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The relationships of biomedical and psychosocial risk factors to infant development at six months of age in Thailand

Cholvanich, Panrapee, Ph.D.
University of Hawaii, 1994

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THE RELATIONSHIPS OF BIOMEDICAL AND PSYCHOSOCIAL RISK FACTORS TO INFANT DEVELOPMENT AT SIX MONTHS OF AGE IN THAILAND

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN PSYCHOLOGY DECEMBER 1994

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For my mother and father, Somsnit and Prasit Cholvanich
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Gratitude is the most difficult emotion to articulate, especially when it is deep. It is when my memory is stored in my heart and not in my mind.

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ABSTRACT

This study represents an initial research project in the area of early infant development and developmental disabilities in Thailand. The study examined the relations of biomedical risk factors to infant development at 6 months of age. The study involved a sample of 40 male and 40 female Thai infants residing in the Bangkok metropolitan area. Medical complications of infants during neonatal period were identified as biomedical risk factors, and socioeconomic status (a combination of maternal education and household income) as psychosocial risk factors. The applicability of the Infant Mullen Scale of Early Learning (Infant MSEL) as an assessment instrument for Thai infant development was also investigated.

Results from this study supported a transactional model of infant development. The results demonstrated that at the age of 6 months, biomedical risk factors were more important than psychosocial risk factors in affecting neurobehavior development. However, the complexity of socioeconomic status was shown to be related to other important psychosocial factors (maternal perception of her infant, maternal perception of husband support and social support, infant's stimulating environment, and mother's behavior in reacting to her infant) that may influence neurobehavior development of Thai infants later in life.
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CHAPTER I
INTRODUCTION

Dramatic medical advances through scientific discoveries and improved health services over the last few decades have resulted in many seriously ill children now surviving into adulthood (WHO, 1992; World Bank, 1993). Estimates of the number of deaths worldwide among children under 5 years of age indicate that the total number of child deaths declined by about 4-5% from 1985 to 1990 (WHO, 1992). The infant mortality rate (IMR), measured as the number of deaths before one year of age per 1000 live births, has also declined since 1975 by about 15% (WHO, 1992).

While the infant mortality rate has decreased, an important consequence has been a significant increase in problems of chronic illness and developmental disabilities among infants and children who have survived a serious illness during infancy (Newacheck & Taylor, 1992; WHO, 1992; World Bank, 1993). As a result, developmental disabilities have become a new health problem among the young population of developed and developing countries.

There now exists a shortage of appropriately trained medical and psychological professionals as well as adequate health care programs to address the needs of infants and children with developmental disabilities. Many physicians who are responsible for providing primary care to children with developmental disabilities have not been adequately trained to diagnose and treat these types of problems (Blackman et al., 1990).

While there is evidence that counseling and treatment can help, there is uncertainty and sometimes lack of consensus about appropriate modes of treatment for specific conditions (Casey & Berman, 1985; Weisz, Weiss, Aicke, & Klotz, 1987). In addition, present procedures for referring children for developmental assessment and
early intervention are not standardized. Consequently, there is believed to be a substantial group of infants and children with developmental disabilities whose problems are untreated and perhaps even unrecognized (Grant, 1982; Office of Technology Assessment, 1986).

**Developmental Disabilities**

As many of the infectious diseases that affected children in the past are conquered or ameliorated (e.g., smallpox, polio, tuberculosis), a growing proportion of pediatric practice is focused on developmental disabilities, including developmental delays, learning difficulties, and emotional and behavioral problems. These conditions have been labeled the "new morbidity of childhood" (Haggerty, Roghmann, & Pless, 1975). All of these conditions have a substantial psychological component, and none fits easily into the physical disease paradigms utilized in the field of medicine (Haggerty et al., 1975).

**Definition**

The terms "developmental disability" and "developmental delay" are sometimes used interchangeably when applied to infants and young children. In general, "developmental disability" has been used in a broader sense with an age range from birth to 22 years of age. "Developmental delay" is applied more specifically to infants and young children. According to the *Longman Dictionary of Psychology and Psychiatry* (1984), only the term "developmental disability" has been described. The term is defined as "a mental or physical disorder originating before the age of 18, which will
probably continue indefinitely and constitute a substantial handicap to normal functioning" (Goldenson, 1984, p. 151).

Both the terms "developmental disability" and "developmental delay" have been introduced in U.S. legislation with the following definitions. According to the Developmental Disability Act (1984), "developmental disability" was defined in Public Law 98-527 as:

... severe, chronic disability of persons age 5 or older which is attributable to mental, physical or combination impairments and manifested before the age of 22. This is likely to continue indefinitely and results in substantial functional limitations in three or more areas: self care, receptive or expressive language, learning, mobility, self-direction, capacity for independent living, and economic self sufficiency. This reflects the need for care, treatment or other services, of lifelong or extended duration (Developmental Disability Act, 1984).

In 1990, Public Law 98-527 was updated and further defined the term "developmental disability" as:

... applied to infants and young children birth to five who have substantial developmental delay or specific congenital or acquired conditions or have high probability of resulting in developmental disabilities without services (Developmental Disability Act, 1990).

The term "developmental delay" has also been defined in other U.S. legislation to be more specific for infants and toddlers. According to Public Law 99-457, Sec. 672, in 1986, "developmental delay" has been defined as follows:
(1) The term "handicapped infants and toddlers" means individuals from birth to age 2, inclusive, who need early intervention services because they --

(A) are experiencing developmental delays, as measured by appropriate diagnostic instruments and procedures in one or more of the following areas: cognitive, development, physical development, language and speech development, psychosocial development, or self-help skills, or

(B) have a diagnosed physical or mental condition which has high probability of resulting in developmental delay.

Such term may also include, at a State's discretion, individuals from birth to age 2, inclusive, who are at risk of having substantial developmental delays if early intervention services are not provided (Developmental Disability Act, 1986, as cited in Meisels & Provence, 1989, p. 61).

Copeland and Kimmel (1989) defined the child with developmental disabilities as "having significant and chronic disabilities that are attributable to mental and/or physical impairment, with the onset of the disability any time since conception" (Copeland and Kimmel, 1989, p. 3).

Murphy, Nichter, and Liden (1982), proposed classifying infants with developmental disability into three categories: (1) developmental delay, (2) developmental disorder, and (3) developmental deficit:

Developmental delay is an indication that a skill has not been achieved or mastered within the normal age range but the infant has displayed evidence of a gradual progression toward the final task. For example, a child may not have mastered walking by 17 months but all other prerequisite developmental steps (crawling, creeping, kneeling, half-kneeling, standing) have been achieved at an
equally slow pace. In other words, the rate at which skills are achieved is slower than normally accepted.

*Developmental disorder* differs from a delay in the quality of performance that is accomplished if the skills are left unattended. For example, Murphy et al. (1982) explained that, without corrective glasses, myopic vision will always remain blurred. Corrective lenses will help the child attain normal sight. Similarly, because of a neurological impairment a toddler may not be able to pull to stand and walk independently. With the aid of a walker or braces, a whole new vista presents itself to the child.

*Developmental deficit* implies a more permanent disability such as blindness, or a congenital hearing loss. The condition cannot be corrected but as the infant grows, he or she can be taught to adjust to the disability and become more independent with the use of adapted equipment. (Murphy, Nichter, & Liden, 1982, pp. 260-266)

**Epidemiology of Developmental Disabilities**

While infant mortality rates worldwide have fallen dramatically (WHO, 1992), this trend may be an indirect indicator of the prevalence of childhood developmental disabilities. For example, the infant mortality rates in the U.S. have fallen from the rate of 12.2 in 1980 to 10.9 in 1983, and to 10.1 in 1986 (WHO, 1992). Over the same period of time, there has been a sevenfold increase in children with cystic fibrosis, and a twofold or greater increase in children with spina bifida, leukemia, and congenital heart disease (Gortmaker & Sappenfield, 1984). In addition, there has been a 65% increase in severe respiratory system problems, as well as increases in severe hearing
impairment and a variety of mental and nervous system disorders (Newacheck, Budetti, & Halfon, 1986).

Despite information on the trends for an overall reduction of infant and child mortality rate, knowledge of the worldwide prevalence and distribution of childhood developmental disabilities is limited. This may be due to less attention to the problem in the past, resulting in the present lack of common definitional criteria and prevalence rates in many countries. While the United Nations has published statistics on developmental disabilities in the year 1990, the information is still limited in scope, and problems have been raised concerning research methodological issues in conducting the survey (UN, 1990).

Despite the limitation of worldwide data, the United Nations' Report on Children estimated that at least 5% of the children in a given population are severely handicapped, and between 10% and 15% need special attention due to physical abnormalities, chronic illness, accidents, or mental disabilities (UN, 1971). The UNICEF's report on The State of the World's Children 1981-1982 described the situation of developmental disabilities as "ten million children quietly becoming disabled in mind or body" (Grant, 1982, p.11).

Epidemiological studies from different countries support the extent of the problem. There are reports of 60,000 children born with physical or mental handicaps annually in the Republic of Germany. In France, nearly one million people under the age of 18 suffer from the effects of mental retardation, cerebral palsy, or other developmental problems (Paxman, 1982). An increased prevalence of cerebral palsy among children in the Republic of Ireland, from 1.56/1,000 livebirths in 1976 to 1.76/1,000 livebirths in 1981, has been reported (Dowding, 1990). An estimated 15%, or about 761,000 Turkish children, have been defined as "different," or as
experiencing some type of behavior or emotional problem (UN, 1976). In the Philippines, two million children and adolescents have been classified as "handicapped" (Council for Welfare of Children, 1976). In Chile, 10-15% of the children and adolescents are estimated to have emotional disability, with an additional 5-10% having significant emotional symptomatology (Florenzano, 1991). In Canada, the estimated prevalence according to parental reports is that 18.1% of the children suffer from emotional disability (Offord, Boyle, and Szatmairi, 1987).

Data on the prevalence of developmental disabilities in the U.S. also are indicative of the seriousness of the problem. A survey of parents by the National Health Interview Survey of Child Health (NHIS-CH) was conducted in 1988 for children 17 years of age and under. The findings with regard to overall prevalence were that 4% of U.S. children or 2.5 million have had a developmental delay inclusive of developmental disabilities, 6.5% of children or 3.4 million have had a learning disability, and 13.4%, or 7 million have had an emotional or behavioral problem that required psychological treatment. When these items were combined, the result was that a total of about 20% of U.S children, or almost 10.7 million, had experienced some type of developmental. When the subgroup of children in poor health were assessed in the NHIS-CH study, the prevalence rate was 35% (Zill & Schoenborn, 1990).

As high as these figures may seem, they probably underestimate the true prevalence of the conditions (Zill & Schoenborn, 1990). Since the data are based on parents' reports, the only childhood disorders counted in NHIS-CH were those that had been recognized by parents, or those identified by physicians, psychologists, or teachers, and communicated to parents with sufficient clarity that the parents were able to report them to survey interviewers (Zill & Schoenborn, 1990).
Despite the limitations of parental report, estimates derived from NHIS-CH provide national benchmarks on the overall frequency of recognized developmental disabilities in U.S. children. By way of comparison, listed are the estimated numbers of American children and adolescents having some of the chronic physical conditions that are common in childhood: chronic bronchitis, 3.5 million; asthma, 3.2 million; dermatitis, 2.2 million; orthopedic impairments, 1.8 million; heart murmurs, 1.1 million (Zill & Schoenborn, 1990). Clearly, developmental disabilities rank among the most prevalent of health conditions among U.S. children.

Consequences of Developmental Disabilities

Developmental disabilities among young children are not transient or inconsequential. Developmental disabilities can have profound and lasting effects on family functioning and on children's life opportunities. These conditions often interfere with children's academic success and peer relationships and put a strain on parental resources and family structures (Weiss, 1991). Developmental delays and possible consequent disabilities are also costly and burdensome to society, requiring special services in schools and other institutions, and sometimes necessitating long-term care at state expense (Birenbaum, Guyor, & Cohen, 1989; Oduntan, 1990; WHO, 1992).
Rationale for the Study of Developmental Disabilities and Risk Factors

Advances in perinatal and neonatal care have enabled dramatic improvements in the survival of medically high-risk infants such as premature or low birth weight infants (Taeusch & Yogman, 1987). This has lead to a shift in emphasis from the study of infant mortality to concern about better understanding the scope and nature of morbidity in infancy (Collin, Halsey & Anderson, 1991).

Many infants and their mothers experience difficulties during the perinatal period, including time during pregnancy, labor, delivery, and the period immediately after birth. These complications may lead to problems or disabilities in the development of the child. Possible consequences for such infants include mental retardation, cerebral palsy, seizure disorders, and abnormalities in perceptual and cognitive functioning.

Knowledge that increases the extent to which we can predict developmental problems from data available in infancy is clearly important. Research can make major contributions in the areas of (a) theoretical advancement, (b) clinical applications, and (c) practical and cost-effective services related to developmental disabilities.

Theoretical advances contribute to our understanding of the biological causal mechanisms and specific transactions between the child and the environment that may determine developmental outcomes from early in life (Sanson, Oberklaid, Pedlow, & Prior, 1991).

In clinical settings, more objective methods to accurately screen for high-risk infants have been increasingly required of clinicians and other health professionals (Raney, Bryant, Wasik, Sparling, Feridt, & La Vange, 1992; Williams, Williams, &
While many standardized methods for assessing perinatal data for poor developmental outcome have been developed, there is still considerable debate over how best to screen for perinatal risk conditions so that both outcome and cost-effectiveness are maximized (Hobel, 1978). Also, objective screening methods for identifying and measuring the severity of perinatal conditions or risk factors need to be developed. These methods are necessary in order to quantify those factors to investigate statistical models designed to predict development in infancy and childhood (Molfese, 1989).

Clinical studies help to develop effective early interventions for reducing fetal and infant morbidity and mortality (Ryan, Sweeney, & Solola, 1980; Sokol, Wolf, Rosen, & Weingarden, 1980). They can also provide information to professionals on the nature and extent of guidance and support that can be offered to parents with the aim of ameliorating developmental problems in infants (Sanson et al., 1991).

Practically, identification with a high degree of sensitivity and specificity of high risk infants prior to discharge from the hospital would substantially decrease the number of infants requiring developmental follow-up. This would reduce the cost of assessment services, diminish parental anxiety concerning developmental outcome, and still identify those infants who are in need of follow-up and early intervention (Ramey et al., 1992).

Unfortunately, an effective perinatal developmental screening process for high risk infants is currently not available (Brazy, Eckerman, Oehler, Goldstein, & O’Rand, 1991; Scheiner & Sexton, 1991). The specific risk factors that are assessed by the various objective methods vary widely, and there seems to be little agreement as to how the risk factors should best be assessed. In addition, perinatal risk scores from the currently available scales have often been found to be only weak predictors of behavior in infancy and later childhood (Bee, Bernard, Eyeres, Gray, Hammond, Spietz, Snyder, &
Clark, 1982; Cohen, Parmelee, Sigman, & Beckwith, 1982; Forslund & Bjerre, 1983; Molfese & Thomson, 1985). According to Molfese (1989), "the weak contribution of perinatal risk scores seems to be due more to the limited types of complications included on the assessment scales and to the deficiencies in the procedures used to assign scores to the perinatal risks rather than to the unimportance of perinatal risks per se" (Molfese 1989, p. 2).

History of Studies on High-risk Children

During the past two decades, various approaches to the study of high-risk infants for developmental disabilities have emerged. The work of investigators in these areas extend from infants to children considered to be at risk as a result of either biomedical or environmental problems (O'Dougherty & Wright, 1990).

Two types of biomedical problems have been identified. First are infants diagnosed as having a medical disorder for which there exists an established risk for abnormal development. The second type of biomedical problem involves infants with a history of specific prenatal, perinatal, neonatal and early development events that indicate a possible biological insult to the developing central nervous system. These events may either singly or "combinatively" increase the risk for future disorder or deviant development (Kopp & Krakow, 1983).

Another type of risk status originates from environmental problems. This involves infants considered to be at risk for later development as a result of depriving or damaging environmental experiences. The transactions of these environmental and biomedical factors are of critical importance in either enhancing or diminishing the
development of at-risk infants (Gottfried, 1973; Sameroff & Chandler, 1975; Sameroff & Seifer, 1983).

Biomedical Approach

Evidence for biomedical risk has come from retrospective studies (e.g., Lilienfield & Parkhurst, 1951; Pasamanick, Knobloch, & Lilienfield, 1956; Pasamanick & Knobloch, 1966) and from prospective studies (e.g., Broman, Nichols, & Kennedy, 1975; Corah, Anthony, Painter, Stern, & Thurston, 1965; Graham, Ernhart, Thurston, & Craft, 1962; Graham, Matarazzo, & Cadwell, 1956; Werner, Bierman, & French, 1971) that have implicated early medical complications in developmental problems.

In general, there appear to be three major groups of biomedical risk factors during the perinatal period. These are antepartum or prenatal (during pregnancy), intrapartum (at labor and delivery), and postpartum or neonatal period (0-1 month after birth). For example, maternal conditions such as smoking, drinking, use of illegal drugs, diabetes, chronic hypertension, renal disease, heart disease, abnormal cervical cytology, uterine malformation, and incompetent cervix are considered prenatal risk factors. Toxemia, uterine rupture, placenta previa, abruptio placentae, multiple pregnancy, abnormal presentation of the fetus, and breech delivery are examples of intrapartum risk factors. Infants' medical conditions, such as prematurity, respiratory distress syndrome, anoxia, hypoglycemia, congestive heart failure, CNS depression, hyperbilirubinemia, sepsis, etc., are neonatal risk factors (Hobel, Hyvarinen, Okada, & Oh, 1973; Littman & Parmelee, 1978).

The concept of a "continuum of reproductive wastage" was first formulated to describe the wide range of manifestations of disabilities that could result from early CNS
trauma (Lilienfeld & Parkhurst, 1951). Reproductive wastage was described as a range of disabilities grouped in terms of level of severity as follows: "lethal components" such as abortion, neonatal death, stillbirth; "sublethal components" such as cerebral palsy, epilepsy, hemiplegia; and "subtle components" such as learning disability, hyperactivity, and minimal brain dysfunction.

Later, Pasamanick and associates elaborated this concept through a series of retrospective studies that expanded the range of deviant developmental outcomes thought to result from early damage (Pasamanick, Knobloch, & Lilienfield, 1956; Pasamanick & Knobloch, 1966). They subsequently applied the term "continuum of reproductive casualty" to encompass the range of minor motor, perceptual, learning, and behavioral disabilities associated with possible early brain insult.

From these early retrospective studies, a number of risk factors such as anoxia, prematurity, obstetrical complications, and malnutrition were identified as negatively influencing the child's adaptation and increasing the risk for later disorder. This concept of "continuum of reproductive casualty" suggested that a child's later developmental status could be predicted from biological perinatal complications (Pasamanick & Knobloch, 1966).

However, this hypothesized association between early possible cerebral insult and subsequent abnormal outcomes has not been confirmed by most follow-up studies and prospective longitudinal studies. Those studies could demonstrate only low correlations between any single perinatal or neonatal biomedical risk variable and later disabilities. For example, Graham et al. (1956, 1962, 1965) conducted a comprehensive series of studies on perinatal anoxia. They examined hundreds of infants during the newborn period, followed them up to three years of age, and then conducted a final assessment at age seven. They found that anoxia was strongly associated with impaired neurological and
developmental status in the newborn period, but not at age three and seven. By age 3, history of anoxia was only weakly associated with neurological and developmental impairment. By age 7, those perinatal anoxia children were inferior to their normal controls on only 2 of 21 cognitive and perceptual tests (the vocabulary subtest of WISC and the perceptual-motor test). The researchers concluded that attempts to predict current functioning in later childhood from measures of anoxia in newborns were highly unreliable (Corah, et al., 1965).

This finding of higher associations of intellectual consequences of perinatal anoxia among infants and preschoolers than among older children has been well documented by other longitudinal studies (Broman, et al., 1975; Werner, et al., 1971). In the Collaborative Perinatal Project of the National Institute of Neurological Diseases and Stroke, Broman et al. (1975) reported on the study of 56,000 pregnant mothers and 53,000 infants. This study was conducted over a 6-year period from 1959 to 1965, with comprehensive data compiled during pregnancy, birth, neonatal, 4-month, 8-month, early childhood, and elementary school.

They found that early brain abnormality, rare neurological conditions, and developmental delay were significant predictors of infant cognitive competence. However, they also found that the most consistent predictors of later cognitive competence in childhood were maternal education and socioeconomic factors. This important study provided a means of identifying biomedical factors influential in high-risk pregnancies, and also documented the importance of poverty and adverse environmental rearing conditions in childhood mortality and morbidity (Bromen et al., 1975).

Another longitudinal study started on Kauai, Hawaii, in 1954 involved 857 multi-ethnic infants (Werner et al., 1971; Werner & Smith, 1977, 1982). Multiple
assessments were done during the mother's pregnancy, at birth, and at 2, 10, and 18 years. In the first 2 years of life, information on perinatal and neonatal events and developmental, psychological, and nutritional status were recorded. Later, individual psychological assessments were obtained along with information from the child's school record, as well as from social welfare and other agencies. By age 18, more than one-half of this predominantly lower SES sample had learning or emotional problems.

Several medical factors during perinatal period were associated with later impairments of cognitive, physical, or emotional functioning only when accompanied by adverse environmental circumstances. However, this relationship was weaker for those infants who had experienced moderate perinatal risk. Besides the importance of perinatal risk factors, the Kauai study also demonstrated the importance of psychosocial factors such as family socioeconomic status and child rearing factors as crucial moderator variables.

In conclusion, studies that have used perinatal biomedical factors to predict developmental outcome have met with only limited success. Taken together, the research literature seems to be paradoxical. As noted by Cohen et al. (1982), "Clinical and retrospective studies indicate that children who have developmental problems have had birth complications, on the other hand, birth complications are not adequate predictors of developmental problems" (p. 265).

**Environmental Approach**

In addition to biomedical risk factors, environmental and social factors have also been recognized as important variables when studying the development of high-risk infants. In a review of the research on the development of low birthweight children,
Benton (1940) found that social factors were confounded with both low birthweight and with the dependent measures used with low birthweight children. Thus, while the importance of biological risk factors was not to be diminished, social factors were found to be the most reliable predictors of later developmental outcome (Cohen, 1986).

Three major longitudinal studies on biomedical risk factors have also suggested the importance of powerful contributory social, family, and environmental factors (Broman, et al., 1975; Corah, et al., 1965; Graham, et al., 1956; 1962; Werner, et al., 1971). Based on these findings, Sameroff and Chandler (1975) criticized the concept of "continuum of reproductive casualty" for omitting from consideration those environmental factors which were correlated with, and probably causative of, perinatal problems, and those which moderated the influence of biological problems.

Sameroff and Chandler (1975) then proposed as an alternative a "continuum of caretaking casualty." Later, Sameroff and Seifer (1983) discussed risk potential in the following way:

In defining the developmental risk associated with any specific child, the characteristics of the child must be related to the ability of the environment to regulate the development of that child toward social norms. In extreme cases of massive biological abnormality, such regulation may be ineffectual. At the other extreme, disordered social environments might convert biologically normal infants into caretaking casualties (Sameroff & Seifer, 1983, p. 1255).

Other studies have also reported a lack of predictive ability of biomedical factors during prenatal and perinatal periods for developmental and intellectual functioning at school age. They did find evidence for the predictive ability of psychosocial variables, such as the family's socioeconomic status (SES), which were usually defined as a
composite measure of parents' education, income, and occupation (e.g. Adler, Boyce, Chesney, Cohen, Folkman, Kahn, & Syme, 1994; Cohen et al., 1982; Largo, Graf, Kundu, Hunziker, & Molinary, 1990; Littman & Parmelee, 1978; Sameroff, 1986). Other types of psychosocial factors such as maternal psychological status, stress, anxiety, depression (Molfese, Bricker, Ménion, Beadnell, Yaple, & Moirs, 1987a; Pianta, Egeland & Sroufe, 1989, Rosen & Stein, 1980; Sagi, Jaffe, Tirosh, Findler, & Harel, 1988), marital problems, parenting problems, psychological problems of the family (Altemeier, Vietze, Sherrod, Sander, Falsey, & O'Connor, 1979; Gabarino & Sherman, 1980), attitude toward pregnancy, social support, husband support (Aylward, et al., 1988; Molfese, et al., 1987a; Sagi et al., 1988), objective and subjective maternal perception of neonate (Bates, Freeland, & Lounsbury, 1979; Sagi et al., 1988; Sanson et al., 1991), and family background, occupational and educational status of parents (Sanson et al., 1991) have been found to be related to infant development.

Theorists and researchers have made major advances in conceptualizing important aspects of the environment that affect children's development and behavior. Infant development has been found to be heavily influenced by those aspects of the environment most proximal to the child (i.e., parenting, physical surroundings) (Casey & Bradely, 1987).

This relationship between infant and environment is constantly changing and is specific for individual families at various points in time (Casey & Bradely, 1987). For example, most of the studies that demonstrated the effects of poor environmental factors on infant development used children greater than 3 years of age as their high-risk subjects. In other studies that used high-risk infants of less than 2 years of age, significant correlations were found between medical risk factors and developmental abnormality, but found poor correlations between environmental factors and
developmental outcomes (Escalona, 1982; Scheiner & Sexton, 1991). It has been suggested that the impact of poor learning environment does not become apparent until after 2 years of age, when the child acquires language and abstract thought necessary to solve more complex problems (Escalona, 1982).

**Transactional Approach**

Research has documented that developmental and behavioral potential for most children are affected by the environment in which they live, to an extent at least comparable to the biologic constitution of the child (Casey & Bradley, 1987). The most contemporary model of child development is the "Transactional Model" (Sameroff & Chandler, 1975). This model is described by Casey and Bradley (1987) as one that:

...stresses the dynamic nature of both the child and environment and the child's active role in shaping his or her environment over time. The child and environment interact and affect each other, and each adapts over time as a result of these interactions. The child's health, physical appearance, gender, neurodevelopmental status, and temperament thus may affect the developmental-behavioral status directly at any point, but also indirectly by affecting the home environment. The more adaptable and competent the child and the more supportive and appropriately stimulating the home, the more likely that the child's development and behavior will be optimal. Problems with either the child or the environment create the potential for developmental and behavioral abnormalities. The probability of abnormalities increases when there are both a vulnerable child and an inadequate environment" (Casey & Bradley, 1987, p. 149).
The limited success of high-risk studies that have used only perinatal biomedical factors to predict developmental outcome, along with evidence of powerful environmental factors contributing to that prediction, resulted in a modified concept for researchers to conduct studies on infant development. They focused on a transactional approach in which both biomedical and environmental risk factors were considered. A diagnostic classification in this approach not only reveals unique characteristics of the child but also implicates a possible interaction between the child and the child's social environment.

Studies of risk factors for developmental abnormality in infants and children have noted significant individual variations in the effects of risk factors. Some children eventually developed problems, while others did not. Researchers attempted to explain these resilient children by identifying protective factors that countered their risk. This type of study examined the interaction of medical and environmental risk factors with protective factors.

An example of this type of research was the Kauai study. Werner and Smith (1982) attempted to identify the protective factors in the lives of high-risk children who survived their medical risk and developed normally. All 2-year-old children identified as high medical risks were classified into three different groups at age 18: (a) those identified with significant problems by age 10; (b) those developing problems by age 18; and (c) those "resilient" children who remained without significant educational or psychosocial problems.

The key protective factors identified by the study included easy temperament, small family size, low numbers of stressful experiences within the family, positive parenting attitudes, low level of family conflict, and counseling and remedial assistance.
In their analysis of interactional effects, they found that many of the protective factors were contributory only in the presence of high-risk factors and adverse environmental conditions, with little or no explanatory power in the lives of children with less stress and better socioeconomic conditions (Werner & Smith, 1982).

These protective factors in resilient children remain poorly understood, but it is clear that part of the explanation lies in the overall level of risk. Rutter (1990) suggested that when studying resilient children, the researcher should focus more on interactive mechanisms among risk factors and protective factors rather than the presence or absence of those factors.

The concept of "plasticity" was derived as a result of studies that showed a specific pattern of recovery among high risk infants (Rutter, 1990). Perinatal medical risk factors were found to be more highly correlated with neonatal and early infant outcome measures than with late infancy and childhood measures (Bee, et al., 1982; Cohen, et al., 1982; Forslund & Bjerre, 1983; Molfese & Thomson, 1985). Many longitudinal studies found that higher associations of developmental consequences of perinatal medical risk factors among infants became weaker when subjects reached their childhood (Broman, et al., 1975; Corah, et al., 1965, Graham, et al., 1956, 1962; Werner, et al., 1971). Medical evidence also showed that a great number of children with known insults and identified defects in CNS tissue at birth showed limited effects in later childhood.

The concept of plasticity may be seen as an aspect of the transactional approach. Plasticity has been described as representing the transaction between infant and environment, in which recovery processes within the child occur over time in the context of powerful social, familial, and environmental factors (Rutter, 1990).
Plasticity of children's CNS has also been proposed as part of the transactional approach (Brazelton, 1987). This concept views a young child's CNS as more plastic and capable of more recovery than that of the mature adult, while deemphasizing the importance of biological variables and the impact of CNS insult (Cohen et al., 1982; Largo, et al., 1990; Sameroff, 1986).

However, other researchers have argued that there is little evidence to support the view that the young brain has greater recovery potential. Since CNS tissue is not thought to be regenerative, the capacity for recovery of function is poorly understood (St. James-Roberts, 1979).

Adler, Boyce, Chesney, Cohen, Folkman, Kahn, and Syme (1994) have suggested that SES may affect biological functions, which in turn, influences health status. Usually, SES is treated as operating independently of other variables in predicting health outcomes. In contrast, Adler and associates have conceptualized components of SES, including income, education, and occupation, shape one's life course as enmeshed in key domains of life. These domains include: (a) the physical environment in which one lives and works, and where one is exposed to pathogens, carcinogens, and other environmental hazards; (b) the social environment and associated vulnerability to interpersonal aggression and violence, as well as degree of access to social resources and supports; and (c) socialization and experiences that influence psychological development and ongoing mood, affect, and cognition, and (d) health behaviors (pp. 17-18).

Research Strategies Employed in the Studies

In an attempt to clarify risk factors, researchers have generally employed three types of research strategies. These have been single-risk, combinative-risk, and
multivariate studies (Sanson et al., 1991). The single-risk study involves the strategy of focusing on a single hazardous event that is assumed to be so disastrous that it must lead to later developmental problems. The combinative-risk study assumes that risk factors operate in a cumulative way. Combinative studies also tend to group risk factors into separate indices of either biomedical or environmental factors. Multivariate studies attempt to explain how several diverse factors in both medical and environmental areas interact with each other to produce abnormal outcomes. Multivariate studies are based on the assumption that environmental variables do not function independently to influence outcomes, but rather work in synergy with biomedical variables (Sanson et al., 1991; Molfese, 1989).

In the biomedical area, many of the single-risk type studies have failed to identify pertinent biomedical risk factors that could accurately predict the degree of risk for an individual infant. This is primarily due to a limited focus on isolated factors occurring within the perinatal period. For example, several studies investigated the effects of single risk factors as predictors of developmental impairment. Perinatal anoxia (Graham, et al., 1956, 1962; Corah, et al., 1965) low Apgar score, and perinatal asphyxia (Nelson & Ellenberg, 1981) were each found to be a highly unreliable predictor of developmental impairment.

The concept of "reproductive casualty" has led many researchers to include both biomedical and environmental risk factors in their studies. However, each of these factors has been studied in terms of its unique contribution to developmental difficulties, not in terms of their interactive or combinative effects. There have been few attempts to assess the effects of multiple and/or interacting risk factors (Sameroff, 1986; O'Grady & Metz, 1987).
More recently, the cumulative effect of the presence of a number of risk factors has received an increasing amount of attention. Researchers have tried to develop "risk indices" or "risk scales" for abnormal developmental and behavioral outcome as a way of dealing with a large array of known risk factors. This approach acknowledges that a number of risk factors may have more important cumulative effects on child development than any one risk factor considered in isolation (Stanton, McGee, & Silva, 1991).

Research has provided evidence that risk factors may operate in a cumulative way (Rutter, Tizard, & Whitmore, 1970; Werner & Smith, 1982; Sanson et al., 1991, Stanton et al., 1991). For example, Rutter et al. (1970) found that the presence of only one of the factors on their "Family Adversity Index", which covers parental, family and socioeconomic factors, did not increase the risk for a later disorder. However the presence of four factors from the index was associated with a 10-fold increase in the incidence of a disorder.

Evidence for the combinative effect of risk factors was also supported in a longitudinal study by Sanson et al. (1991). They demonstrated that a single biomedical factor or single psychosocial factor, such as perinatal stress, mother's perception, developmental problems, prematurity, infant's temperament, mother-infant relationship, socioeconomic status, ethnicity, and home environment, could only modestly increase the prevalence of later developmental difficulties. However, the authors demonstrated that certain combinations of risk factors were associated with a marked increase in prevalence rate of developmental problems.

The result of this combinative approach has been the development of different combinative risk scales for either biomedical or environmental domains, but not a single scale that combines different types of risk factors across domains. For example, within
the biomedical domain, several types of perinatal risk scales have been developed, such as the High Risk Pregnancy Screening System (HRPSS) (Hobel et al., 1973), the University of Colorado Neonatal Morbidity Risk Scale (UCNM) (Lubchenco, 1976), the Obstetrical Complications Scale (OCS) (Littman & Parmelee, 1978), the Maternal-Child Health Care Index (MCHCI) (Nesbitt & Aubry, 1969), the Labor Index (LI) (Aubry & Pennington, 1973), the Scale of Optimal Obstetric Conditions (OOC) (Prechtl, 1967), the Rochester Research Obstetric Scale (RROS) (Zax, Sameroff, & Babingian, 1977), the Nursery Neurobiologic risk score (NBRS) (Brazy, et al., 1991), and the Perinatal Risk Inventory (PERI) (Scheiner & Sexton, 1991). These scales contain only medical items, with no psychosocial or environmental risk factors included.

In general, perinatal risk scales have been developed to be easily administered. They can be scored on the basis of medical records and have objective scoring systems. However, the scales also vary in several ways. They may vary in the number of items contained in the scales, the definition of each risk factor, the scores assigned to each risk factor, the purpose of the scale as being used in clinical settings or researches, and the type of population for which the scales have been developed.

While scores from these scales can be used with varying degrees of success to predict development in early infancy, it appears that most of the available perinatal scales are not good predictors for older infants or children (Bee, et al., 1982; Cohen, et al., 1982; Forslund & Bjerre, 1983; Molfese & Thomson, 1985). It is now evident that to predict behaviors in later developmental periods, it may be necessary to revise existing scales or develop new ones (Molfese, 1989).

Similar to perinatal risk scales in the biomedical area, indices have also been developed to assess the environmental domain. These include the Family Adversity Index
(Cohen et al., 1982) that assesses family, psychosocial, and environmental risk factors, the Child Rearing Index (Stanton et al., 1991) that includes measures of the parent on authoritarianism, egalitarianism, tendency to reject the child, protectiveness of the child, number of different experiences, separation from the child, and experience in child rearing, and the Family Status Index (Scheiner & Sexton, 1991), including factors such as age of mother, educational level and occupational status of parents, prenatal characteristics at the time of initiation of prenatal care, the use of drugs, and the presence or absence of psychiatric illness.

Other studies have included separate scales for both biomedical and environmental risk factors. For example, Stanton et al. (1991) examined four domains of adversities in early childhood as predictors for developmental outcomes for 476 girls and 510 boys at age 5 years. The study was designed to measure the cumulative effect of different risk factors that were grouped under four indices: Perinatal Complications Index, Child's Physical Health Index, Family Background Index, and Child-Rearing Practices Index. Results of the study indicated that the scores for family background and child rearing practices were highly correlated to developmental outcomes. The score for health problems was found to be significantly related to motor ability. The perinatal complication index was significantly related to specific cognitive ability scores for boys.

A similar study by Scheiner and Sexton (1991) examined 125 biologically high-risk infants at 9, 18 and 36 months using the Family Status Index and the Perinatal Risk Inventory to predict developmental outcomes. The total score of the Perinatal Risk Inventory, which is a combinative index of medical risk factors, demonstrated a significant correlation with the infant's score on the Bayley and Stanford-Binet. The combinative psychosocial factors of the Family Status Index, however, did not correlate well with developmental outcome. This appears to contrast with the results of other
investigators who have studied children older than 3 years of age. For example, Littman and Parmelee (1978) and Stanton, McGee, and Silva (1991) reported that the developmental outcome of a biologically high-risk child was found to be dependent on the child's SES.

In conclusion, researchers now propose studying both biological and environmental factors in a combinative way when determining the risk for adverse outcomes. The presence of only one risk factor in infancy has not been associated with a markedly greater incidence of adverse outcomes. As the number of identified risk factors increases, so are there greater incidences of later developmental problems.

However, there is still no agreement on the method in which researchers are to conduct risk studies. The result is that methods vary from one study to another, making it difficult to evaluate and compare the different research findings.

**Multivariate Studies**

As reviewed earlier, studies have demonstrated that both medical and environmental factors are important in predicting infant development, and that the development of infants and children is complicated and multidetermined. However, controversy remains over the appropriate research methodology to study developmental risk factors.

Results from major longitudinal studies on biomedical risk factors have suggested the importance of multidimensional assessments, allowing adequate time for recovery processes to occur following adverse perinatal events, and examination of the role played by powerful social, familial, and environmental factors (Broman, et al., 1975; Corah, et al., 1965; Graham, et al., 1956; 1962; Werner, et al., 1971).
Multivariate models have been developed that attempt to explain how several diverse factors in both biological and environmental areas interact with each other to produce abnormal outcomes (Chalmers, 1984; Cohen & Parmelee, 1983; Molfese, et al., 1987a; Norbeck & Tilden, 1983; O'Dougherty, Wright, Garmezy, Loewenson, & Torres, 1983; Obayuwana, Carter, & Barnett, 1984). These multivariate models are based on the assumption that psychosocial or environmental variables do not function independently to influence outcomes, but rather work in synergy with biomedical variables (Molfese, 1989).

Molfese et al. (1987a) tested the multivariate model using perinatal medical risk factors, anxiety, depression, stress in pregnancy, locus of control, and social support to predict perinatal outcomes of mothers and neonates. The mother outcome measures were length of 1st-stage labor, length of 2nd-stage labor, amount of analgesia, amount of anesthesia, and a summary score on intrapartum items from the HRPSS. The neonate outcomes were birthweight, gestational age, 1-min and 5-min Apgar score, and the scores on infant status from the PNCS, and from the Neonatal Subscale of the HRPSS.

The results showed that the relationships between psychosocial factors (anxiety, depression, stress, locus of control and social support) and outcome measures were generally weaker than the relationships between measures of perinatal medical risk factors and outcome measures. They also analyzed different combinations of these factors and found different degrees of prediction on the outcome measures. Finally, the authors concluded that while portions of the multivariate model were useful in characterizing the relationships between the predictor variables and some of the outcome measures, the full model was not useful in predicting all measures. However, the results supported the notion that these variables did not function independently in influencing outcome but
work in synergy, since the multivariate analyses produced stronger predictive results than did simple correlations.

The goal of multivariate studies should involve identifying infants at risk by using multiple assessments at different ages rather than a single assessment at one age group, and measuring a wide range of variables in both biomedical and psychosocial areas (Molfese et al., 1987a). This method of multiple assessments at different stages of development has the advantage of employing multivariate analyses so that the contributions made by various measures independently, and in combination, could be identified. It would then be possible to design a more effective system for eliminating those measures that did not contribute to the prediction of later performance (O'Dougherty & Wright, 1990).

Sameroff and Seifer (1983) recommended that investigators should take into account the following factors when attempting to identify predictors for developmental outcomes among high risk infants: (a) the special characteristics of infant's medical problems, how severe is the problem, and the occurrence of multiple problems, (b) the time period under study and the medical treatments available, (c) whether the data were collected retrospectively or prospectively, (d) the comprehensiveness of developmental outcome measures in physical, cognitive, social, and emotional domains, and (e) the characteristics of the parents and environment to which the infant was exposed on leaving the hospital. In addition, research methodologies and statistical analyses to account for these complex and related factors were needed, rather than employing study designs that correlated only single medical events with outcome measures.
Summary of Research Findings

Several conclusions can be drawn from previous research on identifying predictors for developmental outcomes among high-risk infants.

(1) Studies of single biomedical risk factors have not been successful in predicting developmental disability problems later in life. A new approach exemplified by combinative-risk studies is currently being used. This approach acknowledges that a number of risk factors may have more important cumulative effects on child development than any one risk factor in isolation. A number of different combinative risk indices for biomedical factors and environmental factors have been developed to predict later developmental abnormality in infancy and childhood. It has also been suggested that during the first two years of life, biomedical risk factors are more important than environmental factors. The factor of a poor environment does not appear to have a significant impact on developmental outcome until after 2 years of age, when the child acquires language and abstract thought necessary to solve more complex problems.

(2) An effective perinatal developmental screening process for high risk infants is currently not available. Perinatal risk scores from available scales were found to be weak predictors of developmental outcomes. The predictive ability of combinative risk scales on developmental outcomes were inconsistent, and varied depending on which variables were assessed.

(3) The future trend in the study of infants at developmental risk involves a multivariate approach that can take into account the complex interactions of different risk factors. This approach involves extensive time and resources. It requires a
comprehensive longitudinal project with multiple assessments at different ages, measuring a wide range of variables in both biomedical and psychosocial domains.

Research Issues

While progress has been made in research on developmental disabilities in infants, many important questions still need to be addressed. The following is a summary of the current major research issues related to the causation, mechanism, measurement, and early intervention of developmental disabilities in infants and children.

Multiple Causes of Developmental Disabilities

A child is a product of both nature and nurture. Environmental and biological factors jointly play a role in determining a child's health and developmental outcome. Research has shown that no single factor is always present or always absent when developmental disabilities are found. Rather, the presence of multiple risk factors within the child, the family, and the environment appear to distinguish between those children who develop developmental disabilities and those who are able to cope successfully with developmental tasks of childhood and adolescence. Because developmental disabilities are generally attributable to multiple factors or multiple causes, further study on the multidetermined nature of development and the cumulative nature of risk is required.
Mechanisms of Risk Factors

A major problem in the study of biomedical risk factors for developmental disabilities involved the results from clinical and retrospective studies that showed children with developmental problems experienced many risk factors, but those factors did not accurately predict developmental problems (Cohen, et al., 1982).

Rutter (1990) suggested that researchers should focus studies on interactive mechanisms among risk factors and protective factors rather than on the presence or absence of those factors. St. James-Robert (1979) also argued for the focusing on the mechanisms of risk factors. He suggested that a major problem in studies of this type was due to methodological issues in brain-behavior study. For example, one such issue was the failure to determine the mechanism of a risk factor and verify whether that particular risk factor did in fact cause brain damage.

St. James-Robert (1979) observed that there were two different groups of biomedical risks. The first included those risk factors that were known to cause brain damage and had been verified (e.g., intraventricular hemorrhage). The second included those risk factors that were suspected of causing brain damage and were assumed to have occurred based on behavior measurements (e.g., obstetrical complications, prematurity, anoxia).

The presence of verified brain injury has been significantly associated with increased risks of developmental and intellectual impairment, and psychiatric disorder. The evidence suggests that this association represents the causal influence of brain injury (Chelune & Edwards, 1981; Rutter, Chadwick, & Shaffer, 1983; Stewart, 1983).
Rutter (1983) observed that in earlier research pertaining to perinatal biomedical risk factors, "the very weak associations between perinatal complications and brain damage syndromes can be expected simply because the few children with true brain injuries resulting from perinatal events will be diluted by the much larger number who experienced perinatal hazards but escaped cerebral damage" (p. 4).

Confounding possible risk indicators with known risk mechanisms has contributed to conceptual confusion in the high-risk area (Rutter et al., 1983). Unlike experimental research with animals, in which controlled cerebral changes can be produced and the precise nature of neural and behavioral changes can be studied, research with human subjects is done when the nature, extent, and focus of damage often unknown and uncontrolled.

The development of noninvasive brain imaging techniques that allow in vivo visualization of the brain has been a major breakthrough in increasing the ability to document the occurrence and severity of brain damage. These techniques include computed tomography (CT), positron emission tomography (PET), magnetic resonance imaging (MRI), brain electrical activity mapping (BEAM), and evoked potential.

Progressive improvements in the diagnosis of intraventricular hemorrhage (IVH) in newborn infants is an example of the use of this technology (Korones, 1986). In the past, the only methodology available for the diagnosis of this type of lesion was through the examination of cerebrospinal fluid extracted by lumbar puncture, which was performed only after the appearance of clinical neurologic abnormality. However, there are a number of infants with IVH who are asymptomatic. The new technique of CT scan can identify more precisely these infants with differential degrees of severity of the hemorrhage. The shortcoming of CT scan, however, is the inconvenience and difficulty in transporting the baby to the apparatus.
More recently, CT scan has been replaced by a more convenient technique called intracranial ultrasonography. This is a noninvasive procedure which provides visualization of the brain during nursery stay at the bed-side. With widespread use of cranial ultrasound, the incidence of IVH in premature infants has been reported to be higher than previously observed by CT scan.

Ultrasonography has demonstrated the ability to detect the presence of a large number of hemorrhagic lesions (Korones, 1986). This technique is used in the evaluation of low birthweight infants. It has provided a means of identifying those infants who have sustained damage through cerebral hemorrhage, infarction, or asphyxia. Ultrasonography has also been used to document the relationship between the severity of these events and long-term neurodevelopment handicaps (Palmer, Dubowitz, Levene, & Dubowitz, 1982; Stewart, 1983).

The use of brain imaging techniques can more precisely identify different degrees of brain insult in infants. This has helped to identify causal relationships with developmental disabilities. However, a practical shortcoming of relying on high technology equipment is that it may be available for routine examinations only in big medical or research centers.

Risk Screening Systems

Inconclusive results from earlier research on biomedical risk factors was due in part to researchers relying on inaccurate risk indicators (Aylward, 1992; Molfese, 1989). Thus, there remains a need for a risk assessment screening system that not only provides for highly accurate early identification of infants at high risk for
developmental abnormality, but also contributes insight into the cause or mechanism of these disabilities.

Currently, neonatal risk factors are receiving more attention from researchers based on their better predictive ability of infant morbidity when compared to the prenatal or intrapartum risk factors (Aylward, 1992; Strobino & Baruffi, 1984).

Neonatal risk assessment scales were developed as a combinative index of a number of biomedical conditions of presumed clinical significance during the neonatal period (e.g., Hobel et al., 1973; Littman & Parmelee, 1978; Brazy et al., 1991; Scheiner & Sexton, 1991). The mechanism through which these biomedical conditions affect child development involves brain-cell injury (Rutter, 1990).

Although a clear identification of the risk mechanism is necessary, it is important to note another feature of risk research findings. That is, many risk factors may not seem to have a direct effect. Certain risk factors do not lead to an increased rate of developmental abnormalities if they occur in isolation. On the other hand, the rate is greatly increased if there are two or more concurrent risk variables (Rutter, 1990).

Another recent advance is the concept that a biomedical event could be expressed in terms of degree of severity. This more precise observation could allow for better predictability of developmental outcome. Researchers have hypothesized that the greater the number of biomedical risk factors and the greater their degree of severity, the more likely the infant would demonstrate developmental abnormality (e.g., Brazy et al., 1991; Robertson & Finer, 1985; Sheiner & Sexton, 1991).

A common physiological condition relating to many of the recognized risk factors and is indirectly related to brain cell injury is neonatal asphyxia (Glassanos & Gibes, 1986). Asphyxia has been defined as a clinically evident hypoxic-ischemic episode of the perinatal period, and accounts for more nonprogressive neurologic deficits seen in
children than any other insult (Becker & Taeusch, 1987). It describes any state in which the fetus or newborn infant suffers impaired respiratory gas exchange. There are various degrees of asphyxia, but in all cases there is a significant alteration in oxygen and carbon dioxide tension and in hydrogen ion content. The pathophysiology of asphyxia (Glassanos & Gibes, 1986) can be briefly described as follows:

In utero, the placenta is the major organ for gas exchange. The fetal lungs are filled with fluid, minimally perfused and essentially collapsed. Fetal cardiac output therefore bypasses the lungs through two cardiac shunts, the foramen ovale and the ductus arteriosus, allowing for a more direct route to the placental for gas exchange. Fetal asphyxia can occur by diminution in the flow of oxygen from mother to fetus.

At birth, the fetus must make significant effective breathing, which replaces the fetal lung fluid with air and establishes a functional residual capacity. The closure of the foramen ovale and the ductus arteriosus occurs as well as the perfusion of the pulmonary vascular base, resulting in effective cardiopulmonary function of the infants.

However, any condition that causes hypoxia, acidosis, or a decrease in blood perfusion of the infants will reverse or even prevent these transitions from fetal circulatory to cardiopulmonary function. This results in neonatal asphyxia. With a decreased oxygen supply, the acid-base homeostasis and oxygenation are imbalanced. The newborn infant converts from aerobic glucose oxidation to anaerobic glycolysis, with the end product of lactic acid and carbon dioxide. The lactic acid produces metabolic acidosis and the increased CO₂ leads to respiratory acidosis. In addition, in response to hypoxia, glycogen and glucose are depleted (hypoglycemia) as well as the high-energy phosphate stores,
phosphocreatine and ATP. These affect impairment of brain cell processes. Hypocalcemia, hypomagnesemia, and hyperammonemia have been observed following asphyxia, resulting in severe neurologic sequelae (Simmons, 1974). As asphyxia continues, bradycardia develops, systemic blood pressure falls, cerebral blood flow decreases, and cerebral ischemia or the death of brain cells occurs (Glassanos & Gibes, 1986, pp. 68-69).

In summary, there is a need for a risk screening system that incorporates a range of important assessment factors. It should be developed in the context of a combination of specific risk factors. These factors would be selected on the basis of their potential to contribute to major causes or mechanisms of developmental disabilities. The level of severity of each factor would also be assessed to increase accuracy of the measure. Also included should be physiological conditions, such as neonatal asphyxia, which are commonly related to many of the recognized risk factors related to brain cell injury.

An example of this type of combinative index neonatal risk assessment scale is the *High-Risk Pregnancy Screening System-Neonatal Subscale* (HRPSS-Neonatal Subscale), developed by Hobel et al. (1973). This scale consists of 35 neonatal risk factors, which are representative of the six major biological systems which impact on the normal development of infants. The mechanisms for these risk factors can be related to brain cell injury, either by direct or indirect effect. This scale represents a comprehensive measure of the clinically significant biomedical risk factors in the neonatal period as well as immediately after birth (Strobino & Baruffi, 1984). One significant shortcoming of this scale is that it does not include a measure of the severity for each factor.
The following is a description of the six categories of the HRPSS-Neonatal Subscale and the mechanisms for specific risk factors leading to brain cell injury. Where asphyxia is the mediating condition between a risk factor and brain cell injury, those risk factors will be discussed in terms of their relationship to asphyxia.

**General Category**

*Prematurity* has been defined on this scale as low birth weight infants who weigh less than 2,500 grams at birth. Low birthweight reflects intrauterine growth retardation, and is a major cause of morbidity and mortality in the perinatal period and the first year of life. The lower the birthweight, the higher risk for mortality and morbidity of infants (Houde, 1986). A major complication of prematurity is intraventricular hemorrhage, periventricular leukomalacia, and respiratory distress syndrome. These medical complications can cause brain cell injury and affect neurodevelopment of infants (Taeusch & Yogman, 1987).

*Apgar score* is an account of the events that occur in the delivery room during the first minutes of the infant's life. The Apgar score reflects perinatal distress of infants. The clinical evaluation for the Apgar includes heart rate, respiratory effort, muscle tone, reflex irritability, and color. A total score ranging from 0-10 is assigned. The more vigorous the infant, the higher the score. A low 5-min score indicates persistence of asphyxia with high possibility for brain damage if a distressed infant survives. (Taeusch & Yogman, 1987).

*Resuscitation at birth* is the factor intended to define further complications of infant respiratory distress. It is considered to account for the episodes
of hypoxia and changes in cerebral perfusion or oxygen delivery. The longer the duration of mechanical ventilation, the more severe is the risk (Brazy et al., 1991).

**Respiratory System**

*Respiratory distress syndrome (RDS)* is a condition in which the lungs are not mature enough to produce pulmonary surfactant, resulting in pulmonary vasoconstriction. The physiologic alterations of RDS produce hypoxia, respiratory acidosis, and metabolic acidosis, resulting in asphyxia and subsequent brain cell injury (Ladewig, London, & Olds, 1990).

*Meconium aspiration syndrome*: The presence of meconium stool in the amniotic fluid is a symptom of fetal distress. Meconium aspiration syndrome is a neonatal consequence of fetal asphyxia (Korones, 1986). It rarely occurs in preterm infants. The asphyxial episode in utero apparently increases intestinal peristalsis and relaxes the anal sphincter to release meconium. It also stimulates fetal gasping. The aspiration of meconium results in completely or partially obstructing the airway, leading to hypoxia. In addition, the airway is also affected by an inflammatory response to meconium, also called chemical pneumonitis, resulting in impairment of oxygen perfusion in addition to obstruction of the airway.

*Congenital pneumonia* is the most common of the serious neonatal infections. It has been cited as a cause of death in 10-20% of neonates. Congenital pneumonia is acquired in the utero. The bacteria most frequently involved are *E. coli* and other enteric organisms and group B streptococci. When affected, the infants are in distress at birth with low Apgar score, and resuscitation is necessary (Korones, 1986).
Metabolic Disorder

The most important risk factors are hypoglycemia and hypocalcemia, since these two substrates are necessary for normal functioning of brain cells. Depletion of these substrates impairs brain cell processes and results in neurologic sequelae (Simmons, 1974).

Cardiac System

In newborns, congestive heart failure is often caused by asphyxia (Becker & Taeusch, 1987). It is a clinical syndrome reflecting the inability of the myocardium to meet the metabolic requirements of the body. Therefore the signs and symptoms reflect the decreased cardiac output and decreased tissue and cerebral perfusion, including asphyxia, hypoxia, and acid-base homeostasis imbalance (Merenstein & Gardner, 1989).

Hematologic Problems

Pathologic hyperbilirubinemia can be the result of increased production or decreased excretion of bilirubin, or the combination of these two processes. Hyperbilirubinemia is of clinical concern because of the complication of bilirubin encephalopathy (kernicterus). Free unconjugated bilirubin appears to be an irreversible cytotoxic for central nervous system cells. It acts to uncouple oxidative phosphorylation and reduces protein synthesis in vitro of the mitochondrial level (Frank, Turner, & Merenstein, 1989).
**Hemorrhagic diathesis** is a generalized bleeding problem in the newborn. Bleeding problems of the newborn are often the result of local trauma associated with a difficult delivery. However, severe physiologic deficiencies in clotting factors of the newborn can aggravate the severity of bleeding. This may cause hypoxia, or anemia because of blood loss. Occasionally, large-vessel thrombosis may occur, resulting in gangrene of the affected parts, such as CNS.

**Neonatal sepsis** is the most serious postnatal systematic infection associated with bacteremia. Meningitis in the neonate is a frequent manifestation of sepsis in neonate. Approximately 30-35% of the meningitis survivors are central nervous system handicaps (Korones, 1986). Several other abnormalities may accompany sepsis, including hypoglycemia, hypocalcemia, and unexplained metabolic acidosis (Bruhn, Jones, O'Donnell, & Merenstein, 1989).

**Central Nervous System**

**CNS depression** is the decreased functioning of the CNS, characterized by symptoms ranging from floppiness to coma, including poor muscle tone, reflex abnormalities, lack of spontaneous respiration, and hypothermia. Asphyxia is major cause of CNS depression. Increased intracranial pressure, intracranial hemorrhage (i.e., IVH), or hypoxic-ischemic brain injury can also cause CNS depression (Hagedorn, Gardner, & Abman, 1989).

**Seizures** are signs of malfunctioning neuronal systems. This is due to loss of inhibitory control which may result from damage to a developing brain, or transient effects such as disturbances in blood flow, glucose availability, or hypoxia.
Most often, seizures in the newborn period are the result of a very significant CNS insult (Minarcix & Beachy, 1989).

**Infant Developmental Assessment**

Another important challenge facing researchers is the need to develop instruments sensitive enough to measure the effect of CNS insult on developmental outcomes (O'Dougherty & Wright, 1990). The failure to find an association between medical risk factors and abnormal developmental outcomes may be because the developmental assessment instruments currently available have shortcomings in at least one of the following areas: (a) they are either not sensitive enough to differentiate between normal and abnormal development, (b) they may not be comprehensive due to exclusion of certain basic developmental functions, or (c) they may not be age and/or culturally sensitive. It appears that prediction will differ, depending on whether cognitive, motor, or neurologic function is assessed, with background variables differentially influencing each of these areas (Aylward, Verhulst, & Bell, 1988; Morrison & Villarreal, 1993).

The evidence supports the use of multiple measures of both developmental and neurological assessment to enhance prediction (Aylward, et al., 1988; Gardner, 1985; Morrison & Villarreal, 1993; Mullen, 1989; Sheehan & Klein, 1989). Typically, a neurologic examination or a developmental examination is used. However, there has often been weak concordance when separate assessments are made for neurological functioning (i.e., abnormalities of posture, tone, and movement) and developmental measures (i.e., motor and cognitive development), since underlying neural functions or
maturation are not necessarily reflected in developmental acquisitions (Aylward, et al., 1988; Aylward, 1992). In addition, the aims of separate neurological and developmental assessment instruments often produce information which can overlap and thus be unnecessarily redundant, or differ such that the information obtained may not be functionally related when attempting to explain the developmental delay.

Cultural sensitivity and fairness are other important issues for developmental assessment (Aylward, 1992; Molfese, 1989). The need for cultural sensitivity stems from the influence of a child's environment upon development. Cultural variation affects the child's experience; what is acceptable in one culture may not be in another. It is essential that cultural and linguistic differences should be considered when assessing child development (Aylward, 1992; Mullen, 1989).

Thus, there is a need for an early developmental neuropsychologic evaluation instrument that identifies infants and young children with abnormalities of posture, muscle tone, and movement, as well as problems with developmental delay (Aylward, 1992). Such an instrument should be culturally sensitive. Being a hybrid instrument, it should also combine aspects of both neurologic and developmental examination that would assess brain-behavior relationships in the context of developmental change and maturation.

Currently, there is an early developmental neuropsychologic evaluation instrument, the Infant Mullen Scale of Early Learning (Infant MSEL), being developed and standardized among multiethnic groups in the U.S. population. This instrument has a strong theoretical base that is conceptualized in terms of a neurodevelopment and intrasensory, intersensory processing model, with recognition of the influence of central motor control and mobility on early development (Mullen, 1989).
The Infant MSEL links motor equilibration to early visual and language receptive and expressive development. The scale proposes an interaction within which central motor control and mobility impact on visual spatial organization, fine motor ability, auditory and auditory/visual reception, and verbal communication (see also Chapter II).

According to Mullen (1989), spatial, temporal, and motor structures are important for normal infant development. Vision is the greatest source of spatial cues (Piaget, 1952) and the foundation of early organization and sequential ability. This early visual spatial organization is facilitated through motor development and environmental sounds.

Auditory information primarily provides a temporal sense through the pattern of succession, rhythm, and their changes, with less emphasis on spatial cues. The properties of auditory information are reinforced through environmental sounds, vocal imitation, and vocal utterances.

Normal motor development is also an important component of assessment in the Infant MSEL. When motor development is normal, a state of motor equilibration exists within which responsivity and learning are nurtured. New adaptive positions allow the child to experiment with schemas and people. When motor development is abnormal, extensor patterns often predominate, patterns essential to movement do not develop, and a state of motor disequilibrium exists within which motor exploration is hindered, and problem solving is impaired (Mullen, 1989).

An important aspect of the scale is the assessment of interactions of different modalities. The assumption is that all of the young child's experiences with objects, people, and events in the environment occur within a structured, sequential, framework of space and time and is facilitated through ongoing motor development (Mullen, 1989).
According to Mullen (1989), eight stages of motor and mental development are proposed from birth to thirty-eight months of age. For example, in the age range directly relevant to this study, Mullen (1989) describes the second developmental stage of motor and mental abilities as:

... during this period (4 months to 6 months 30 days), the synergistic relationship among central motor control, vision, and hearing increases in complexity. At approximate seven months, head, shoulder girdle, arm, and upper trunk control form the gross motor base on learning. The child maintains control in sitting with support. Vision is refined, hearing is normal, and breathing has become thoracic. The child coordinates breathing and sound production (phonation) and starts to imitate sounds. Visual and auditory reception, vocal and fine motor abilities are integrated through postural control and adjustment.

Motor milestones: include rolls over, bears weight in prone on extended arms with lateral weight shift and reach, sit supported which provides support from lower trunk and hips, in a high chair or on parent's knee.

Visual Receptive Organization: localizes objects and people at near and far point; looks for object in response to a visual stimulus followed by an auditory stimulus.

Visual Expressive Organization: reaches, grasps, transfers, bangs, and drops objects.

Language Receptive Organization: attends to voice/face (auditory/visual) and vocalizes; coordinates listening, head turning, and looking in response to an auditory stimulus; and enjoys auditory/visual interaction.

Language Expressive Organization: produces and plays with social sounds and babbles (Mullen, 1989, p. 10)
Early Intervention

Studies on the efficacy of early intervention programs have resulted in controversial findings. It is generally agreed that early intervention programs for infants younger than 12 months did not have long-lasting effects (Gentry & Adams, 1978; Strauss & Brownell, 1985), and the short-term gains have been rated as only moderate (Strauss & Brownell, 1985).

The cause of such negative comments on infant intervention programs stems in part from the way the research has been conducted. There have been problems with validity and reliability of the studies, too few number of subjects for statistical power, no control group for objective evaluation, lack of reliability and validity of the measurement tools, questions of competency of the examiner using the tools, and lack of follow-up or postcheck on the level of performance that was the target of intervention. (Gentry & Adams, 1978; Harris, 1981; Hourcade & Parette, 1984).

Moreover, to provide an effective treatment, intensive training for professionals is required (Farber & Williams, 1982; Goldberg, 1975). Individuals performing the screening, assessment, and intervention should receive extensive training in specific techniques related to specific age groups. A professional should have good knowledge of normal and abnormal infant development even at the prenatal stage. They should also be able to evaluate normal full-term infants in the areas of reflex responses, muscle tone, and general body activity as well as be familiar with the concepts of normal muscular maturation and function. They should also be trained in such areas as building successful relationships with families, observing children, implementing developmentally appropriate practices, interpreting assessment results to families, and establishing community linkages for further assessment and intervention services.
Finally, they should keep abreast of current research studies and the results pertaining to medical conditions, diagnostic assessments, and intervention techniques. Pre-service and inservice training, continuing education, and the availability of supervision and consultation are all essential for the delivery of high quality service (Meisels & Provence, 1989).

Although the performances of early intervention programs may appear pessimistic, the literature provides some optimism for continuing to operate and fund these programs (Copeland & Kimmel, 1989). Most interventionists agree with Bricker and Dow (1980) and Matthews (1985) that intervening early with a systematic approach, using a combination of home-based and center-based program works best with infants up to the age of 2 years. Attending to desired behaviors or establishing normal movement patterns at any early age helps minimize the development of related disabilities. It also reduces the need for subsequent special education or institutional care, reduces the rate of school failure, and helps to reduce the parent's isolation and helplessness (Copeland & Kimmel, 1989).

**Developmental Disabilities in Thailand**

**Background of Thailand**

The Kingdom of Thailand, formerly known as Siam, occupies the center of the South-East Asian mainland, bordered by Myanmar (Burma) to the west, by Laos and Cambodia to the east, and by Peninsular Malaysia to the south. Its total area is 513,115 sq. km (198,115 sq. miles). Thailand includes tropical rain forests, agriculturally rich plains, and forest-covered hills and mountains. The pattern of rivers and
mountains divide Thailand into four natural regions: the north, northeastern, central, and south region. Administratively, Thailand is currently divided into 73 provinces, and the capital city is the Bangkok metropolis. The 1990 census recorded a population of 54,532,000 (World Bank, 1992).

Unlike many other developing countries and its southeast Asian neighbors, Thailand has never been colonized by a foreign power, and considers itself an independent nation throughout its history. In many important respects, the Thai population is relatively homogenous and speaks Thai language. The entire indigenous population belongs to the Thai ethnic group and professes Hinayana Buddhism as its religion. A common religion is one of the most important factors contributing to the relative cultural homogeneity of the Thai population. Moreover, there is a general sense of national identity reinforced by a widespread allegiance to the monarchy, which serves as an effective symbol of national unity.

Economics

Thailand is an overwhelmingly agricultural country, with only a limited degree of urbanization. Despite increasing proportions of the population living in urban areas and engaging in non-agricultural pursuits, the country remains predominantly rural and agrarian. According to World Bank statistics (1992), 78.5% of the population live outside areas classified as urban in 1988, and 71% of the labor force were engaged in agriculture in 1980. The data in 1988 indicated that 45.1% of labor force was female.

Economically and politically, the country is dominated by Bangkok, the only major urban area, with a population of 5,876,000 (World Bank, 1992). Although Bangkok is located geographically within the central region, for most purposes the
Bangkok metropolis is considered a distinct region because its population differs considerably in many characteristics from the remainder of the central region.

Thailand is presently experiencing rapid and fundamental social and economic change as it undergoes the process of modernization and development and becomes increasingly involved in the world economic system. Gross National Product (GNP) per capita was $1,030 in 1988 (World Bank, 1992), placing it in the middle-range among those developing countries classified as lower-middle-income. Thailand's rate of economic growth in recent decades, however, has been well above the average for developing countries in general.

**Health**

With respect to several key health indicators, Thailand's situation appears relatively favorable for a developing country. For example, life expectancy at birth for 1989 was estimated to be at 65.6 years. Total fertility rate was 2.5, and infant mortality rate was 28.8 (World Bank, 1992). This was distinctively better than the average for other lower-middle-income developing countries. By way of comparison, WHO statistics for 1987 showed that life expectancy at birth was 64.6 in Thailand, 59.4 in Indonesia, 57.4 in India, and 75.3 years in the U.S.. Total fertility rate was 2.8, 3.6, 4.4, and 1.8; and infant mortality rate was 29.8, 78.0, 101.1, and 10.1 for Thailand, Indonesia, India, and the U.S., respectively (WHO, 1992).

The health-service system in Thailand is a complex mixture of public and private providers. In urban areas, private health services are very important, with 237 private hospitals and clinics available (Thai Population Information Center, 1991). For the large rural population, however, the major source of service is the
Ministry of Public Health, operating through an extensive network of outlets including regional health centers, provincial and district hospitals, and local health stations at the township level. The public health system has expanded considerably in the last two decades. In the rural areas, there are 17 regional hospitals, 69 general hospitals, 557 community hospitals, 60 extended O.P.D., 7,675 health centers, and 486 community health centers (Thai Population Information Center, 1991).

The Ministry of Public Health is responsible for the provision of health care services, disease prevention and control, and other welfare services related to the health of the population. The budget for the fiscal year 1990-1991 was 21 billion baht (5.3% of the total country budget). It has been the policy of the government to expand and provide medical services to cover the population at all levels of administration. The current national health development programs include health administration, health services, community participation in primary health care, technology development for disease control, and health promotion and consumer protection. These programs are designed to achieve the basic minimum need targets, reduce mortality, morbidity and incidence rate of diseases identified as major health problems, reduce the population growth rate to 1.3% by 1991, and expand and promote health personnel and infrastructure. Emphasis is also given to lower morbidity of vaccine preventable diseases common among new born babies, including diphtheria, tetanus, pertussis, polio, and measles.
Developmental Disabilities in Thailand

The only international statistics available for developmental disabilities in Thai children is from the *United Nations Disability Statistics* (1991). Based on the 1981 "impairment" survey cited in this research, there were estimated to be 150,000 Thai children between 0-19 years of age in the surveyed population (0.6%) who were considered to be disabled persons. When the survey population was limited to only children not in school, the number increased to 2.3% in 1983.

These developmental disabilities statistics, however, were criticized on methodological issues (UN, 1991). One issue is that the estimates of the percentage of disabled persons ranged from 0.2 to 20.9% of the population for the 63 surveys of 55 countries. This high degree of variability was partly caused by differences in how "impairment" and "disability" were defined by various countries. It was also caused by differences in types of surveys utilized. In many instances, either "impairment" or "disability" type surveys were used to identify disabled persons. When the "impairment" questions were used, as in the case of Thailand, the percentage of disabled persons was lower than when the "disability" questions were used in the survey (UN, 1991).

Even though there is no updated and reliable survey on the prevalence rate of developmental disabilities in Thai children, the increasing number of children with developmental disabilities or children suspected to have developmental disabilities in Thailand is recognizable and of great concern among pediatricians (Pra Pinklaw Hospital, 1992; Ramathibbodee Medical School, 1992).

There appear to be many factors that indicate a growing problem of developmental disabilities in Thailand.
Advanced Medical Technology

There has been a dramatic reduction in the infant mortality rate over the last two decades in Thailand, from 76.4 for every 1000 live births in 1969, to 28.8 in 1989. This is mainly due to improvement and availability of medical technology and health services (Chayovan, et al., 1988). As in many other countries, advances in medical technology are resulting in many at-risk infants now surviving into childhood. The consequence is an increase in the number of children with developmental disabilities (Newacheck and Taylor, 1992).

Health Priorities and Systems

Another concern about the risk of developmental disabilities in Thai children is a health system that seems to overlook the problem of developmental disabilities. The priorities of health service for infants and children in Thailand are still to conquer major diseases that cause mortality and to promote a higher nutritional status. There has been a successful immunization program reaching a high percentage of children. The percentage of children 0-1 year of age receiving immunization in 1990 ranged from 70% for measles, 86% for OPV and DPT, and 100% for BCG. The nutritional status of Thai children has also improved. Less than 19% of pre-school children and less than 8% in Bangkok experienced nutritional problems in 1990 (Thai Population Information Center, 1991).

Among married women, the first priority for public health services has been to
Table 1. Number and Percentage of Coverage of Maternal Care in Thailand: Antenatal Care, Delivery, and Postnatal Care by Region, 1990

<table>
<thead>
<tr>
<th>Region</th>
<th>Antenatal Care (4 times)</th>
<th>Delivered by Health Personnel</th>
<th>Postnatal Care (4 times)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
</tr>
<tr>
<td>Central</td>
<td>108,689</td>
<td>60.5</td>
<td>152,658</td>
</tr>
<tr>
<td>NorthEastern</td>
<td>220,855</td>
<td>67.6</td>
<td>274,583</td>
</tr>
<tr>
<td>Northern</td>
<td>111,545</td>
<td>70.9</td>
<td>141,196</td>
</tr>
<tr>
<td>Southern</td>
<td>84,279</td>
<td>59.3</td>
<td>115,338</td>
</tr>
<tr>
<td>TOTAL</td>
<td>525,368</td>
<td>65.2</td>
<td>683,775</td>
</tr>
</tbody>
</table>

Table 2. Number and Percentage of Birthweight less than 2,500 Grams, more than 3,000 Grams, and the Coverage of Neonatal Care by Region, 1990

<table>
<thead>
<tr>
<th>Region</th>
<th>Birthweight less than 2,500 grams</th>
<th>Birthweight more than 3,000 grams</th>
<th>Neonatal Care (3 times)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
</tr>
<tr>
<td>Central</td>
<td>11,449</td>
<td>9.5</td>
<td>88,333</td>
</tr>
<tr>
<td>NorthEastern</td>
<td>24,280</td>
<td>8.8</td>
<td>156,670</td>
</tr>
<tr>
<td>Northern</td>
<td>15,231</td>
<td>10.8</td>
<td>74,766</td>
</tr>
<tr>
<td>Southern</td>
<td>9,994</td>
<td>8.7</td>
<td>74,942</td>
</tr>
<tr>
<td>TOTAL</td>
<td>63,954</td>
<td>9.4</td>
<td>394,711</td>
</tr>
</tbody>
</table>

encourage family planning and child spacing to promote the two-child family norm (Thai population Family Center, 1991). This has resulted in the successful reduction in the total fertility rate from 3.1 in 1981 to 2.5 in 1989 (World Bank, 1992).

However, the prenatal care for mothers and neonatal care for infants after birth have not been sufficiently emphasized (see Table 1 and 2). In 1990, only 65.2% of pregnant women had prenatal care, and only 46.4% had postnatal care at least 4 times. Eighty-five percent of the pregnant women had delivery by health personnel, and 47.4% of infants had neonatal care at least 3 times after birth (Thai Population Information, 1991). Since the literature shows that biomedical risk factors for developmental disabilities occur largely around the perinatal period, the inadequacy of maternal and child health services in Thailand is considered to be at risk for developmental disabilities.

**Prevalence of Low Birthweight (LBW)**

The incidence rate of LBW infants born each year has slightly increased over the last 4 years. Incidence rates were 8.2, 8.7, 9.6, and 9.4% of live births for the years 1987, 1988, 1989 and 1990 respectively (Thai Population Family Center, 1991). This is another indicator for concern about an increase in developmental disabilities among Thai children. LBW is one of the major biomedical risk factors leading to many types of neonatal disorders, including respiratory distress syndrome (RDS) and intraventricular hemorrhage (IVH), all risk factors for developmental disabilities.

The statistics on LBW and RDS available from the Pra Pinklaw Hospital (1992) show that out of 6,199 live births in 1990, 660 or 10.7% were low birthweight (LBW) of less than 2,500 grams. Sixty seven of these LBW infants (10.2%)
demonstrated respiratory distress syndrome (RDS), and 47 were on ventilator, ranging from 3-30 days. Among the 67 RDS infants, 26 died before 30 days of age.

**Poverty and Education**

Thailand is a developing country with a majority of people classified as economically disadvantaged. Universal compulsory education in Thailand was enacted into law in 1921, with implementation virtually completed by 1980. In 1980, 59% of Thais aged 15 or over had a fourth-grade education, and only 21% had attended school beyond the fourth grade. Among women in the major reproductive ages of 20-44, 70% had a fourth-grade education and 17% had more than a fourth-grade education (Chayovan, Kamnuansilpa, & Knodel, 1988). Since the low level of education of parents and poverty are considered to be psychosocial and environmental risk factors for developmental disabilities, Thailand is a country at high risk for developmental disabilities problems.

A study by Chayovan and associates (1988) showed that maternal education was related to the percentage of Thai mothers receiving prenatal care from physicians: 91% of mothers with an educational background beyond grade 12 received prenatal care from physicians, while 42% of mothers with an educational background between grades 8-12 and 26% of mothers with no education received prenatal care from physicians. Similar results were seen between the level of maternal education and the percentage of mothers who received delivery assistance from health personnells, had their babies immunized, and received assistance from health personnells when the infants were sick (Chayovan et al., 1988).
Pediatric AIDS

The increased prevalence of AIDS and HIV-positive patients is a major concern in Thailand. Data as of October 31, 1991, showed a prevalence of 28 AIDS-infants. All of them were vertically transmitted, having the virus transmitted from the mothers (Thai Population Information Center, 1991). An increase in the number of AIDS infants is expected in Thailand, with consequent problems related to developmental disabilities being critical.

Lack of Professionals and Instruments

The ratio of medical professionals to the general Thai population is 1:1,361 for physicians, and 1:962 for nurses (Thai Population Information Center, 1991). Of the 12,713 physicians in Thailand, about 600 are pediatricians, and only 6 are developmental pediatricians (Pra Pinklaw Hospital, 1992).

Since the first priority of physicians and pediatricians is related to survival of the infant, there are very few developmental pediatricians in Thailand who are trained to deal with developmental disabilities problems (Ramathibbodee Medical School, 1992; Pra Pinklaw Hospital, 1992). Only basic developmental milestones such as creeping, sitting, walking, etc. are used in routine developmental checkups. A result is that many infants and young children with developmental problems are probably unrecognized in all but the most severe cases.

In addition, a reliable instrument for infant development in the Thai population has not been developed. One exception to this situation is the use of the Denver Developmental Screening Test (DDST) at the Child Development Clinic at Ramathibbodee
Hospital (Ramathibbodee Medical School, 1992). However, this instrument has not been standardized among Thai infants.

The early intervention for infants with recognized developmental disabilities is also a major problem because of lack of intervention programs and professionals who are trained for the early intervention. Currently, parents and family members trying to deal with the problem of their developmental disabilities children receive little or no support from professionals.

Ignorance of the Problem

The extent to which problems are experienced in the prevention, assessment, and early intervention of developmental disabilities in Thailand is directly related to the situation of physicians focusing resources on the survival of the infant. The inattention to developmental disabilities up to the present time has resulted in a lack of common definitional criteria as well as accurate information of the prevalence of developmental disabilities in Thailand.

Purposes of the Study and Statements of the Research Questions

Purposes of the Study

There were three major purposes for this study. The first purpose was to determine the applicability of the Infant MSEL as an assessment instrument for Thai
infant development. While this instrument had face validity, its objective validity has not been established within a Thai population.

The second purpose was to examine the relations between biomedical and psychosocial risk factors to infant physical growth and infant neurobehavior development at age six months in a Thai sample.

The third purpose of this study was to explore the relationships between biomedical and psychosocial (SES) risk factors and the following psychosocial factors among the Thai infants: (a) maternal perceptions related to her infant, husband support, and social support, (b) the infants' stimulating environment, and (c) maternal behavior in reacting to her infant.

Many studies have suggested that infant stimulating environment, maternal behavior in reacting to her infant (Casey & Bradly, 1987; Hammond & Snyder, 1987), maternal perception of her infant (Sagi et al., 1988; Sanson et al., 1991), maternal perception of husband support, and maternal perception of social support (Aylward et al., 1988; Molfese et al., 1987a; Sagi et al., 1988) were important factors and may directly or indirectly related to child development. While biomedical risk status and SES of the infants may affect these psychosocial factors, presently, there have been no studies that have examined these relationships (Sagi et al., 1988; Sanson et al., 1991).

**Benefits of the Study**

This study contributes to the understanding of the relations of biomedical and psychosocial risk factors to early development of the Thai infants. The study may also contribute to the social welfare and health of the Thai population since significant increases in the prevalence of developmental disabilities among infants and children in
Thailand are expected. In order to deal with this problem, better understanding of the nature of developmental disabilities as well as the development of applicable instruments to assess for developmental disabilities among Thai infants are required.

This study also represents the initial point of research on infant neurobehavior development and developmental disabilities in Thailand. Basic knowledge was gained on the assessment of high risk infants for developmental disabilities in Thai infants. The intensive training required to conduct this study can also serve as a foundation for future work in the investigation of important issues related to developmental disabilities in Thailand, can lead to increased dissemination of information in this area, and may stimulate other professionals to be more aware of developmental disability issues in Thailand.

**Hypotheses for the Study**

**Hypothesis 1**

The Infant MSEL is widely used as a valid measure of infant development in the U.S. (Mullen, 1989; Mullen et al., 1989). To explore the applicability of the Infant MSEL among Thai infants, the Denver II (a revised version of the DDST) was used as a criterion to examine the concurrent validity of the Infant MSEL.

It was hypothesized that total scores of the Infant MSEL, as a measure of infant development of the Thai infant at 6 months of age, will be highly correlated with total scores of the Denver II in measuring Thai infant development for the same sample.
Hypothesis 2

Infants physical growth is mainly a function of biomedical factors with a small role played by the environment (Dworetzky, 1987; Gesell, 1928). It was hypothesized that the 6-month-old Thai infants with high biomedical risk status will show significantly smaller values for growth measures when compared to normal infants, regardless of SES status.

Hypothesis 3

The literature provided evidence that a combination of biomedical risk factors and psychosocial risk factors had cumulative effects on infant development (e.g., Brazy et al., 1991; Hobel, 1976; Molfese, 1989; Scheiner & Sexton, 1991). The study of high biomedical risk infants also suggested that biomedical risk factors were more important than environmental or psychosocial risk factors in predicting infant development during the first two years of life (Escalona, 1982; Scheiner & Sexton, 1991).

It was hypothesized that the 6-month-old Thai infants with high biomedical risk status will show significantly lower scores on developmental measures when compared to normal infants, regardless of SES status.
CHAPTER II

METHOD

A transactional approach (i.e., consideration of the characteristics of the dynamic relationships that occur between an infant and the environment) between the biomedical and psychosocial areas was used in this study. Further, since the literature showed that risk factors operate in a combinative fashion, the combinative-risk strategy was used to identify high biomedical risk status. In this study, neonatal risk factors, based on the mechanism of brain-cell injury, were used as biomedical risk factors. Two psychosocial risk factors, maternal education and household income, were combined into an SES-composite score to determine psychosocial risk status of the infants. Gender effect was balanced by obtaining equal numbers of males and females.

Subjects

Subjects for the study were 40 male and 40 female Thai infants (mean age 6.17 months; range 5.5-6.5 months) born at one of three participating hospitals in the Bangkok metropolitan area (Pra Pinklaw Hospital, Ramathibbodee Hospital, and Childrens' Hospital). Infants with genetic disorders or birth defects were not considered for participation. All families received compensation for travel to and from the hospital for the assessment session. Informed consent was obtained from all participating parents.

Infants were recruited if they fit the criteria of one of the following four groups:
(a) Normal infants with low SES (*NL Group*). Infants were considered normal if they had an HRPSS score of 0 and low SES with an SES composite score of 2-3.

(b) Normal infants with high SES (*NH Group*). Infants were considered normal if they had an HRPSS score of 0 and high SES with an SES composite score of 5-6.

(c) High biomedical risk infants with low SES (*HL Group*). Infants were considered to be at a high biomedical risk if they had HRPSS score of 30 or more and a low SES composite score of 2-3.

(d) High biomedical risk infants with high SES (*HH Group*). Infants were considered to be at a high biomedical risk if they had an HRPSS score of 30 or more and a high SES composite score of 5-6.

A more detailed description of the physical characteristics of all subjects in each group is found in Table 3.
<table>
<thead>
<tr>
<th>Neonatal and Infant's Characteristics</th>
<th>NL Group</th>
<th>NH Group</th>
<th>HL Group</th>
<th>HH Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Gestational Age (wks)</td>
<td>38.80</td>
<td>0.70</td>
<td>38.80</td>
<td>0.70</td>
</tr>
<tr>
<td>Birth weight (grams)</td>
<td>3209.50</td>
<td>503.40</td>
<td>3070.00</td>
<td>345.15</td>
</tr>
<tr>
<td>Corrected age (Days)</td>
<td>185.00</td>
<td>4.45</td>
<td>182.20</td>
<td>5.29</td>
</tr>
<tr>
<td>Head circumference (cm)</td>
<td>42.42</td>
<td>1.22</td>
<td>42.48</td>
<td>1.05</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>65.70</td>
<td>3.42</td>
<td>65.52</td>
<td>2.46</td>
</tr>
<tr>
<td>Weight (grams)</td>
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<td>1.12</td>
<td>7.41</td>
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<td>0.00</td>
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</tr>
<tr>
<td>SES levels</td>
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<td>0.51</td>
<td>5.45</td>
<td>0.51</td>
</tr>
<tr>
<td>Maternal Age</td>
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<td>4.07</td>
<td>28.35</td>
<td>6.03</td>
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<tr>
<td>Parity</td>
<td>1.25</td>
<td>0.44</td>
<td>1.25</td>
<td>0.55</td>
</tr>
</tbody>
</table>

NL = Normal/Low SES
NH = Normal/High SES
HL = High Biological Risk/Low SES
HH = High Biological Risk/High SES
Instruments

Five assessments were conducted for each subject: (a) biomedical risk, (b) psychosocial risk, (c) infant development, (d) infant environmental stimulation, and (e) maternal perception.

Biomedical Risk Assessment

The High-Risk Pregnancy Screening System-Neonatal Subscale (HRPSS-Neonatal Subscale) (Appendix A) was used to define infants’ biomedical risk status. This subscale is one of the three independent subscales of the High-Risk Pregnancy Screening System (HRPSS).

The HRPSS, developed by Hobel, Hyvarinen, Okada, and Oh (1973), contains 126 biomedical risk items derived from perinatal risk scales and the authors' clinical experiences. These items are grouped into three independent subscales: (a) Prenatal Subscale - 51 items, (b) Intrapartum Subscale - 40 items, and (c) Neonatal Subscale - 35 items. Each item in a subscale is assigned a score of 1, 5, or 10, based on its assumed value in predicting morbidity and mortality. If the subject has the named condition or fits the defining characteristics of the item, then that item is selected. The scores of all selected items within each subscale are summed to obtain a total subscale score. If no items are selected, a total subscale score of 0 is assigned to indicate no biomedical risk. In general, total subscale scores of less than 10 indicate "low risk", and subscale scores of 10 or greater indicate "high risk" (Hobel et al., 1973). The HRPSS has also been reconfigured into the Problem-Oriented Perinatal Risk Assessment...
System (POPRAS) and is widely used as a perinatal screening device in medical centers throughout the U.S. (Molfese, 1989, Strobino & Baruffi, 1984).

The HRPSS-Neonatal Subscale consists of 35 clinical conditions, and includes events in the neonatal period as well as events immediately after birth (Hobel et al., 1973). These conditions are grouped into 6 categories: (a) general, (b) respiratory, (c) metabolic disorders, (d) cardiac, (e) hematologic problems, and (f) central nervous system (See also "Risk screening system" in Chapter I for more details).

Two studies evaluated the validity of the HRPSS Neonatal Subscale as a measure of infant morbidity (Hobel, 1976; Strobino & Baruffi, 1984). Hobel (1976) established criterion-related validity in a longitudinal study of 60 high-risk and 52 low-risk infants (as defined by the HRPSS-neonatal score) between the ages of 1-2 years. The percentage of infants requiring rehospitalization, of infants with low weight gain, of infants with low height increment, of infants with abnormal muscle tone, and of infants with low Cattell Development scores were significantly greater among the high-risk than the low-risk infants.

Strobino and Baruffi (1984) also reported on the psychometric properties of the HRPSS-Neonatal Subscale. They examined the internal consistency and criterion-related validity of the instrument with a sample of 1,600 infants. It was assumed that if the scores were internally consistent, infants with one condition would also have other conditions. Two methods were utilized to examine their criteria for internal consistency: the percent distribution of the number of risk items for infants with each item, and the proportion of infants with a given item for infants with one or more conditions. Results from the first method showed that all 28 factors that were studied occurred with some frequency with at least one or more other risks, and in most instances with several other factors. Results from the second method showed that each
risk factor co-occurred in almost all instances with at least 5 or more other risk factors.

Length of hospital stay, which has been found to be associated with developmental delays, was used to determine the criterion-related validity of the scores (McCormick, Shapiro, & Starfield, 1980). The correlation between the neonatal score and length of hospital stay was 0.67. The authors concluded that the neonatal risk score was internally consistent and a valid predictor of infant morbidity.

**Psychosocial Risk Assessment**

An *SES Questionnaire* (Appendix B) was developed by the researcher to define infants' psychosocial risk status based on studies by O'Dougherty and Wright (1990), Chayovan et al. (1988), and Wongboonsin, Mason, and Choe (1991).

Psychosocial risk is commonly defined by the socioeconomic status (SES) of the infant's family, based on a combination of parental education and household income (e.g., O'Dougherty & Wright, 1990). Studies on Thai society also specifically identify low income and low level of education as important psychosocial risk factors for infant health. In a study conducted by Wongboonsin et al. (1991) in the Bangkok metropolitan area, the educational and household income status among Thai women were categorized. They also noted that in Thai culture the mother is the predominant caretaker, especially for children less than 2 years old. Using the criteria of parental education and household income together with data from the Wongboonsin et al. study which emphasized the importance of the mother (i.e., maternal education), the researcher differentiated three levels each for maternal education and maternal household income to develop an SES Questionnaire:
Maternal Education

Level 1: less than grade 8 (primary education)
Level 2: grade 8 -12 (secondary education)
Level 3: more than grade 12 (college education)

Household Income

Level 1: less than 5,300 baht per month
Level 2: 5,300 - 9,400 baht per month
Level 3: more than 9,400 baht per month

An SES composite score was calculated by summing the numerical Level for Maternal education and the numerical Level for Household Income, resulting in an SES score ranging from 2 to 6. For the present study, a composite score of 2 or 3 was considered "low SES," whereas, a score of 5 or 6 was considered "high SES." Infants with a maternal SES composite score of 4 were not included in this study.

Infant Development Assessment

The Infant Mullen Scales of Early Learning, a comprehensive diagnostic instrument for developmental delay (Mullen, 1989), and the Denver II, a screening instrument that has been widely used for developmental delay (Frankenburg & Dodds, 1990) were utilized to assess infant development.

The Infant Mullen Scales of Early Learning (Infant MSEL) (Appendix C) is a comprehensive scale of mental and motor ability for young children from birth to 36 months of age (Mullen, 1989). This scale is considered a norm-based developmental instrument that has been used to measure learning abilities by assuming the influence of
central motor control and mobility on early development. The Infant MSEL is theoretically based on the neurodevelopment and intrasensory, intersensory processing model (Mullen, 1989; see also in Chapter I). Intrasensory is defined as information processing that involves one modality, visual or auditory. Intersensory is defined as information processing that involves two modalities, auditory and visual. The Infant MSEL assesses visual and language abilities at both receptive and expressive levels, providing an integrated framework within which infant development and interactional patterns can be examined. The scale yields important diagnostic information on neurosensory systems and expressive abilities. The scale has broad implications for research, early intervention, and parent education (Mullen, 1989).

The Infant MSEL is divided into five scales: one motor ability scale and four mental ability scales (see also in Chapter I):

(1) Gross Motor Base (GMB):

The GMB scale assesses motor milestones (i.e., sitting, walking, jumping, and overall large muscle movement).

For six-month-old infants, motor milestones include rolling over, bearing weight in prone position on extended arms with lateral weight shift and reach, and sitting with support, which provides support from lower trunk and hips in a high chair or on parent's knee.

(2) Visual Receptive Organization (VRO):

The VRO Scale assesses the intrasensory modality. In the VRO Scale, activities make use of visual forms in various patterns and involve oculomotor operations which include localizing on a target, tracking in horizontal, vertical and diagonal plains, and scanning multiple points on a surface.
VRO tasks measure visual discrimination, spatial organization, sequencing, short-term visual memory, ability to organize two, three, and four variables, and visual spatial concepts including position, shape, and size.

For six-month-old infants, VRO activities include localizing objects and people at near and far points, and looking for an object in response to a visual stimulus followed by an auditory stimulus (e.g., looking for a toy that has been dropped and made a loud noise on the floor).

3) Visual Expressive Organization (VEO):

The VEO Scale assesses the intersensory modality. In the VEO Scale, activities measure fine motor development and involve perceptual and motor dimensions. Underlying muscle tone (state of physical readiness), adaptive arm/hand function, and visual spatial organization are involved in all VEO tasks.

VEO tasks are primarily manipulative and measure bilateral and unilateral hand patterns and prewriting readiness. Adaptive arm/hand function involves graded reach, grasp, release, wrist/arm rotation, and horizontal and vertical arm movements.

For six-month-old infants, VEO tasks include reaching, grasping, transferring, banging, and dropping objects.

4) Language Receptive Organization (LRO):

The LRO Scale assesses both intrasensory and intersensory modalities. In the LRO Scale, measured activities involve auditory and combined auditory/visual (A/V) information processing. Auditory information involves auditory discrimination, while A/V information involves auditory discrimination and oculomotor efficiency.
Auditory comprehension, memory, and temporal and spatial cues are involved in LRO tasks, with various combinations of auditory and A/V presentational features defining the tasks. LRO tasks that provide auditory information assess the ability to listen to verbal input, comprehend questions, follow one and two-step directions, and also assess knowledge of verbal-spatial concepts. Auditory receptive tasks are primarily measures of short-term auditory memory, but some tasks assess long-term memory.

LRO tasks that measure A/V information assess ability to listen, to remember temporal regularities, and to visually discriminate and remember spatial cues related to position, size color, and length.

For six-month-old infants, LRO activities include attending to voice/face (auditory/visual) followed by vocalizations, coordinating listening, head turning, and looking in response to an auditory stimulus, and enjoying auditory/visual interaction.

(5) Language Expressive Organization (LEO):

The LEO Scale assesses the intersensory modality. The LEO Scale activities measure overall verbal ability and involve vocal-motor skills (i.e., ability to use the articulators to produce speech).

Verbal ability, auditory comprehension, and auditory memory are involved in all LEO tasks, and various combinations of presentational features define the tasks.

For six-month-old infants, LEO tasks include playing with social sounds and voluntary babbling.
To score the Infant MSEL, raw test scores are determined for each of the five Infant MSEL Scales. T-scores with a mean of 50 and a standard deviation of 10 is available as standard scores based on a standardization study of the test using a sample of 1,231 multi-ethnic children in the U.S.

In this study, since the test was not standardized for Thai children, raw scores were used for each scale. The raw scores of all five scales were then summed for a total raw score.

Mullen (1989) reported on the psychometric properties of the scale. Test-retest reliability of .98-.99 and inter-rater reliability of .98-.99 were reported for each of the five scales. Internal consistency, using the Chronbach alpha coefficient, for the five infant MSEL Scales were reported to be .90-.91 for age groups 1-12 months, .89-.91 for age groups 14-25 months, and .87 to .89 for age groups 28-36 months. Concurrent validity was reported as a correlation of .97 between the Infant MSEL composite score and the Mental Scale of the Bayley Scales of Infant Development, and a correlation of .95 between the Motor Scale of the Bayley and the Infant MSEL, GMB scale.

Mullen, Merenda, Buka, and Vohr (1989) conducted a criterion-related validity study of the Infant MSEL. Their subjects were 95 children ages 14-29 months, 45 of whom had been diagnosed as developmental delay (DD) with an unknown etiology, and 50 of whom were normal controls. The Infant MSEL and the Bayley MDI correctly differentiated between all 45 DD infants and the normal controls. However, the Infant MSEL demonstrated distinct advantages over the Bayley MDI in the ability to identify different learning profiles of the DD infants. Within the DD group, the Bayley MDI identified only 2 different groups of DD, a mental retardation group (MR) and a second group that had developmental scores ranging from below average to average. On the other hand, cluster analysis of the Infant MSEL mental subscales identified an MR group
with 3 dominant learning disabled (LD) profiles for the DD infants. These included an 
LD group with delay in visual reception and language reception (n=11), an LD group 
with delay in language reception and language expression (n=12), and an LD group with 
delay in visual expression and language reception (n=6). Further, an MR group with 
delay in all four receptive and expressive areas (n=14) was also identified. The 
remaining two children had unique LD profiles.

The distinct advantages of the Infant MSEL over the Bayley MDI in the ability to 
identify developmentally delayed infants with different learning disabled profiles were 
also supported by Morrison and Villarreal (1993) in a recent study of prenatally drug­ 
exposed infants. They reported that consistent differences were found between the 
Bayley MDI and the infant MSEL when assessing the development of prenatally drug­ 
exposed infants. Results showed that while the Bayley MDI consistently indicated an 
average performance for prenatally drug-exposed infants, 35 to 59% of the infants 
were considered developmentally delayed on Infant MSEL subscales.

The results from these studies suggest that the Infant MSEL is more sensitive in 
identifying developmental delays during infancy than the Bayley MDI (Morrison & 
Villarreal, 1993). Furthermore, the Infant MSEL is useful in identifying specific 
learning disabled profiles, and provides a baseline for planning and facilitating early 
interventions for developmentally delayed infants (Mullen et al., 1989).

The Denver II (Appendix D) was first developed as the Denver Developmental 
Screening Test (DDST) in 1967 by Frankenburg and Dodds, to help health providers 
detect potential developmental problems in young children. Since its original 
publication, the DDST has been widely used throughout the world. It has been adapted for 
use and standardized in over a dozen countries, and has been used to screen more than 50
million children throughout the world, including Thailand. In fact, the DDST should be used as a criterion in this study since it has been the only infant development assessment instrument utilized (in collaboration with the author Dr. Frankenberg) by the Child Developmental Unit at the Ramathibbodee Hospital in Bangkok (Ramathibbodee Hospital, 1992). However, due to the revision of the DDST in becoming the Denver II, and acceptance by Ramathibbodee's Child Developmental Unit of the Denver II as a future replacement for the DDST version, the Denver II was then considered as the criterion for Thai infant development assessment in this study.

Recently, the test underwent a major revision, culminating in 1990 with the Denver II. In the process of revising and restandardizing the test, several modifications were made to the original 105 items. This included omitting items due to their limited clinical value or difficulty in administration or scoring. Some DDST items were revised for clarification, and many new items were added, especially in the language sector. (Frankenberg, Dodds, Archer, Bresnick, Maschka, Edelman, & Shapiro, 1990). The new items were written and selected by professionals specializing in child development and pediatric screening.

The Denver II is designed to screen for developmental delays from birth to 6 years. The test is designed to compare a given child's performance on a variety of tasks to the performance of other children at the same age. Besides the use of identifying the developmentally delayed child, it can also be used to identify changes in developmental rates or patterns over time.

The Denver II consists of 125 items, which are arranged on the test form in four areas of developmental tasks:
(1) Personal-Social: get along with people and caring for personal needs.

For six-month-old infants, personal-social skills include regarding one's own hands, working for a toy, feeding oneself, playing pat-a-cake, indicating what one wants, and waving bye-bye.

(2) Fine Motor-Adaptive: eye-hand coordination, manipulation of small objects, and problem solving.

For six-month-old infants, fine motor-adaptive skills include reaching, looking for dropped yarn, raking raisins, passing a cube, taking two cubes, thumb-finger grasping, and banging two cubes held in hands.

(3) Language: hearing, understanding, and using language.

For six-month-old infants, language skills include turning to a rattling sound, turning to a voice, producing a single syllabus, imitating speech sounds, saying dada-mama, combining syllables, and jabbering.

(4) Gross Motor: sitting, walking, jumping, and overall large muscle movement.

For six-month-old infants, gross motor skills include rolling over, pulling to sit with head maintained in midline and upright, sitting with no support, standing while holding on, and pulling to standing position.

The following alphabetical scores are used for each item of the Denver II:

"P" Pass - The child successfully performs the item, or the caregiver reports (when appropriate) that the child does the item.

"F" Fail - The child does not successfully perform the item, or the caregiver reports (when appropriate) that the child does not do the item.
"N.O."  No Opportunity - The child has not had the chance to perform the item, due to restrictions from the caregiver or other reasons.

"R"  Refusal - The child refuses to attempt the item.

The alphabetical score of each item is compared to standardized norms of same-age peers. These comparisons determine whether the child will be considered "normal," "delayed," or "cautioned" for that particular item (Frankenberg et al., 1990). For example, if a child fails an item that 90% of other same-age peers could perform, the child is considered "delayed." If the child fails an item that 25-75% of children passed, the child would be considered "normal" for that item. Failure of an item passed by 75-90% of children is considered "cautioned."

An overall rating for each child of "normal" or "abnormal" is assigned, as determined by information from performance on all items of the test. Children are judged normal if performance indicates no delays for any item and a maximum of one caution. Abnormal status is assigned when there are delays for 2 or more items. For further details on scoring, please consult the Denver II screening manual (Frankenburg et al., 1990).

In this study, the overall rating of an infant as "normal" or "abnormal" was assigned to two numerical scores: 0 for "normal"; 1 for "abnormal."

Two types of reliability were reported in studies of the Denver II (Frankenburg et al., 1990). The inter-rater reliability for the items included in the Denver II was 0.99, and the 7 to 10 day test-retest reliability for the same items was 0.90. Worldwide acceptance of the test attests to its content validity. Frankenburg et al. (1990) contend that the validity of the Denver II rests upon its standardization, not on its correlation with other tests since presently, all tests of infant development are constructed differently.
Infant Environmental Stimulation Assessment

The *Home Observation for Measurement of the Environment by Mother Questionnaire* (HOME-Mother Questionnaire) (Appendix E) was used to measure infant environmental stimulation, with some modifications made to adjust for differences in Thai culture and age appropriateness of the subjects in this study.

The HOME-Mother Questionnaire (HOME-MQ) is an adaptation of the Home Observation for Measurement of the Environment (HOME), the instrument most commonly used for assessment of the home environment (Bradley & Caldwell, 1976). The HOME consists of 45 items designed to assess stimulating characteristics of a young child's environment. Data are obtained from a parental interview and home observation.

An obvious limitation of the HOME is the requirement of a home visit. Several researchers addressed this issue by developing adaptations of the HOME for clinic use (Taeusch & Yogman, 1987). The HOME-Mother Questionnaire, based on the traditional HOME, consists of a questionnaire and direct observation during clinical testing (Hammond & Snyder, 1987).

Validity of the HOME-Mother Questionnaire was established in a study of 133 two-year-old children (Hammond & Snyder, 1987). Scores on the Stanford-Binet intelligence test when the children were four years old correlated with HOME-Mother Questionnaire scores ($r = 0.60$) and the traditional HOME scores ($r = 0.57$) that were measured when the children were two years old. The authors concluded that the HOME-Mother Questionnaire was as valid as the traditional HOME in predicting Stanford-Binet performance in subjects two years later, at age four.
The present study used a modified version of the HOME-Mother Questionnaire. Items in the interview section of the questionnaire were either omitted or modified by the researcher based on consultations with infant development specialists to reflect Thai cultural appropriateness and age appropriateness of the subjects. The modified version consisted of a 17-item interview questionnaire and a HOME-MQ Subscale I which is a 10-item behavioral observation scale (which consisted of the original HOME Subscale I, "Emotional and Verbal Responsivity of Mother").

The following are examples of items that were omitted: (a) Item 2: Where does your child keep his/her toys?; and (b) Item 19: How many books does your child have? An example of an item that was modified was Item 5, which asks about the availability of toys used for nine categories of activities: muscle activity, self-exploratory, push or pull toys, learning equipment appropriate to age, learning equipment necessary for learning, eye-hand coordination, eye-hand coordination and combination, literary toys, and music toys. Examples of toys omitted were tricycle, scooter, high chair, and dress-up toys.

Maternal Perception Assessment

A Maternal Perception Questionnaire (Appendix F) consisting of a total of five items was developed by the researcher to determine maternal perceptions in three areas: (a) perceived level of difficulty in caring for her child as compared to the average child (Sanson et al., 1991); (b) perceived level of overall social support in caring for the infant and for stress events in life (Molfese et al., 1987a); and (c) perceived level of husband’s support in caring for the infant and for stress events in life (Altemeier et al., 1979; Gabarino & Sherman, 1980). Response on the one item for maternal perception...
of infant difficulty was scored on a five-point Likert scale. Responses for two items on maternal perception of social support and two items on husband support were scored on a three-point Likert scale.

Procedures

Subject Recruitment

Subjects were recruited from all infants under the age of 5 months currently receiving medical care from participating pediatricians at three hospitals located in the Bangkok metropolitan area. Subjects were recruited either through a direct approach by the attending pediatrician or through a letter from the pediatrician and researcher. During this initial contact with parents of all subjects, the nature of the study and assurances of the confidentiality were conveyed. All personal identification in the infant's medical record was shielded from the researcher throughout the study.

In the direct approach, the pediatricians prescreened infants for potential biomedical and psychosocial risk status at the time of the infants' regularly scheduled postnatal care hospital visit. During this hospital visit, medical records and information used to determine the SES level of potential subjects were provided by the attending pediatrician to the researcher. The researcher immediately evaluated the medical records and scored them for biomedical and psychosocial risk using the HRPSS and SES instruments. Consent for participation in the study was obtained by the pediatrician from parents of infants meeting the inclusion criteria and an assessment session was scheduled.
Infants recruited by mail were first identified through examination of their medical records that were provided by the attending pediatricians. Parents of infants meeting the HRPSS criteria for inclusion into the study were contacted by the attending pediatrician with a letter prepared by the researcher. The study was briefly explained, and participation was requested by signing and returning an enclosed consent form along with information used to determine their SES level (Appendix G). This initial contact was followed by another letter or telephone contact by hospital staff, in which an assessment session was scheduled for all infants. (Infants recruited by mail who did not meet the SES inclusion criteria were also assessed but not included in the study groups.)

Assessment sessions for all infants were scheduled for a future date when the infant reached the age range of 5.5 to 6.5 months (corrected age for premature subjects).

**Assignment of Subjects to Risk Groups**

Subjects were assigned to one of four risk groups based on HRPSS scores and SES composite scores using a quota-sampling research design:

(a) **NL Group:** Infants with an HRPSS score of 0 and an SES composite score of 2-3.

(b) **NH Group:** Infants with an HRPSS score of 0 and an SES composite score of 5-6.

(c) **HL Group:** Infants with an HRPSS score of 30 or more and an SES composite score of 2-3.

(d) **HH Group:** Infants with an HRPSS score of 30 or more and an SES composite score of 5-6.
A total of 80 infants were included in the study. There were 20 subjects in each group: 10 males and 10 females.

Assessment of Infant Development

Infant development was assessed using the Infant MSEL and the Denver II. The order of the tests was counterbalanced between the Infant MSEL and the Denver II within each of the four groups.

Prior to the assessment of subjects for this study, inter-rater reliability was assessed between the researcher and the research supervisor, who had been trained to use the Infant MSEL and the Denver II. A training sample of 10 infants similar to the research sample was used. The supervisor observed the researcher as she conducted the assessments with the training sample while at the same time independently scoring the infants. Differences in scoring were resolved in discussions between researcher and supervisor. Inter-rater reliability of .95 was established before conducting the assessment with the research subjects. The supervisor also randomly observed and evaluated 10% of the subjects throughout the study to ensure continued reliability of scoring by the researcher.

Infant development assessments were conducted by the researcher on all subjects while they were in the age range of 5.5 to 6.5 months (corrected age for premature subjects). Each subject was assigned an identification code by the pediatrician. The assessments were conducted in the hospital nursery setting. At the beginning of each assessment period, all subjects were determined to be "actively awake" (Wolff, 1966) or were otherwise rescheduled. In addition to the infant development assessments, neuromotor assessments for 6-month-old infants were also evaluated for future
reference by the attending pediatrician. These assessments included the absence of primitive reflexes (ATNR, palmer grasp, and moro reflex), the presence of protective reaction (downward parachute), and the assessment of muscle tone and range of motion (Copeland & Kimmel, 1989). Weight, height, and head circumference were also measured for all subjects.

Follow-up Interview with the Infant’s Mother

Following the assessment of infant development, the researcher conducted an interview of the mother. Information on the confidentiality and purpose of the study were confirmed to the mother. Previously obtained information related to the SES composite score was also substantiated.

The interview included administration of the HOME-Mother Questionnaire and the Maternal Perception Questionnaire. The mother’s reactions to her infant during the interview and clinical testing were observed and recorded as part of the HOME-Mother Questionnaire. Finally, in an open discussion, the mother was encouraged to talk or ask questions about her infant. The pediatrician joined in at the end of the interview if problems related to the infant’s development and health were identified during assessment, or if the mother requested a discussion with the pediatrician regarding her infant's health.
CHAPTER III
RESULTS

Infant Characteristics

Eighty infants were recruited into four groups determined by their HRPSS neonatal scores and SES composite scores. The relationships between group assignment and infant and neonatal characteristics were first explored. Following this, main and interaction effects of risk groups and SES were assessed after infant variables were adjusted for differences associated with maternal age and parity.

As summarized on Table 3, the four infant characteristics measured on the day of testing were: (a) corrected age, (b) head circumference, (c) height, and (d) weight. Head circumference, height and weight were measures for infant physical growth in this study. Neonatal variables consisted of gestational age and birth weight. Correlations for all six variables are summarized on Table 4, with the range of correlations from 0.15 to 0.83.
Table 4. Correlations of Neonatal and Infant’s Characteristics:
(n=80, with equal numbers of 40 males and 40 females)

<table>
<thead>
<tr>
<th>Neonatal and Infant's Characteristics</th>
<th>Gestational Age</th>
<th>Birth Weight</th>
<th>Corrected Age</th>
<th>Head Circum</th>
<th>Height</th>
<th>Weight</th>
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</thead>
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<tr>
<td>Gestational Age (wks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth weight (grams)</td>
<td>0.83*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Age (days)</td>
<td>-0.02</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head circumference (cm)</td>
<td>0.35*</td>
<td>0.44*</td>
<td>0.17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>0.30*</td>
<td>0.42*</td>
<td>0.15</td>
<td>0.70*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (grams)</td>
<td>0.28*</td>
<td>0.42*</td>
<td>0.18</td>
<td>0.76*</td>
<td>0.82*</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05
The Relations of Biomedical Risk and SES to Infant Physical Growth Development and Neonatal Variables

To explore the association of biomedical risk groups and SES levels to neonatal variables and infant physical growth, a 2 X 2 factorial design (biomedical Risk X SES) was employed utilizing the Statistica program for performing ANCOVA with equal n's. Covariates were maternal age and parity. Evaluation of the homogeneity of covariate regression showed no interaction between covariates and between-group factors for any neonatal or infant variables. Thus, the adjustment for the covariates was the same for all groups.

Table 5 presents ANCOVAs showing the associations between biomedical risk groups and the neonatal variables and infant physical growth. After adjustment for covariates, significant main effects were obtained between biomedical risk group and physical growth measures for head circumference, $F(1, 74) = 23.69, p < .001$; height, $F(1, 74) = 17.07, p < .001$; and weight, $F(1, 74) = 15.92, p < .001$. Similar to the three infant variables, significant main effects were also found between biomedical risk groups and gestational age, $F(1, 74) = 52.12, p < .001$; and birth weight, $F(1, 74) = 65.29, p < .001$. 
Table 5. Neonatal and Infant's Characteristics of High Biomedical Risk Group and Normal Group: Means, Standard Deviations, and ANCOVA Tests of Significance. (n=40 in each group, with equal numbers of 20 males and 20 females)

<table>
<thead>
<tr>
<th>Neonatal Characteristics</th>
<th>High Risk Mean (SD)</th>
<th>Normal Mean (SD)</th>
<th>Significant Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational Age (wks)</td>
<td>35.00 (3.52)</td>
<td>38.80 (0.69)</td>
<td>F(1, 74) = 52.12*</td>
</tr>
<tr>
<td>Birth weight (grams)</td>
<td>2158.50 (110.81)</td>
<td>3139.75 (431.84)</td>
<td>F(1, 74) = 65.29*</td>
</tr>
<tr>
<td>Head circumference (cm)</td>
<td>40.60 (1.89)</td>
<td>42.45 (1.13)</td>
<td>F(1, 74) = 23.69*</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>61.90 (4.75)</td>
<td>65.61 (2.95)</td>
<td>F(1, 74) = 17.07*</td>
</tr>
<tr>
<td>Weight (grams)</td>
<td>6.28 (1.31)</td>
<td>7.38 (0.99)</td>
<td>F(1, 74) = 15.92*</td>
</tr>
</tbody>
</table>

* p < .001
No SES main effects or interaction effects were found for all neonatal variables and all three measures of infant physical growth, indicating that the relationships between biomedical risk groups and these variables were constant across the two SES groups. As expected, infants in the normal group were born with significantly more gestational age and weighed more than infants in the high biomedical risk group, regardless of their SES levels. In addition, on the day of testing, these normal infants had significantly better physical growth development. They had bigger head circumferences, were taller, and weighed more than the high biomedical risk infants regardless of their SES levels.

Controis for Effects of Age, Biomedical Risk Status, and SES Levels

There were no significant main or interaction effects for biomedical risk groups and SES levels with infant's age. This result indicates that there were no significant differences among the four study groups for corrected age of infants on the day of testing (see Table 3).

The characteristics of the two between-group independent variables, biomedical risk status and SES levels of the infants, in each study group were also shown in Table 3. Within the high biomedical risk group, there was no significant difference of the HRPSS scores across the 2 SES levels, HL (mean ± SD = 38.40 ± 10.85) and HH groups (mean ± SD = 35.26 ± 3.94).

The SES levels were also controlled in the study. SES composite scores of 2-3 were considered low SES status, while scores of 5-6 were considered high SES status (see chapter 2). Within the low SES group, the analysis showed no significant difference between SES composite scores of the 2 biomedical risk groups, NL (mean ±
SD = 2.55 ± 0.51) and HL (mean ± SD = 2.40 ± 0.50). Similarly for the high SES group, there was no significant difference between SES composite scores of the 2 biomedical risk groups, NH (mean ± SD = 5.45 ± 0.51) and HH (mean ± SD = 5.45 ± 0.51).

These findings reflect satisfactory control for effects of age, biomedical risk status, and SES levels of the That infants (see Table 3).

The Relations of Biomedical Risk and SES to Infant Development (Infant MSEL)

A 2 X 2 between-groups analysis of covariance was performed on developmental outcome of the infants. Independent variables consisted of biomedical risk factors (high risk and normal) and SES levels (high and low), factorially combined. Covariates were maternal age and parity. The Statistica program for performing ANCOVA with equal n's across groups was used. Evaluation of homogeneity of covariates regression showed no interaction between covariates and between-group factors for all developmental measures. Thus, the adjustment for the covariates was the same for all groups.

After adjustment for covariates, significant main effects for biomedical risk groups were obtained on all developmental measures (Table 6). Significant SES main effects and the interaction effects were not found for any of the measures. As predicted, the high risk group consistently displayed poorer developmental outcome on all measures when compared to the normal group, regardless of SES levels.
Table 6. Developmental Outcomes of High Biomedical Risk Group and Normal Group: Means, Standard Deviations, and ANCOVA Tests of Significance (n=40 in each group, with equal numbers of 20 males and 20 females)

<table>
<thead>
<tr>
<th>Developmental Measures</th>
<th>High Risk</th>
<th>Normal</th>
<th>Significant Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Infant MSEL (Total Score)</td>
<td>20.46</td>
<td>7.39</td>
<td>37.78</td>
</tr>
<tr>
<td>GMB</td>
<td>3.92</td>
<td>1.88</td>
<td>7.35</td>
</tr>
<tr>
<td>VRO</td>
<td>4.19</td>
<td>1.74</td>
<td>7.90</td>
</tr>
<tr>
<td>VEO</td>
<td>3.44</td>
<td>1.55</td>
<td>7.30</td>
</tr>
<tr>
<td>LRO</td>
<td>4.06</td>
<td>1.70</td>
<td>8.33</td>
</tr>
<tr>
<td>LEO</td>
<td>4.85</td>
<td>1.59</td>
<td>6.90</td>
</tr>
<tr>
<td>Denver II (Total Score)</td>
<td>0.80</td>
<td>0.41</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Infant MSEL = Infant Mullen Scale of Early Learning
GMB = Gross Motor Base
VRO = Visual Receptive Organization
VEO = Visual Expressive Organization
LRO = Language Receptive Organization
LEO = Language Expressive Organization

* $p < .001$
Correlation of Developmental Measures on the Denver II and the Infant MSEL

A correlation of 0.84 ($p < .05$) was found between total scores of the Denver II and the Infant MSEL.

The Relations of Biomedical Risk and SES to Other Psychosocial and Environmental Factors

This study examined the relations of biomedical risk and SES to other psychosocial and environmental factors of Thai infants at age six months. These factors included: (a) mother's perception of social support, (b) mother's perception of husband support, (c) the mother's perception of infant's difficultness, (d) the infant's overall stimulating environment, and (e) maternal behavior in reacting to her infant.

(a) The Relations of Biomedical Risk and SES to Maternal Perceptions of Husband Support, Maternal Perception of Social Support, and Maternal Perception of Infant's Difficultness

The relationship between biomedical risk groups and SES and maternal perceptions of infant, husband support and social support were explored. A 2 X 2 factorial design (biomedical risk X SES) was employed utilizing the Statistica for performing between-group ANCOVAs, with maternal age and parity as covariates. The relationship between the two covariates and independent variables showed no significant interaction for any maternal perceptions measure. This homogeneity of DV-covariate
regression implies that the equal covariate adjustment for maternal perception measures was appropriate for all groups.

Table 7 presents the results of ANCOVAs indicating significant relationship between SES groups and maternal perceptions of overall social support and husband support. After adjusting for covariates, significant main effects for SES were obtained on maternal perceptions for both husband support, $F(1, 74) = 9.19, p < .005$ and social support, $F(1, 74) = 20.16, p < .001$. No biomedical risk effect or interaction effect was found. On the contrary, analysis indicated that the only significant main effect for biomedical risk group was obtained in the relationship to maternal perception of the infant, $F(1, 74) = 9.85, p < .005$, after adjustment for covariates (Table 8). No SES main effect or interaction effect was found.

These results suggest that mothers' perceptions of husband and other social support were significantly related to their SES levels. High SES mothers believed themselves to have better support from their husbands and society compared with lower SES mothers, regardless of their infants' biomedical status.

However, the analysis also suggested that it was the biomedical risk status of infants, not SES, that played an important role in determining maternal perception of infants. The mothers of high biomedical risk infants subjectively rated their babies as more difficult to take care of than the mothers of normal infants, regardless of their SES levels.
Table 7. Maternal Perceptions of Husband Support, and Social Support of High SES and Low SES Groups: Means, Standard Deviations, and ANCOVA Tests of Significance (n=40 in each group, with equal numbers of 20 males and 20 females)

<table>
<thead>
<tr>
<th>Maternal Perceptions</th>
<th>High SES</th>
<th>Low SES</th>
<th>Significant Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Husband Support</td>
<td>5.08</td>
<td>1.27</td>
<td>4.08</td>
</tr>
<tr>
<td>Social Support</td>
<td>5.45</td>
<td>0.90</td>
<td>3.90</td>
</tr>
</tbody>
</table>

* p < .005
** p < .001

Table 8. Maternal Perception of Infant of High Biomedical Risk Group and Normal Group: Means, Standard Deviations, and ANCOVA Tests of Significance (n=40 in each group, with equal numbers of 20 males and 20 females)

<table>
<thead>
<tr>
<th>Maternal Perception</th>
<th>High Risk</th>
<th>Normal</th>
<th>Significant Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Infant's Difficultness</td>
<td>3.40</td>
<td>1.27</td>
<td>4.18</td>
</tr>
</tbody>
</table>

* p < .005
The Relations of Biomedical Risk and SES to Infant's Stimulating Environment (HOME-MQ) and Maternal Reactive Behavior (HOME-MQ Subscale I)

A 2 X 2 between-groups ANCOVA was performed to evaluate the association of biomedical risk and SES with the infant's stimulating environment. Independent variables consisted of biomedical risk factors (high risk and normal) and SES levels (high and low), factorially combined. Proposed covariates were maternal age and parity. The Statistica for ANCOVA with equal n's across the study groups was used. Evaluation of homogeneity of DV-covariate regression was satisfied for maternal age. Parity, however, showed significant interaction with between-group factors for the total score of HOME-MQ measurement, $F(3, 72) = 3.63, p < .05$, and was not used further as a covariate for this analysis.

After partialing out the effect of maternal age, significant main effects of biomedical risk, $F(1, 75) = 5.33, p < .05$, and SES, $F(1, 75) = 129.29, p < .001$, were found to be associated with the HOME-MQ score (Table 9 & 10). No interaction effect was found.

Further analysis was conducted on the HOME Subscale I measures, an observation of mother's emotional and verbal responsiveness in reacting to her infant. Analysis indicated satisfactory homogeneity of regression between covariates, maternal age and parity, and measures of subscale I of the HOME for all the groups. The results from ANCOVA (Table 10) revealed significant main effects for SES level, $F(1, 74) = 38.77, p < .001$, with no effects for biomedical risk or interaction.
Table 9. Infant's Environmental Stimulation (HOME-MQ Total Score) of High Biomedical Risk Group and Normal Group: Means, Standard Deviations, and ANCOVA Tests of Significance (n=40 in each group, with equal numbers of 20 males and 20 females)

<table>
<thead>
<tr>
<th>Measures</th>
<th>High Risk</th>
<th>Normal</th>
<th>Significant Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>HOME-MQ Total Score</td>
<td>22.05</td>
<td>5.71</td>
<td>23.80</td>
</tr>
</tbody>
</table>

* p < .05

Table 10. Infant's Environmental Stimulation (HOME-MQ Total Score) and Mother's Reactive Behaviors (HOME-MQ Subscale I) of High SES and Low SES Groups: Means, Standard Deviations, and ANCOVA Tests of Significance (n=40 in each group, with equal numbers of 20 males and 20 females)

<table>
<thead>
<tr>
<th>Measures</th>
<th>High SES</th>
<th>Low SES</th>
<th>Significant Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>HOME-MQ Total Score</td>
<td>27.38</td>
<td>2.49</td>
<td>18.48</td>
</tr>
<tr>
<td>HOME-MQ Subscale I Score</td>
<td>9.70</td>
<td>1.68</td>
<td>7.03</td>
</tr>
</tbody>
</table>

^{**} p < .001
The results from these analyses suggested that the mothers of normal infants provided better stimulating environment for their babies when compared to the mothers of high-risk infants, regardless of their SES level. However, higher SES mothers also provided better stimulating environment, especially in reacting with more emotional and verbal responses to their infants, than mothers of lower SES level, regardless of the infants' biomedical status.

The Correlations among Outcome Measures

Correlations for all six outcome measures, which are maternal perception of infant's difficultness, maternal perception of social support, maternal perception of husband support, the HOME-MQ score, the HOME-MQ Subscale I score, and the Infant MSEL score, are summarized on Table 11, with the range of correlations from 0.12 to 0.78. Four relations among these outcome measures are of interest for this study:
Table 11. Correlations of Outcome Measures:
(n=80, with equal numbers of 40 males and 40 females)

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Perception of Infant's Difficultness</th>
<th>Perception of Social Support</th>
<th>Perception of Husband Support</th>
<th>HOME-MQ Total Score</th>
<th>HOME-MQ Subscale I Score</th>
<th>Infant Development (InfantMSEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal Perception of Infant's Difficultness</td>
<td>0.32*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal Perception of Social Support</td>
<td></td>
<td>0.57*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal Perception of Husband Support</td>
<td>0.29*</td>
<td>0.67*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulating Environment (HOME-MQ total score)</td>
<td>0.27*</td>
<td>0.55*</td>
<td>0.36*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathov's Reactive Behavior (HOME-MQ Subscale I)</td>
<td>0.17</td>
<td>0.37*</td>
<td>0.26*</td>
<td>0.78*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infant Development (Infant MSEL)</td>
<td>0.43*</td>
<td>0.21</td>
<td>0.12</td>
<td>0.30*</td>
<td>0.21</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05
(a) Correlation between Score of Maternal Perception of Infant Difficulty and Total Scores of Infant MSEL

Results indicated that the way mothers perceived their infants correlated with infant development \((r = 0.43, p < .05)\). Within the high risk group, a positive correlation was found between maternal perception of infant and developmental outcome of the infants as measured by Infant MSEL \((r = 0.36, p < .05)\). This relationship existed among the high biomedical risk infants. No such correlation was found for the group of normal infants.

Further analysis of the 14 mothers (17.5%) who rated their infants as either more difficult or much more difficult than average revealed a relationship between maternal perception of infant's as being 'difficult' and infant development in this study \((r = 0.49)\). However, this correlation was nonsignificant.

The scores of maternal perceptions of husband and social support did not significantly correlate with total scores of the Infant MSEL.

(b) Correlation between Score of Maternal Perception of Infant Difficulty and Total Scores of HOME-MQ

The way mothers perceived their infants also correlated with infant stimulating environment \((r = 0.28, p < .05)\). Within the high risk group, a positive correlation was found between maternal perception of infant and infant's stimulating environment as measured by HOME-MQ \((r = 0.35, p < .05)\). This relationship existed among the high biomedical risk infants, not with normal infants.
(c) Correlation between Total Scores of Infant MSEL and HOME-MQ

A significant correlation was found between the total scores for the Infant MSEL and the HOME-MQ score \( (r = .30, p < .05) \). No significant correlation was found between the total scores for the Infant MSEL and the HOME Subscale I.

(d) Correlations among Scores of Maternal Perception of Husband Support, Maternal Perception of Social Support, HOME-MQ Subscale I, and Total score of HOME-MQ

Significant correlations were found between score of maternal perception of husband's support and total score of HOME-MQ \( (r = .36, p < .05) \), score of maternal perception of social support and total score of HOME-MQ \( (r = .55, p < .05) \), scores of maternal perception of husband's support and HOME-MQ Subscale I \( (r = .26, p < .05) \), scores of maternal perception of social support and HOME-MQ Subscale I \( (r = .37, p < .05) \), and score of HOME-MQ Subscale I and total score of HOME-MQ \( (r = .78, p < .05) \).
CHAPTER IV
DISCUSSION

This study represented an initial effort to conduct research on infant neurobehavior development and developmental disabilities in Thailand. Basic knowledge was gained on the assessment of high risk infants for developmental delays in Thai infants in several important areas. A determination was made as to the applicability of the Infant MSEL as an assessment instrument for Thai infant neurobehavior development. Relations between biomedical and psychosocial risk factors to infant physical growth and infant neurobehavior development were investigated among six month old Thai infants. The importance of other psychosocial factors to known developmental delay risk factors and developmental outcomes was also investigated.

The Applicability of the Infant MSEL for Thai Infants

The applicability of the Infant MSEL as an assessment instrument for Thai infant development was investigated in this study. The Denver II was used as a criterion for concurrent validation of the Infant MSEL.

The study's first hypothesis received strong support. The results suggest that the Infant MSEL may be applicable for use as an instrument to assess Thai infant neurobehavior development. By using the Denver II as a criterion, the concurrent validation of the Infant MSEL was established between the Infant MSEL and the Denver II.
The Relations of Biomedical Risk and Psychosocial Risk Factors (SES) to Physical Growth Measures of Thai Infants

The second hypothesis received strong support. As expected, Thai infants' physical growth at age six months was mainly a function of biomedical factors and not SES. When high biomedical risk infants were tested at approximately six months old, they had significantly smaller head circumferences, were shorter, and weighed less than normal infants regardless of their SES levels.

For normal infants, physical growth is mainly a function of biological factors (Dworetzky, 1987; Gesell, 1928), with the period of most rapid growth occurring in the first six months of life (Fogel, 1991). The effect of biomedical risk status on normal physical growth of young infants is supported by many studies (Cruise, 1973; Manser, 1984; Peterson & Frank, 1987; Werner et al., 1971). Low biomedical risk infants (e.g., premature infant without a serious medical illness) are born smaller but show maximum catch-up growth from 36 to 44 postmenstrual weeks, and have growth measures within the normal range by 1 year corrected age (Cruise, 1973; Manser, 1984; Peterson & Frank, 1987). High biomedical risk infants are born with less gestational age, weigh less than normal infants at birth, and exhibit slower catch-up growth. They attain growth measures within the normal range between 2 to 3 years of age (Manser, 1984).

The lack of a strong relationship between SES level and infant physical growth at six months of age was not surprising. Environmental factors have been found to play an important role in hindering physical growth only if an infant suffered from severely poor nutrition (Dworetzky, 1987, Gesell, 1928, Werner et al., 1971). Severe malnutrition, however, was not an issue for infants in this study. This may due to a
biased sampling since all mothers resided in the Bangkok metropolitan area and had easy access to free medical care. All the high SES mothers and most of the low SES mothers (38 of 40) freely utilized regular prenatal care and neonatal care from professionals, including immunization and regular medical check-up for their infants. Low SES mothers experiencing financial problems were provided free formula for their infants.

The availability and utilization of easily accessible free medical care may be responsible for the lack of major differences in SES levels regarding infant growth measures. This situation also appeared in the Kauai study (Werner et al., 1971). The lack of SES effects on infant growth measures found in that study were attributed to Kauai mothers having easy access to medical health care and freely utilizing it (Werner et al., 1971).

The Relations of Biomedical Risk and Psychosocial Risk Factors (SES) to Developmental Measures of Thai Infants

The third hypothesis received strong support. High biomedical risk infants demonstrated lower levels of performance on measures of neurobehavior development at six months of age when compared to the normal group, regardless of their SES levels.

These results suggest that the effects of biomedical risk factors on neurobehavior development are demonstrated at six months of age in Thai infants. While significant effects of SES on neurobehavior development are not apparent at this age, they may be manifested later in infancy and childhood.

This finding is consistent with those reported by Aylward et al. (1992) and Scheiner and Sexton (1991). Aylward et al. (1992) reported that infant neurobehavior development at 6, 9, and 12 months of age was significantly correlated with biomedical
risk status of the infants, but was not significantly correlated with their SES composite index. Scheiner and Sexton (1991) also demonstrated a significant correlation between biomedical risk status of the infants and developmental outcome at the age of 9 and 18 months, while finding no significant correlation between family status index and developmental outcome at the two age levels (Scheiner & Sexton, 1991).

These findings may not be contradictory with other studies that concluded developmental outcome of a biomedically high-risk infant was dependent on the infant's SES (e.g. Cohen et al., 1982; Largo, et al., 1990; Littman & Parmelee, 1978; Sameroff, 1986). Most of the research that reported a significant SES effect on developmental outcomes studied children at an older age (5 years of age or older). This investigation along with others that found a similar lack of SES effects on developmental outcome studied infants or younger children (less than 2 years of age).

Farran and Ramey (1980) found that maternal education correlated positively with infant neurobehavior development by 18 months of age, but not at 6 months. Largo et al. (1990), in a longitudinal study among normal, high-risk, and developmental delay infants, also found that SES did not exert any effects on neurobehavior development during infancy, but tended to have an increasing effect with age. Of interest was the observation that the impact of SES on child development was also related to their risk status. SES was found to exert its effects on mental performance at around 18-24 months of age for normal infants, and at 3 years of age for high-risk infants. SES had no effect on mental performance for developmental delay children up to the age of 9 years.

Escalona (1982) suggested that the impact of poor learning environment does not become apparent until after 2 years of age, when the child acquires language and abstract thought necessary to solve more complex problems.
The Relations of Biomedical Risk and Psychosocial Risk Factors (SES) to Other Psychosocial or Environmental Factors of the Thai Infants at 6 Months of Age

This study examined the relations of biomedical risk and SES to other psychosocial and environmental factors for Thai infants at age six months. These factors included: (a) mother's perception of infant's difficultness, (b) mother's perception of social support, (c) mother's perception of husband support, (d) infant's overall stimulating environment, and (e) maternal behavior in reacting to her infant.

Overall, the following relations were found: (1) biomedical risk, but not SES, was significantly related with mother's perception of infant's difficultness; (2) SES, but not biomedical risk, was significantly related with mother's perception of social support and husband support, and mother's reactive behavior; and (3) biomedical risk and SES were significantly related with the infant's overall stimulating environment. No interaction effects between biomedical risk status and SES were found for all these relations.

(1) Biomedical Risk and Mother's Perception of Infant's Difficulty

Biomedical risk status of the infant but not SES was important in determining how mothers subjectively rated their infants as compared to the average infant. Mothers of high risk infants rated their infants as significantly more difficult than mothers of normal infants, regardless of their SES levels.
Even though the results suggested that mothers of high biomedical risk infants rated their babies as more difficult than mothers of normal infants, that did not mean they perceived their infants as "difficult." The mean rating score for high risk infants (3.40 ± 1.27) was actually at the average level (a score of 3). Only 17.5% (14 of 80) of the mothers in this study, 27.5% (11 of 40) of mothers of high risk infants and 7.5% (3 of 40) mothers of normal infants, actually rated their infants as either more difficult (a score of 2) or much more difficult (a score of 1) than average. In general, there is always a strong bias for most mothers to regard their child as easier to care for than the average child (Carey, 1982).

The 14 mothers who rated their infants as "difficult" referred to behavior problems as the reason for their rating. Previous studies have shown that the way mothers perceived how easy or difficult it was to care for their infant usually reflected maternal perception of an infants' behavior problems (e.g., difficult temperament, feeding or sleeping problems), and not perception of infant development (Bates, 1980; Carey, 1982, Sanson et al., 1991).

Studies support the importance of distinguishing between two types of maternal perceptions of infants: (a) perception of difficultness (i.e., difficultness or easiness of the infants, and (b) perception of development (Carey, 1982). Maternal perceptions of infants' difficultness, not perceptions of infant development, have been reported to have predictive value for later behavior problems in childhood (Bates, 1980; Carey, 1982, Sanson et al., 1991). Alternatively, maternal perceptions of infant development, not maternal perceptions on infant difficultness, have been reported to have predictive value of infant development (Carey, 1982; Frankenbergs, Vandoorminck, & Liddell, 1976; Rogers, Booth, Duffy, Hassen, McCormick, Snitzer, & Zorn, 1992).
(2) SES and Mother's Perception of Social Support and Husband Support, and Mother's Reactive Behavior

SES level, but not biomedical risk status of infants, was significantly related to the mother's perception of social support, husband support, and mother's reactive behavior.

The results suggested that high SES mothers perceived that they had better support from their husbands and society than low SES mothers on issues of infant care taking and overall stressful events in life.

Despite obvious differences across cultures in family child rearing practices and the nature of social support for mothers, some studies have reported similar findings. Cohen and Williamson (1988) reported that perception of stress decreased in a dose-response fashion in relation to increases in household income and education. Sagi et al. (1988) suggested that maternal perceptions among Israeli mothers of their infants, husbands' support, support from other family members, and HOME scores were significantly related to medical and psychosocial difficulties in their own life, which in turn related to inadequacies in child development.

The results suggest that high SES mothers express more reactive behaviors toward their infants than low SES mothers. The HOME-MQ Subscale I measures indicated that high SES Thai mothers reacted to their six-month-old infants with more emotional and verbal responses (i.e., they responded contingently, attended to, talked to, and spontaneously interacted with their infants) than low SES mothers.

Cultural differences may be an important factor to consider when examining the
nature of parent-child interactions. With respect for this consideration, the results of this study contribute similar findings along with other related studies. For example, these results are consistent with findings by Snyder and Spietz (1987) of significant effects for level of maternal education on mother's emotional and verbal responsive behavior in reacting to their infants, also measured by the HOME Subscale I. Tulkin (1977) also found that SES levels had a significant effect on maternal reactive behaviors. This study provided further elaboration on the similarities and differences in individual maternal reactive behaviors between high and low SES level families. White college-educated parents did not differ from white, high-school drop-out parents in how often the baby was picked up, kissed, tickled, or bounced, or in the way the mother responded when the infant touched her or handed her something. However, the major difference found between the two SES groups was that the college-educated mothers talked to their babies more and responded more often to the babies' vocalization than did the high-school drop-out mothers.

(3) Biomedical Risk, SES, and Infant's Stimulating Environment

Biomedical risk and SES were significantly related to infant's stimulating environment. Normal infants are associated with better stimulating environments than high risk infants. High SES infants are associated with better stimulating environments than lower SES infants.

The effect of SES on infant's stimulating environment was also found in a study by Snyder and Spietz (1987). They reported a significant effect for maternal education on infant's overall stimulating environment, as measured by the total score for the HOME scale. Also, parents with professional backgrounds (e.g., teachers) were more likely to
read to and interact with their children than parents with blue or white collar jobs (Feiring & Lewis, 1981). Farren & Haskins (1980) reported that mothers of higher income spent twice as much time in mutual play with their infants when compared to lower income mothers.

**Correlations among Psychosocial, Environmental Factors and Infant Development (Infant MSEL)**

The results showed that all the outcome measures in this study were intercorrelated. Four relations among these variables may be of interest for examining neurobehavior development among Thai infants. These are (1) maternal perceptions on infant's difficulty and Infant MSEL; (2) maternal perceptions on infant's difficulty and stimulating environment; (3) stimulating environment and Infant MSEL; and (4) maternal perception on husband support, social support, stimulating environment, and mother's reactive behavior.

1. **Maternal Perceptions on Infant's Difficulty and Infant MSEL**

In this study, a significant relationship between maternal perceptions on infant difficulty and infant development was demonstrated. When the biomedical risk status of infants was considered in the analysis, this relationship revealed significance only within the group of high biomedical risk infants. No such relationship was established within the group of normal infants. The significant correlation found with the high biomedical risk infants may explain the overall significant correlation within the total sample.
Previous studies indicated that maternal perceptions of infant development, not maternal perceptions of infant's difficultness, have predictive value for infant development (Carey, 1982; Frankenberg, et al., 1976; Rogers et al., 1992). The relation found in this study between maternal perceptions on infant difficultness and infant development may be explained in terms of the relationship between maternal perceptions of infant development and maternal perceptions on infant difficultness. However, the relation between maternal perception of infant difficultness and maternal perceptions regarding infant development was not examined in this study. It is suggested that this relation be examined in future studies.

The notion of "difficult infant" according to maternal rating as compared to an average infant was examined in this study. As noted above, only 14 mothers rated their infants as either more difficult or much more difficult than average. Maternal perception of infant's as being 'difficult' and infant development failed to correlate significantly in this study. This may have been due to the relatively small sample size, however, and the correlation approached significance. Future studies should explore this relation with a larger sample size.

When an infant is perceived as "difficult," there is suggestive evidence for later behavior problems (Carey, 1982). Sanson et al. (1991) also reported that maternal perception of infant's difficulty was the strongest single risk factor for infant's temperament problems, which later related to adjustment problems in childhood. Nevertheless, an interesting finding from this study is that 64% (9 of 14) of the "difficult" infants were considered developmental delays according to the Denver II.
(2) Maternal Perception of Infant's Difficultness and Stimulating Environment

A modest relationship between maternal perception of her infant and infant's stimulating environment was found in this study. When biomedical risk status of infants was considered in the analysis, this relationship was stronger but was significant only within the group of biomedical risk infants.

This finding is consistent with a study by Ramey & Brownlee (1981). They reported that maternal perception of her infant's difficultness influenced the quality of the environmental that parents provided to the infant. This finding has been supported by many studies (e.g., Bell & Harper, 1977; Brown, Bakeman, Snyder, Fredrickson, Morgan, & Hepler, 1975; Farren & Haskins, 1980). It has been suggested that the more troublesome the infants, the greater is the burden assumed by the mothers. There is a corresponding increase in the tendency of the mother not to interact with or to provide a stimulating environment to an irritable child (Ramey & Brownlee, 1981).

(3) Stimulating Environment and Infant MSEL

A significant relation between the infant's stimulating environment and infant development was found in this study.

Relations between infant's stimulating environment and infant neurobehavior development have been reported at 6 and 12 months of age (Snyder, 1978), at three years of age (Bradley & Caldwell, 1976), and at four years of age (Hammond & Snyder, 1987). These results suggest that measures of stimulating environment reflect complex environmental factors which may be prerequisites to later neurobehavior development.
(4) Maternal Perception on Husband Support, Social Support, Stimulating Environment, and Mother's Reactive Behavior

Significant relations among maternal perception on husband support, social support, stimulating environment, and mother's reactive behavior were found in this study.

These relations may indicate that the more social support and husband support the mother perceives is available to her, the less psychosocial stress a mother experiences. This situation may then support an increase in the quality of the mother's interaction with the infant, and provide a better stimulating environment for the infant. There is presently a lack of studies concerning the relations among these specific variables, suggesting the need for future research to examine the importance of these relations as they may influence the neurobehavior development of infants.
Implications of Findings

The theoretical implications of this study suggest a transactional model for infant development. The characteristics of the specific transactions that occur between an infant and the caretaking environment should be considered for a more complete understanding of the area of infant neurobehavior development.

Research implications suggest a multivariate approach in investigating transactions between the infant and the environment in terms of their importance to neurobehavior development. Studies should take into consideration that these transactions between the infant and his environment are constantly changing. This necessitates the need to specify the parameters for the important domains of culture, family characteristics, and individual characteristics at specific points in time (Casey & Bradely, 1987). A longitudinal study may also be required to capture the nature of changes among these transactions at various points in time.

The findings support previous research that found biomedical risk status of the high-risk infants to be more important than environmental or psychosocial factors in affecting infant development during the infancy period. Early infant development depends on the biological strength of the infant and starts with early central motor control (Mullen, 1989). The motor development then progresses into more complex interactions with early visual development and receptive and expressive language development as the infant moves from a sensorimotor mode of functioning to a conceptual mode. Later, development processes reflect a more complicated dynamic relationship among biomedical factors and many different environmental and psychosocial factors (Mullen, 1989).

The complexity of SES was suggested by the associations among SES and other
psychosocial and environmental factors. Adler et al. (1994) proposed broader underlying dimensions of other potent psychosocial factors as mechanisms for the complexity of SES. The effect of SES should not be treated only as a main effect to predict infant development. SES may function most powerfully in relating to combinations of variables.

The standard measures for SES, such as income, education and occupation, should not be treated separately, but rather included combinatively when identifying SES level. Further, these three standard SES indicators should be expanded to include other psychosocial or environmental factors that are enmeshed in key domains of life (e.g., physical and social environment, social resources and supports, perceptions, health behaviors, etc.) (Adler, et al., 1994).

The clinical implications for this study appear to allow for the applicability of the Infant MSEL as an infant developmental assessment instrument for Thai infants during early infancy. For the purpose of early intervention planning, the profile of infant development across all subscales of the Infant MSEL should be used instead of the total score. Use of this developmental profile will allow for identification of an infant's strength and weakness in each developmental domain (Mullen, 1989).

Identification of the biomedical and psychosocial variables in this study that were related to infant development should also be considered in the conceptualizing and planning of early intervention programs. Biomedical and psychosocial factors can be identified early in the infant's life. A functional analysis identifying the role of these variables on infant development should be done to identify points of intervention, set goals for treatment effects, and evaluate progress.
Limitations of the Study

There are several limitations related to the nature of the sample and the instruments used in the study.

(1) Only infants six months of age were included, all residing in the Bangkok metropolitan area. Conclusions reached on the applicability of the Infant MSEL for Thai infants, and the relations of biomedical and psychosocial factors to Thai infant neurobehavior development are limited to 6 month old infants. The results may not be generalizable to Thai infants residing outside of Bangkok.

(2) The instruments for infant developmental assessment used in this study were developed and standardized on the U.S. population. Even though these two tests were standardized among multi-ethnic groups within the U.S., including Asian Americans, they have not been standardized for the Thai population. To deal with this problem, a matching control group was included to develop a baseline for Thai infant development at the age of 6 months. Raw scores were used instead of standard scores for the Infant MSEL. Thus, the results on infant development from this study can be reported only as a comparison study to the control group. A discussion regarding developmental delay among all Thai infants is beyond the scope of this study.

(3) The biomedical risk data used to calculate neonatal risk scores was obtained retrospectively from medical records. The accuracy of the data was dependent on the thoroughness and preciseness of the medical records. However, the instrument used in this study for neonatal risk assessment (HRPSS-Neonatal Subscale) primarily requires the diagnoses of major medical conditions such as respiratory distress syndrome, congestive heart failure, or congenital pneumonia. These major medical conditions are routinely diagnosed and recorded by the physician in the infant's medical record.
Additional details that may not be included in a medical record, such as the duration and severity of each condition, the duration of therapeutic management, type and dosage of drug used, or confirmation data from the high technology equipment, are not required by the HRPSS-Neonatal Subscale when calculating risk scores.

(4) The SES composite score and the score of the HOME-Mother Questionnaire were derived from self-reports from mothers of infants. The accuracy of the data will depend on how reliable the mothers are in giving the information. It has been found that in early childhood, mothers are the best source of data on their children's behavior and environment, with sufficient reliability and validity (Achenbach & Edelberg, 1978; Bates & Bayles, 1984; Sanson et al., 1991), especially when they are asked the right questions in an appropriate way (Carey, 1982).

Weeks (1986) proposed that in order to increase the accuracy for this type of data, issues of confidentiality and motivation need to be addressed. He suggested that if the subjects were ensured confidentiality of their personal information and understood the benefits of their participation in the study, they would be motivated to participate and give accurate information.

In this study, confidentiality of the information was ensured to the mothers in the written consent form and through verbal communications from the participating pediatricians and the researcher. The pediatricians explained to the mothers the benefit of a developmental assessment for their babies, a procedure not routinely available at the hospitals. The pediatricians also explained to the mothers that accurate information about them was required in order to better understand the development of their infants. During the interview, the researcher also confirmed with the mothers the confidentiality of the information and the benefit of giving accurate data.
Future Recommendations

Studies should be conducted to expand the applicability of the Infant MSEL for Thai infants up to the age of 42 months, the age range for which the instrument was designed and standardized. Standardization and norms for the Infant MSEL need to be established for Thai infants and children. In addition, criteria for determining developmental delay and subsequent consideration for early intervention services needs to be established for Thai infants and children. Sensitivity and specificity for the instrument in identifying developmental delay within each subscale also needs to be established.

This expansion on the use of the Infant MSEL should also be examined with special consideration given to cultural factors related to possible differences in social and language development. Items contained in the Infant MSEL assess increasingly complex social and verbal behaviors with increases in the age of the infant.

Important maternal behaviors in reaction to infants should be identified within the Thai culture. There may be cultural differences in maternal behaviors toward their infants. For example, Western mothers tend to rely more on speech as a means of stimulating their babies (Fogal, 1991). A valid instrument to measure Thai maternal behaviors that is predictive of infant neurobehavior development needs to be developed.

A related analysis should be conducted to examine similarities and differences of maternal behaviors among different SES groups in Thai culture. In addition, the complexity of SES should be examined by including other psychosocial variables enmeshed in the key domains of infant development.

Multivariate studies representing transactional models for infant development should be developed. Results of this study as well as others indicate that different
developmental domains become prominent at different ages, resulting in various biomedical and psychosocial factors playing important roles on development at different points in time. Longitudinal studies need to be conducted to identify those factors and their transactional relations and to capture the changes among these transactions at various points in time for a better understanding of infant neurobehavior development.
APPENDIX A: The HRPSS-Neonatal Subscale

The HRPSS-Neonatal Subscale

I). General:
   1. Prematurity <2,000 gm
   2. 5-min Apgar <5
   3. Resuscitation at birth
   4. Fetal anomalies
   5. Dysmaturity
   6. Prematurity <2,000-2,500 gm
   7. 1-min Apgar <5
   8. Feeding problem
   9. Multiple birth

II). Respiratory:
   1. Respiratory distress syndrome
   2. Meconium aspiration syndrome
   3. Congenital pneumonia
   4. Anomalies of respiratory system
   5. Apnea
   6. Other respiratory distress
   7. Transient tachypnea

III). Metabolic Disorder:
   1. Hypoglycemia
   2. Hypocalcemia
   3. Hypomagnesemia or hypermagnesemia
   4. Hypoparathyroidism
   5. Failure to gain weight
   6. Jitteriness or hyperactivity with specific causes

IV). Cardiac:
   1. Major cardiac anomalies requiring immediate catheterization
   2. Congestive heart failure
   3. Persistent cyanosis
   4. Cardiac anomalies not requiring immediate catheterization
   5. Murmur

V). Hematologic Problems:
   1. Hyperbilirubinemia
   2. Hemorrhagic diathesis
   3. Chromosomal anomalies
   4. Sepsis
   5. Anemia

VI). Central Nervous System:
   1. CNS depression > 24 hours
   2. Seizure
   3. CNS depression < 24 hours

TOTAL
APPENDIX B: The SES Questionnaire

SES QUESTIONNAIRE

Mother's Name: ___________________________ Birthdate: ___________ Age: __

Breast feeding: □ Yes ___ months □ No
Living with father of the child: □ Yes □ No

Birth order of the child: _____ Other caretaker: _______________________

Home Address: ___________________________ Phone: __________________

Occupation: _____ Work Address: ___________ Phone: __________________

Next of Kin: _____ Address: _________________ Phone: __________________

Education
Graduated from: ___________________________ Level: _______
Years in school: ___________________________

Education Level:
□ 1) Less than grade 8 (primary)
□ 2) Grade 8 - 12 (secondary)
□ 3) More than grade 12 (college)

Household Income (per month)
Mother's income: _______________ Father's Income: _______________
Household income: _______________ Household expense: ____________

Number of people in family: ___________

Income Level:
□ 1) Less than 5,300 baht
□ 2) 5,300 - 9,400 baht
□ 3) more than 9,400 baht

SES Composite Score: _______
<table>
<thead>
<tr>
<th>Stage</th>
<th>Age Score</th>
<th>GMB Scale</th>
<th>VRO Scale</th>
<th>VEO Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 MONTH</td>
<td>GM11 Enjoy being held/realign (\Delta)</td>
<td>VR08 Finishes on triangle (\Delta)</td>
<td>VR08 Arm's flexed/hands fist (\Delta)</td>
<td>VR08</td>
</tr>
<tr>
<td>1 MONTH</td>
<td>GM12 Rotates head (\Phi)</td>
<td>VR01 Tracks triangle (\Delta)</td>
<td>VR01 Tracks (\Phi)</td>
<td>VR02</td>
</tr>
<tr>
<td>2 MONTHS</td>
<td>GM13 Holds upright, head steady (\Delta)</td>
<td>VR02 Tracks schematic face (\Delta)</td>
<td>VR02 Tracks (\Phi)</td>
<td>VR02</td>
</tr>
<tr>
<td>3 MONTHS</td>
<td>GM14 Supports on forearms (\Delta)</td>
<td>VR03 Tracks moving object (180^\circ) (\Phi)</td>
<td>VR03 Bilateral orientation in midline (\Phi)</td>
<td>VR03</td>
</tr>
<tr>
<td>4 MONTHS</td>
<td>GM15 Sits, head steady (\associated{\Phi}) (\Delta)</td>
<td>VR04 Inspects own hand (\Phi)</td>
<td>VR04 Grasps peg (\text{circular-palm}) (\Phi)</td>
<td>VR04</td>
</tr>
<tr>
<td>5 MONTHS</td>
<td>GM16 Rolls over (P) to (S) (\Delta)</td>
<td>VR05 Localizes objects near, far (\associated{\Phi}) (\Delta)</td>
<td>VR05 Reaches, grasps (\text{radial-palm})</td>
<td>VR05</td>
</tr>
<tr>
<td>6 MONTHS</td>
<td>GM17 Shifts weight, reaches (P) (\Delta)</td>
<td>VR06 Looks/dropped toy (\text{A/FV}) (\associated{\Phi})</td>
<td>VR06 Transfers, hangs, drops (\text{2~/3}) (\Phi)</td>
<td>VR06</td>
</tr>
<tr>
<td>7 MONTHS</td>
<td>GM18 Stands (\Phi) (\Delta)</td>
<td>VR07 Pulls yarn/to obtain disc (\associated{\Phi}) (\Phi)</td>
<td>VR07 Refined grasp/chew (\Phi)</td>
<td>VR07</td>
</tr>
<tr>
<td>8 MONTHS</td>
<td>GM19 Sits, arms free (\Phi) (\Delta)</td>
<td>VR08 Looks/partially hidden object (\Phi)</td>
<td>VR08 Partial pincer grasp (\Phi)</td>
<td>VR08</td>
</tr>
<tr>
<td>9 MONTHS</td>
<td>GM20 Pulls self to stand (\Phi)</td>
<td>VR09 Looks/fully hidden object</td>
<td>VR09 Ranges in midline, horizontal (\Phi)</td>
<td>VR09</td>
</tr>
<tr>
<td>10 MONTHS</td>
<td>GM21 Gets from sit to hands/knees (\Delta)</td>
<td>VR10 Repositions cup</td>
<td>VR10 Turns block out (\Phi)</td>
<td>VR10</td>
</tr>
<tr>
<td>11 MONTHS</td>
<td>GM22 Walks, one hand held (\Delta)</td>
<td>VR11 Makes object association (1)</td>
<td>VR11 Uses two hands together</td>
<td>VR11</td>
</tr>
<tr>
<td>12 MONTHS</td>
<td>GM23 Stands alone (\Delta)</td>
<td>VR12 Looks, two clothes</td>
<td>VR12 Empty/fill, vertical movement (\Phi \Phi)</td>
<td>VR12</td>
</tr>
<tr>
<td>13 MONTHS</td>
<td>GM24 Throws a ball underhand</td>
<td>VR13 Attends to picture (\text{A/FV})</td>
<td>VR13 Refined pincer grasp</td>
<td>VR13</td>
</tr>
<tr>
<td>14 MONTHS</td>
<td>GM25 Walks alone (\Delta)</td>
<td>VR14 Discriminates one form (\Phi \Phi\Phi)</td>
<td>VR14 Purpostive fill behavior (1.1)</td>
<td>VR14</td>
</tr>
<tr>
<td>15 MONTHS</td>
<td>GM26 Gets to stand/sideways to sit (\Phi)</td>
<td>VR15 Looks cup/cloth</td>
<td>VR15 Turns pages, several at a time</td>
<td>VR15</td>
</tr>
<tr>
<td>16 MONTHS</td>
<td>GM27 Stands, squats, stands (\Phi)</td>
<td>VR16 Matches objects (1) (\text{A/FV}) (\Phi)</td>
<td>VR16 Stacks three blocks vertically</td>
<td>VR16</td>
</tr>
<tr>
<td>17 MONTHS</td>
<td>GM28 Walks up stairs, hands held (\Delta)</td>
<td>VR17 Discriminates two forms</td>
<td>VR17 Imitates cayms stroke</td>
<td>VR17</td>
</tr>
<tr>
<td>18 MONTHS</td>
<td>GM29 Runs stiffly (\Phi)</td>
<td>VR18 Meats three cups</td>
<td>VR18 Puts chip in horizontal slot (3)</td>
<td>VR18</td>
</tr>
<tr>
<td>19 MONTHS</td>
<td>GM30 Kicks a 10 to 12-inch ball (\Phi)</td>
<td>VR19 Discriminates three forms</td>
<td>VR19 Stacks six blocks vertically</td>
<td>VR19</td>
</tr>
<tr>
<td>21 MONTHS</td>
<td>GM31 Walks (4-/5) steps, one foot on line</td>
<td>VR20 Matches objects (2) (\Phi \Phi\Phi\Phi)</td>
<td>VR20 Imitates vertical line</td>
<td>VR20</td>
</tr>
<tr>
<td>22.5 MONTHS</td>
<td>GM32 Stands on one foot (1/2) with help (\Phi)</td>
<td>VR21 Sorts by category (2)</td>
<td>VR21 Puts chips in vertical slot (3)</td>
<td>VR21</td>
</tr>
<tr>
<td>24 MONTHS</td>
<td>GM33 Walks up stairs by self, nonalternating (\Phi)</td>
<td>VR22 Meats four cups</td>
<td>VR22 Imitates four block train</td>
<td>VR22</td>
</tr>
<tr>
<td>25.5 MONTHS</td>
<td>GM34 Jumps down from step, one foot leads (\Phi)</td>
<td>VR23 Discriminates four forms</td>
<td>VR23 Unfastens, covers nut/bolt</td>
<td>VR23</td>
</tr>
<tr>
<td>27 MONTHS</td>
<td>GM35 Jumps to place, feet together</td>
<td>VR24 Matches objects (3) (\Phi \Phi\Phi\Phi)</td>
<td>VR24 Imitates horizontal line</td>
<td>VR24</td>
</tr>
<tr>
<td>28.5 MONTHS</td>
<td>GM36 Walks on tiptoes (\Phi)</td>
<td>VR25 Matches by shape (6) (\Phi \Phi\Phi)</td>
<td>VR25 Turns pages, one at a time</td>
<td>VR25</td>
</tr>
<tr>
<td>30 MONTHS</td>
<td>GM37 Walks on line, feet alternating (\Phi)</td>
<td>VR26 Matches pictures (2) (\text{PCM}^{\Phi}) (\Phi) (\Phi)</td>
<td>VR26 Imitates four block train with (\Phi \Phi\Phi\Phi)</td>
<td>VR26</td>
</tr>
<tr>
<td>31.5 MONTHS</td>
<td>GM38 Walks down stairs by self, alternating (\Phi)</td>
<td>VR27 Matches by size, color (8) (\Phi \Phi\Phi\Phi)</td>
<td>VR27 Stacks nine blocks vertically</td>
<td>VR27</td>
</tr>
<tr>
<td>33 MONTHS</td>
<td>GM39 Jumps from bottom step, feet together (\Phi) (\Phi)</td>
<td>VR28 Special details (1) (\text{PCM}^{\Phi})</td>
<td>VR28 Copies circle</td>
<td>VR28</td>
</tr>
<tr>
<td>34.5 MONTHS</td>
<td>GM40 Gate to stand/forwards to sit (\Phi)</td>
<td>VR29 Special details (2) (\text{PCM}^{\Phi}) (\Phi) (\Phi)</td>
<td>VR29 Strings beads (3) (\Phi \Phi\Phi)</td>
<td>VR29</td>
</tr>
<tr>
<td>36 MONTHS</td>
<td>GM41 Balances on one foot (2-3) seconds (\Phi) (\Phi)</td>
<td>VR30 Memory for picture (\text{PCM}^{\Phi}) (12) (\Phi) (\Phi)</td>
<td>VR30 Imitates four block tower (\Phi \Phi\Phi\Phi)</td>
<td>VR30</td>
</tr>
<tr>
<td>37.5 MONTHS</td>
<td>GM42 Hops two times (\Phi)</td>
<td>VR31 Discriminates position (4) (\text{PCM}^{\Phi}) (12) (\Phi)</td>
<td>VR31 Draws in path (2) (\Phi \Phi\Phi)</td>
<td>VR31</td>
</tr>
<tr>
<td>39 MONTHS</td>
<td>GM43 Walks on line, doesn't step off</td>
<td>VR32 Special details (1) (\text{PCM}^{\Phi})</td>
<td>VR32 Copies circle, line</td>
<td>VR32</td>
</tr>
<tr>
<td>40.5 MONTHS</td>
<td>GM44 Runs well, turns corners, stops</td>
<td>VR33 Identifies objects (1) (\Phi \Phi\Phi)</td>
<td>VR33 Puts paper three times (\Phi \Phi\Phi)</td>
<td>VR33</td>
</tr>
<tr>
<td>42 MONTHS</td>
<td>GM45 Bides tricycle, pedals, steers (\Phi)</td>
<td>VR34 Memory for objects (2) (\Phi \Phi\Phi)</td>
<td>VR34 Cuts with scissors</td>
<td>VR34</td>
</tr>
</tbody>
</table>

\(\text{GMB Illustrations}\)
### Appendix C: Infant MSEL Scoring Sheet

<table>
<thead>
<tr>
<th>VEO Scale</th>
<th>LRO Scale</th>
<th>LEO Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) □ VEO1 Arms flexed/hands fists (S)                                     □ LEO1 Rests reflectively/loud noise (S)                                   □ LEO8 Sucking/swallowing/chewing movements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO2 Holds ring reflectively (S)                                        □ LEO1 Alerts to sound                                                   □ LEO1 Vocalises</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO3 Bilateral orientation in midline (S)                               □ LEO2 Attends to voice, face/smile (A/V)                                  □ LEO2 Smiles and sounds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO4 Grasps peg (ulnar-palmar) (PPr) (SSit)                             □ LEO3 Coordinates listening/turning (PPr)                                  □ LEO3 Coos, chuckles, or laughs (2/2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) □ VEO5 Reciprocates passive (SSit)                                     □ LEO4 Attends to voice, face/vocalizes (A/V) (PPr, SSit)                  □ LEO4 Makes vocalisations (like ah, ah, m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO6 Transfers, grasps (radial-palmar) (SSit)                           □ LEO5 Coordinates listening/looking (SSit)                                  □ LEO5 Plays with sounds (like o, u, ah-go)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO7 Refined grasp/thumb opposition (SSit)                              □ LEO6 Enjoy self/mirror interaction (A/V)                                  □ LEO6 Voluntary babbling (ba, ba, ba)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO8 Partial pincer grasp (SSit)                                        □ LEO7 Attends to words/movement (A/V) (SSit)                                □ LEO7 Produces three sounds (p, b, d, g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO9 Hangs in midline, horizontal movement                              □ LEO8 Recognizes familiar names, words                                    □ LEO8 Vocalizes 2-syllable sounds (da-da)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO10 Takes block out [], puts in []                                    □ LEO9 Recognizes name                                                     □ LEO9 Says first word</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO11 Uses two hands together                                          □ LEO10 Understands simple verbal input                                     □ LEO10 Plays gestures/language game</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO12 Empty/fill, vertical movement (4)                                 □ LEO11 Understands inhibitory words                                       □ LEO11 Uses one word</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO13 Refined pincer grasp                                              □ LEO12 Understands gestures/commands (A/V)                                □ LEO12 Jabbers with inflection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO14 Pursuit vertical movement (4)                                     □ LEO13 Identifies objects (1) (A/V)                                       □ LEO13 Uses two different words</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO15 Turns pages, several at a time                                   □ LEO14 Gives toy on verbal request (1)                                     □ LEO14 Combines jargon/gestures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO16 Stacks three blocks vertically                                  □ LEO15 Comprehends questions I (1)                                        □ LEO15 Combines words/gestures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO17 Imitates crayon strokes                                          □ LEO16 Recognizes body parts (1) (A/V)                                    □ LEO16 Names objects (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO18 Puts chip in horizontal slot (3)                                  □ LEO17 Follows directions (2)                                              □ LEO17 Uses eight words</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO19 Stacks six blocks vertically                                     □ LEO18 Comprehends questions II (1) (A/V)                                 □ LEO18 Labels pictures (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO20 Imitates vertical line                                           □ LEO19 Recognizes body parts (4) (A/V)                                    □ LEO19 Picture vocabulary (5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO21 Puts chips in vertical slot (3)                                   □ LEO20 Follows related commands (1)                                       □ LEO20 Uses two-word phrases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO22 Imitates four block train                                         □ LEO21 Verbal spatial awareness (1)                                       □ LEO21 Uses pronouns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO23 Unscrews, screws nut/bolt                                         □ LEO22 Identifies pictures (2) (A/V)                                      □ LEO22 Names objects (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO24 Imitates horizontal line                                         □ LEO23 Recognizes body parts (6) (A/V)                                    □ LEO23 Picture vocabulary (11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO25 Turns pages, one at a time                                       □ LEO24 Identifies object function (3) (A/V)                               □ LEO24 Counts to two</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO26 Imitates four block train with driver                            □ LEO25 Verbal spatial awareness (2)                                       □ LEO25 Repeats two numbers (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO27 Stacks nine blocks vertically                                    □ LEO26 Comprehends action words (1) (A/V)                                 □ LEO26 Names objects (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO28 Copies circle                                                    □ LEO27 Verbal size concepts (3) (A/V)                                     □ LEO27 Picture vocabulary (15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO29 Strings beads (3)                                                □ LEO28 Follows two unrelated commands (1)                                  □ LEO28 Comprehends questions III (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO30 Imitates four block tower                                        □ LEO29 Verbal spatial awareness (3)                                       □ LEO29 Uses three to four-word sentences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO31 Draws in path (2)                                               □ LEO30 Identifies actions (2) (A/V)                                       □ LEO30 Counts to three</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO32 Copies circle, line                                              □ LEO31 Identifies game concepts (3) (A/V)                                 □ LEO31 Picture vocabulary (17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO33 Folds paper three times                                          □ LEO32 General knowledge (6)                                               □ LEO32 Comprehends questions III (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO34 Cuts with scissors                                               □ LEO33 Verbal spatial awareness (4)                                       □ LEO33 Verbal analogies (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>□ VEO35 Copies circle, line                                              □ LEO34 Identifies colors (4) (A/V)                                       □ LEO34 Repeats sentences I (2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix D: Denver II Scoring Sheet

Denver II

Examiner:  
Date:  

Name:  
Birthdate:  
ID No.:  

% of children passing 30 60

TEST BEHAVIOR

<table>
<thead>
<tr>
<th>Typical</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compliance (See Note 31)

<table>
<thead>
<tr>
<th>Always Completes</th>
<th>Usually Completes</th>
<th>Rarely Completes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Interest in Surroundings

<table>
<thead>
<tr>
<th>Alert</th>
<th>Somewhat Disinterested</th>
<th>Seriously Disinterested</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fearfulness

<table>
<thead>
<tr>
<th>None</th>
<th>Mild</th>
<th>Extreme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Attention Span

<table>
<thead>
<tr>
<th>Appropriate</th>
<th>Somewhat Distractable</th>
<th>Very Distractable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**APPENDIX E: The HOME-Mother Questionnaire**

**THE HOME-MQ**

**Subscale I: Behavior Observation of Mother (Emotional and Verbal Responsivity of Mother)**

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mother spontaneously vocalizes to child at least twice during visit (exclude scolding)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Mother responds to child's vocalizations with verbal response</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Mother tells child the name of some object during visit or says name of person or object in a &quot;teaching style&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Mother speech is distinct, clear and audible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Mother initiates verbal interchanges with observer (e.g., asks questions, make spontaneous comments)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Mother expresses ideas freely and easily and uses statements of appropriate length for conversations (e.g. gives more than brief answers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Mother spontaneously praises the child's qualities or behavior twice during visit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. When speaking of or to child, mother's voice conveys positive feeling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Mother caresses or kisses child at least once during visit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Mother shows some positive emotional responses to praise of child offered by visitor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL**   |   |

---
Subscale II: Mother's Interview

1. What are your child's 3 favorite toys?
   ____________________________________________________________
   ____________________________________________________________

2. How does he/she learn to play with a new and/or difficult toy?
   □ a. I let him/her figure it out by himself
   □ b. I show him/her how it works and get him/her started playing
   □ c. Other (explain) __________________________________________

3. Check the toys, household objects or equipment your child has available to play with
   (Note: the choices are chosen from the original questionnaire to be appropriate for
   5-7 month old infant)
   □ a). ball
   □ b). beads to string
   □ c). blocks
   □ d). books
   □ f). doll
   □ i). objects with wheels child ride
   □ j). musical toys
   □ m). playpen
   □ n). pull toy
   □ o). push toy
   □ p). rocking horse
   □ s). stuffed toy
   □ x). mobile
   □ y). toys or objects to go in and out of boxes, cans
   □ z). other ________

4. How do you decide what kind of toys to make or buy for child, i.e., what are your
   guidelines?
   □ a. Something I noticed he/she likes
   □ b. Something to help him/her learn new skills
   □ c. Something I liked

5. How often do you manage to read stories to him/her?
   □ a. Haven't start yet
   □ b. Every day
   □ c. 1-2 times a week
   □ d. 3-6 times a week

6. Do you occasionally let your child play in sand, mud, water, or fingerpaints?
   □ a. Yes
   □ b. No

7. In thinking back over the past weeks, how many times have you had to slap his hands
   or spank his bottom?
   □ a. More than 3 times
   □ b. 2-3 times
8. Does your family have a pet?
   [ ] a. Yes
   [ ] b. No

9. When is the last well-child checkup? ____________________________

10. How many times a week does your child get out of the house (to play outdoor or to go somewhere?)
    [ ] a. Every day
    [ ] b. 4 or more times a week
    [ ] c. 1-3 times a week

11. How many baby sitters or persons regularly take care of your child when you are away?
    [ ] a. 1-3
    [ ] b. 4-6
    [ ] c. None

12. How often do you visit or receive visits from relatives?
    [ ] a. Daily
    [ ] b. Monthly
    [ ] c. Weekly
    [ ] d. Not at all

13. When you are working around the house, do you...(the answer may be more than one)
    [ ] a. Talk with your child about what you are doing
    [ ] b. Talk with your child about his activities
    [ ] c. No talk because he's not around when you're working around the house
    [ ] d. Not usually talk

14. What things are you helping your child to learn at this age?

15. What things do you make your home safe for your child?

16. Is there anything else you would like to tell us to help us understand more about your child?
APPENDIX F: Maternal Perception Questionnaire

MATERNAL PERCEPTION

INFANT

1. How the mother regards her child as overall, comparing to average child?
   - Much easier
   - Easier
   - Average
   - More difficult
   - Much more difficult

SOCIAL SUPPORT

2. Social support in taking care of infant
   - Much support From whom:
   - Average support From whom:
   - Less support From whom:

3. Social support in stress events in life
   - Much support From whom:
   - Average support From whom:
   - Less support From whom:

HUSBAND SUPPORT

4. Husband's support in taking care of infant
   - Much support
   - Average support
   - Less support

5. Husband's support in stress events in life
   - Much support
   - Average support
   - Less support
ตัวแมาก

วบสภรรย–วิทยาศาสตร์และเทคโนโลยี

ชื่อเจ้า.............................................................ผู้ปกครองของ..........................................................

[ ] มีความประสงค์จะนำบุตรมาวิ่งการตรวจสอบพิษสารการ ความรู้และเวลาที่สะดวกเร็ว
( เลือกหัวหน้ากว่า 1 เวลา ..........................
และหัวหน้ากว่า 3 เวลาพัก
เวลาและท้องที่ที่แน่ชัด
เก็บมาจากหน้าที่ 3 วัน)
[ ] ..........................................................
[ ] ..........................................................
[ ] ..........................................................
[ ] ..........................................................

[ ] หามีความประสงค์จะนำบุตรมาวิ่งการตรวจสอบพิษสารการ

ข้อมูลเกี่ยวกับการศึกษาและรายละเอียดของคุณพ่อคุณแม่
(กรุณากรอกข้อมูลอย่างจริงจังเพื่อเก็บไว้เป็นประโยชน์ต่อการวิจัยระลึกและ
เดิมของแพทย์)

1. คุณแม่ เฝ้า จบการศึกษาสูงสุดเป็น...........................................
2. คุณพ่อ เฝ้า จบการศึกษาสูงสุดเป็น...........................................
3. รายละเอียดของครอบครัวที่เดิม...........................................

ที่อยู่และเบอร์โทรศัพท์ที่ติดต่อได้

ที่อยู่..........................................................
..........................................................
เบอร์โทรศัพท์.............................................

สอบถามรายละเอียดเพิ่มเติมที่พื้นที่.............................................
คุณภาพรินทร์.............................................
เบอร์โทรศัพท์.............................................
และเวลา 20.00 น.
และเวลา–อาทิตย์
ที่ว่าการ

ความสำนึกในการวิเคราะห์

คุณภาพสุขภาพ

ของเด็ก

และแนวทางการแก้ไข

คุณภาพสุขภาพ

ของเด็ก
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