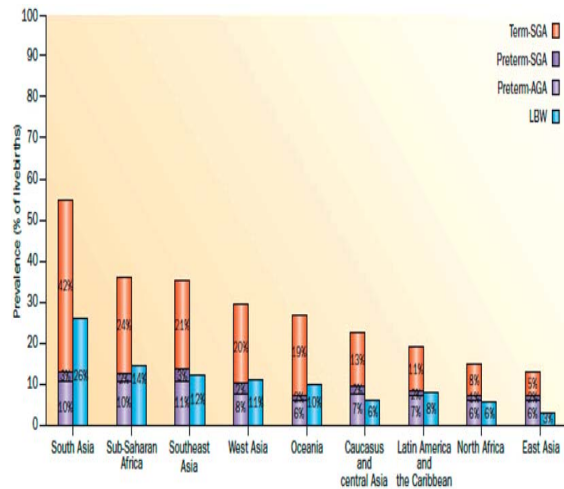


Fig. 2. Prevalence of SGA, preterm birth, and LBW infants by United Nations Millennium Development Goal regions in 2010 (reprinted with permission according to CC Creative Commons Attribution-NonCommercial-NoDerivs from Lee et al³³)

3. METHODOLOGY

3.1 Sampling and Data Collection

The research and survey were conducted from May 6, 2009, to July 6, 2009. This study sent an official document to or visited relevant schools, conducting random sampling of 50% of physical disabilities schools, and ultimately selected 10 schools with the approval of school authorities and

school parents. Mental retardation school 6 schools in Seoul, 1 in Daegu, 1 in Jeollabuk-do, 1 in Gyeongsangbuk-do, 1 in Gyeongsangnam-do and 1 in Seoul The questionnaire was distributed to 2,163 elementary and high school students among the nationwide handicapped children with disabilities, The study conducted a self-administered survey, in which the survey subject responded as frankly as they could remember, targeting 949 school parents who agreed to participate. The tool used for this research was a structured questionnaire including a total of 19 questions comprising 16 questions about general characteristics, two questions about premature birth status, and one question about disease status, type of diseases, and so on.

Sociodemographic variables and present disease status by gender, female students were found to have a higher ratio of subjects with a disease than male students. This was statistically significant with a *p*-value of .015. In age, there were 48 elementary school students (15.05%), 54 middle school students (17.25%), and 49 high school students (15.17%), and middle school students' prevalence was found to be highest, though this finding was not statistically significant. According to the current mother's job, the distribution of diseases among her children was also different. The highest rate for full-time housewives was 104 (17.96 %), while the lowest rate for regular working mothers was 13 (10.92 %).

Table 2. Correlation between Sociodemographic Factor and the Present Disease Status

	Disease	No (%)	Yes (%)	χ^2	p_ value
gender	male	613 (85.73)	102 (14.27)	5.87	0.015
	female	185 (79.06)	49 (20.94)		
Age (yr)	7-12	271 (84.95)	48 (15.05)	0.72	0.694
	13-15	259 (82.75)	54 (17.25)		
	16-18	274 (84.83)	49 (15.17)		
mother's job	no employment	475 (82.04)	104 (17.96)	3.23	0.510
	employment	106 (89.08)	13 (10.92)		
	part time	108 (84.38)	20 (15.63)		
	self employment	76 (88.37)	10 (11.63)		
	other	8(88.89)	1(11.11)		

3.2 Research tools and content

The tools of this study were structured questionnaires consisting of a total of 19 questions, including on general characteristics, 16 paragraph, 2 on premature birth, and 1 on disease condition and disease type. To determine whether their child is an independent variable at birth or a premature infant at birth, parents were asked to respond by selecting \circ or X and indicating when the child was and what was the weight at birth. For the dependent variable, the instruction was to select \circ or X to respond to the disease and the disease name of the disease.

3.3 Analysis and Method

To process and analyze the collected data, this study used SAS Ver. 9.4 for Windows. Descriptive statistics were conducted with respect to research subjects' general characteristics, and an χ^2 -test and one-way ANOVA were conducted with respect to the variance of variables based on general characteristics. Additionally, the study conducted frequency analysis of the name of each disease and the number of subjects suffering from the disease. Overall disease risk rate due to birth weight was analyzed using multi-level logistic regression.

4. RESULTS

4.1 Correlation between Disabled Children's and Adolescents' Sociodemographic Variables and Present Disease Status

* Only disease status is classified by target (patient to be chopped only)

In terms of disease status by type of disability, the rate of disability was 11 (20.75 %) for children

with disabilities and teens with the highest rates of disease because they examined only physical diseases. The physical disease rate of children with both intellectual and delayed disabilities was 24 (20.34 %) among the target audience, similar to those with physical disabilities. P-value was not statistically significant, at 0.182.

Table 3. Comparison of disease status by disability

	No disease (%)	disease (%)	χ^2	p_value
Intellectual disability	668 (85.20)	116 (14.80)	3.39	0.182
Intellectual, delayed disability	94 (79.66)	24 (20.34)		
Delayed disability	42 (79.25)	11 (20.75)		

* Only disease status is classified by target (patient to be chopped only)

4.2 Disease Risk in Childhood and Adolescence by Disabled Children’s and Adolescents’ Birth Weight

As shown in Table 3, this study compared disease status during childhood and adolescence with birth weight in the case of children and adolescents with disabilities. For low birth weight infants under 2,500g, 39 persons (17.26%) were found to have a ratio of a disease, and this figure was statistically significantly higher ($p = .006$) than that of the 102 persons (14.89%) having prevalence among subjects whose birth weight was over 2,500g.

Table 4. Disease Risk of Children and Adolescents with Disabilities by Birth Weight

birth weight	no disease (%)	disease (%)	χ^2	p_value
Normal Birthweight Infant	583(85.11)	102(14.89)	7.55	0.006
Low Birthweight Infant(<2.5kg)	187(82.74)	39(17.26)		

* Only disease status is classified by target (patient to be

chopped only)

In examining the disease risk ratio in childhood and adolescence with respect to birth weight, the disease risk ratio for the 2,500-3000g birth weight group was 0.795 (0.553-1.143) times lower; the disease risk ratio for the normal birth weight group of 3000-4000g was 0.602 (0.411-0.880), and the disease risk ratio for the over-4000g group was 0.307 (0.156~0.605). Thus, it was found that the disease risk ratio was highest at the low birth weight level, and as birth weight increased, the risk ratio of suffering various diseases tended to gradually decrease. The group with the heaviest birth weight showed the lowest disease risk ratio, and results were statistically significant (Table 4).

Table 5. Comparison between Birth Weight and Disease Risk Ration

	OR	95%	
		95%	95%
	1		
<2.5kg	0.795		
2.5-2.99kg	0.602	0.553	1.143
3-3.99kg	0.307	0.411	0.880
>4kg	0.307	0.156	0.605

* Classification of only Disease Status by Subject (even for patients with multiple diseases, only disease existence/non-existence is marked)

4.3 Current Diseases in Children or Adolescents with Disabilities Born as Low or Normal Birth Weight Infants

The prevalence rates of 49 diseases were examined in children or adolescents with disabilities. Heart disease showed the largest difference between normal and low birth weight infants. Among children or adolescents suffering from heart disease, 11 subjects (62.5%) were low birth weight infants and six subjects (37.5%) were normal birth weight infants. This was the largest difference in prevalence rate. Prader-Willi syndrome showed the second largest difference. Seven subjects (66.7%) were low birth weight infants and three (33.3 %) were normal birth weight infants.

Table 6. Current Diseases in Children or Adolescents with Disabilities and Low Birth Weight Infants (Under 2,5kg)

diseases/ low birth weight	<2.5kg (N=226) yes(%)	Normal (N=685) no(%)	Total (N=911)
Epilepsy	9(3.98%)	27(3.94%)	36(7.92%)
Angelman syndrome	1(0.44%)	0(0%)	1(0.44%)
Scoliosis	4(1.76%)	4(0.58%)	8(2.34%)
Short stature	1(0.44%)	0(0%)	1(0.44%)
Hemiplegia	0(0%)	1(0.14%)	1(0.14%)
Convulsion	13(17.70%)	26(3.80%)	39(21.5%)
Brain disease	2(0.88%)	4(0.56%)	6(1.44%)
Rhinitis	1(0.44%)	3(0.42%)	4(0.86%)
Renal disease	3(1.32%)	4(0.56%)	6(1.88%)
Heart disease	11(4.87%)	6(0.84%)	17(5.71%)
Diabetes mellitus	2(0.88%)	2(0.28%)	4(1.16%)
Thyroid disease	1(0.44%)	3(0.42%)	4(0.86%)
Pulmonary disease	2(0.88%)	0(0%)	2(0.88%)
Asthma	0(0%)	2(0.28%)	2(0.28%)
Allergy	0(0%)	2(0.28%)	2(0.28%)
Tuberous sclerosis	1(0.44%)	1(0.14%)	2(0.58%)
Cleft lip and cleft palate	1(0.44%)	1(0.14%)	2(0.58%)
Hemophilia	0(0%)	1(0.14%)	1(0.14%)
Large organ surgery	1(0.44%)	0(0%)	1(0.44%)
Liver disease	1(0.44%)	0(0%)	1(0.44%)
Visual disturbance	2(0.88%)	1(0.14%)	3(1.02%)
Hearing impairment	1(0.44%)	0(0%)	1(0.44%)
Moyamoya	0(0%)	2(0.28%)	2(0.28%)
Osteoporosis	1(0.44%)	0(0%)	1(0.44%)
Strabismus	0(0%)	2(0.28%)	2(0.28%)
Foot disease	0(0%)	2(0.28%)	2(0.28%)
Cataract	1(0.44%)	0(0%)	1(0.44%)
Otitis media	1(0.44%)	1(0.14%)	2(0.58%)
Pulmonary hypertension	1(0.44%)	0(0%)	1(0.44%)
Tic	0(0%)	1(0.14%)	1(0.14%)
ADHD	0(0%)	1(0.14%)	1(0.14%)
Bronchiectasis	0(0%)	1(0.14%)	1(0.14%)
Developmental disability	0(0%)	1(0.14%)	1(0.14%)
Essential tremor	1(0.44%)	0(0%)	1(0.44%)
Congenital missing teeth	0(0%)	1(0.14%)	1(0.14%)

Lymphedema	1(0.44%)	1(0.14%)	2(0.14%)
Gluten intolerance	1(0.44%)	0(0%)	1(0.44%)
Rett syndrome	1(0.44%)	0(0%)	1(0.44%)
Rheumatoid arthritis	0(0%)	1(0.14%)	1(0.14%)
Knee joint disorder	0(0%)	1(0.14%)	1(0.14%)
Williams syndrome	0(0%)	1(0.14%)	1(0.14%)
Phenylketonuria	1(0.44%)	0(0%)	1(0.44%)
Prader-Willi syndrome	7(3.1%)	3(0.42%)	9(3.52%)
Total	73(32.3%)	107(15.62)	180(47.95%)

* Indicate all duplicate diseases of the same person (a condition diagnosed by the doctor and currently under treatment)

5. DISCUSSION

In this study, we investigated and analyzed the risks of disease in children and adolescents with a focus on low birth weight infants weighing less than 2,500g at birth. With decreasing birth weight, children and adolescents were more easily exposed to various diseases, and birth weight was highly correlated with the prevalence rates of diseases in children and adolescents. Among previous studies on preterm infants, those analyzing only preterm infants showed a relationship between the prenatal period and diseases. The same results were found in this study.³⁵ The prevalence rates of diseases were examined in preterm infants weighing less than 2,500g and in normal birth weight infants. The prevalence rates of heart diseases and other rare diseases⁴ were higher in the preterm infants than in the normal birth weight infants. In other studies, the prevalence rates of epilepsy, convulsions, and brain diseases in adolescents born as preterm infants were found to be lower than those in adolescents born as normal birth weight infants. However, in a study on particular diseases, including epilepsy and convulsions, the prevalence rates in preterm infants were found to be much higher than those in normal birth weight infants.¹¹

There are limitations to this study. It is difficult to generalize the study's results, as it does not cover all children or adolescents with disabilities in Korea. However, subjects were evenly recruited from all areas across the country rather than particular areas. We divided the country into eight regions, then evenly recruited subjects through stratified sampling methods according to the ratios in each region. Thus, this study is able to overcome its

limitation.

Our validation study showed high correlations between self-reported birth weight and birth registry data.

6. CONCLUSIONS

In this study, we investigated and analyzed the risks of disease in children and adolescents with a focus on low birth weight infants below 2,500g in information systems. With decreasing birth weight, children and adolescents were more easily exposed to various diseases, and birth weight was highly correlated with prevalence rates of diseases in children and adolescents. This study found that risk of disease decreases in children and adolescents with increasing birth weight. With increasing birth weight, the prevalence rates of various diseases were statistically significantly lower.

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