Ecological Influences of Early Childhood Obesity:
A Multi-Level Analysis

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THESIS
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This thesis is dedicated to my family and Dr. Beverly J. McElmurry; without them, this thesis would never have been accomplished.
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SUMMARY

This dissertation is comprised of two studies that were conducted to identify factors associated with the development of overweight/obesity during the early childhood period. The first study was performed to determine the timing of adipose rebound (AR) for United States (U.S.) children using a national survey data set, the National Health and Nutrition Examination Survey (NHANES). Combined data of the NHANES 1999-2008 were used to estimate the national level of this critical period for U.S. children developing obesity. Data of 8,813 children aged 2-10 years were analyzed. Mean body mass index (BMI) was estimated using the survey sample analysis method. Visual inspection method was employed to examine the timing of AR. The first study found that gender and race/ethnicity differences in AR were identified at an early age. AR occurred earlier in girls and in Non-Hispanic Black children than in Non-Hispanic White children. According to this study, sex and racial/ethnic differences in AR were identified at an early age. To address the obesity problem, it is important to start prevention and intervention strategies in early childhood. Moreover, differences in timing of AR by sex and race/ethnicity should be considered in planning early and timely intervention efforts to prevent more effectively childhood obesity.

The second study was conducted to explore the contributing factors for early childhood overweight/obesity within the contexts of the child’s home, school, and community and to determine how much each of the ecological contexts contributes to childhood overweight/obesity. The study framework was developed from Bronfenbrenner’s ecological systems theory. Data for 2,100 children from the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), were used in a series of multilevel modeling analyses. This study found that there was significant variation in childhood overweight/obesity by school and community ($p < 0.05$). The variation in childhood overweight/obesity by school and community ($p < 0.05$). The variation in childhood
overweight/obesity was explained mainly by the child and family factors. Children were more overweight/obese if they were Hispanic or other minority races, their birth weight was more than 4,000 grams, they ate fruit fewer than 2 times per day, the maternal weight gain during pregnancy was more than the Institute of Medicine (IOM) recommendation (2009), the maternal weight status was categorized in the overweight and obese group, and the household income was $25,000 or less. Explained variance of childhood overweight/obesity with children’s family and school factors at the school level was 26.72% and at the community level, 2.37%. The variance composition at children’s family level alone was 70.91%. The findings from this study reveal that all three levels of children’s ecological environments explained early childhood overweight/obesity with statistical significances. These results suggested investigations of early childhood overweight/obesity required identifying contextual factors at multiple level of the ecological environment of the child.

Taken together, these studies suggest that the early childhood period is an important time to initiate obesity prevention effort. The early childhood period is an important period of growth related to the timing of AR. Children are also in the transition period between early childcare providers and school. They might be exposed to multiple childcare providers and educators and to different kinds of environment at the same time. Therefore, it is important to understand how all ecological contexts work together to influence early childhood overweight/obesity. To combat childhood overweight/obesity problem, obesity-prevention interventions need to incorporate the importance of both the individual child’s physical growth pattern and child’s multiple ecological environment factors in obesity prevention programs.
I. INTRODUCTION

A. Background

Obesity is a national health problem for children in the United States (U.S.). The prevalence of obese children in the U.S. has increased in the last 30 years. From 1976 to 2008, the prevalence of obesity in children ages 2 to 5 increased from 5% to 10.4% and for ages 6 to 11, from 6.5% to 19.6% (Ogden & Carroll, 2010). In the U.S., obesity prevalence has varied by racial/ethnic group and has been more prevalent among minority children. From the National Health and Nutrition Examination Survey (NHANES) 2003–2006, the prevalence of children who are aged 2 to 5 and have a BMI \( \geq 95 \) percentile was 10.7% among non-Hispanic White children, 14.9% among non-Hispanic Black children, and 16.7% among Mexican American children. For ages 6 to 11, the prevalence of children with a BMI \( \geq 95 \) percentile was 15% among non-Hispanic White children, 21.3% among non-Hispanic Black children, and 23.8% among Mexican American children (Ogden, Carroll, & Flegal, 2008).

The increased prevalence of overweight and obesity have raised considerable concern about children’s health and well-being (Reilly et al., 2005). Children who are overweight are more likely to suffer from orthopedic problems, sleep apnea, and depression. Obese children also have a high risk of developing diseases such as cardiovascular, gastrointestinal, endocrinological, and orthopedic morbidity and mortality in adulthood (Mo-suwan, Prongprapai, Junjana, & Puetpaiboon, 1998). Obesity also burdens the health care system. Wang, McPherson, Marsh, Gortmaker, and Brown (2011) estimated that in the next two decades annual medical costs from treating obesity-related disorders would cost about U.S. $22–66 billion per year.

Because obesity has various negative health consequences on children and also increases the morbidity later in adulthood, to combat the obesity problem it is important to identify children at
risk for future obesity and prevent obesity in early life. One strategy to predict adult obesity is related to the timing of adiposity rebound (AR). Researchers have shown that AR is a critical period for the development of adiposity that persists into later life (Adair, 2008; Dietz, 1994; Drohan, 2002; He & Karlberg, 2002; Rolland-Cachera et al., 1987, 2006). AR occurs when BMI increases in infancy and then decreases until it reaches the lowest point between 5 and 7 years of age before increasing again and continuing to increase until early adulthood. Age that the lowest point of BMI is reached is the start of AR (Adair, 2008; Rolland-Cachera, Deheeger, Maillot, & Bellisle, 2006; Rolland-Cachera et al., 1984). Extensive evidence has shown that children who experience early AR (≤ 5–5.5 years) are at risk of being overweight adolescents (Rolland-Cachera et al., 1984) and adults (Freedman, Kettel Khan, Sedula, Srinivasan, & Berenson, 2001; Pan et al., 2009; Whitaker, Pepe, Wright, Seidel, & Dietz, 1998; Williams, Davie, & Lam, 1999;) compared with children with late AR (≥ 7 years). Early AR is also associated with the development of type 2 diabetes (Bharagava, et al., 2004; Eriksson, Forsén, Tumilehto, Osmand, & Barker, 2003).

B. Statement of the Problem

For U.S. children, the age of AR has been studied, but there has been no research using secondary data analysis of national data to establish the age. Previous studies about the timing of AR in the U.S. were based on local data and specific race (Freedman et al., 2001; Skinner, Bounds, Carruth, Morris, & Ziegler, 2003; Whitaker et al., 1998). Thus, the generalizability of the information from previous studies of AR is limited. Therefore, there is the need of the current study to develop an understanding of this critical period of U.S. children in developing obesity.

Because the early childhood period is a critical period for developing obesity that continues into adulthood, to prevent obesity and its health-related problems, it is critical that children in the early childhood period receive special attention, and that health care providers
understand potential factors for the development of obesity and how to manage these factors in early life. In the last three decades, the prevalence of overweight children in the early childhood period more than doubled (Ogden & Carroll, 2010). A number of studies only determined simple relationships between childhood overweight and predictors. These studies did not show the relationship of multiple contexts simultaneously influencing obesity in children. It is extensively acknowledged that childhood obesity is resulted from a multifactorial etiology involving individuals and environmental factors (Center for Disease Control and Prevention [CDC], 2009). Therefore, the present research is needed to understand potential factors that contribute to the development of childhood obesity from multiple contexts that children live. Understanding these factors could increase our ability to manage the obesity problem for children.

C. **Significance of the Study**

This dissertation used two U.S. national data sets for data analysis. The first study used the NHANES which includes BMI information from a wild rank of age groups for analyzing the data. This data set allowed identifying subgroups of children who display different timing of AR by sex and race/ethnicity. This diverse AR timing could help health care providers develop a better understanding of AR period in the development of obesity by U. S. children. Also, this information would be useful in designing sex and race specific obesity prevention strategies for early age children. The second study used ECLS-B data set to identify contextual factors for the development of childhood overweight/obesity at multiple level of the ecological environment of the child. The ECLS-B data set included information from various sources that could influence child’s health outcomes including home and school settings. The rich information from this data set could provide comprehensive view relating to the development of childhood obesity. The findings from this study provide a better understanding of the multi-determinants of early
childhood obesity while providing a framework to foster a multilevel and multisector effort to prevent child from obesity.

D. Purpose of the Study

The purpose of this study was three-fold: (1) to identify the timing of AR for U.S. children using secondary analysis of a national survey data set, (2) to identify the contributing factors for early childhood overweight/obesity within the contexts of the child’s home, school, and community and, (3) to determine how much each of the ecological contexts contributes to childhood overweight/obesity.

E. Research Questions

The following research questions are posed:

1. What is the age of AR by sex and race for U.S. children?

2. What are the multi-determinants of early childhood overweight/obesity with in the context of home, child’s school, and community environments?

3. How much does each of the ecological contexts: home, school and community contribute to childhood overweight/obesity?
II. TIMING OF ADIPOSY REBOUND: A STEP TOWARD PREVENTING OBESITY

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A. Introduction

The prevalence of overweight children aged 2 to 19 years in the U.S. has increased approximately 3-4 times in the last 3 decades (Ogden & Carroll, 2010). Overweight prevalence has varied by racial/ethnic group and has been more prevalent among racial/ethnic minority children (Ogden, Carroll, & Flegal, 2008). To reduce obesity prevalence and prevent obesity-associated health problems, it is important to identify children at risk for future obesity and prevent obesity in early life.

One strategy to predict adult obesity is related to identification of the timing of adiposity rebound (AR). Researchers have shown that AR is a critical period for the development of adiposity that persists into later life (Adair, 2008; Dietz, 1994; Drohan, 2002; He & Karlberg, 2002; Rolland-Cachera et al., 1987, 2006). Usually, children’s BMI increases during the first year of life. After that, the BMI gradually decreases until it reaches the lowest point around 6 years of age before increasing again (Eisenmann, Heelan, & Welk, 2004; Rolland-Cachera, Deheeger, Maillot, & Bellisle, 2006; Rolland-Cachera et al., 1984; Williams, Davie, & Lam, 1999; Williams & Goulding, 2008; Williams, 2005). Age that the lowest point of BMI is reached is the start point of AR (Rolland-Cachera, Deheeger, Maillot, & Bellisle, 2006; Rolland-Cachera et al., 1984). A number of studies have shown that children who experience early age of AR (≤ 5–5.5 years) are at risk of being overweight adolescents (Rolland-Cachera et al., 1984) and adults (Freedman, Kettel
Khan, Sedula, Srinivasan, & Berenson, 2001; Pan et al., 2009; Whitaker, Pepe, Wright, Seidel, & Dietz, 1998; Williams, Davie, & Lam, 1999) compared with children with late age of AR ($\geq 7$ years). Early age of AR is also associated with the development of type 2 diabetes (Bharagava, et al., 2004; Eriksson, Forsén, Tumilehto, Osmand, & Barker, 2003).

The age of AR among U.S. children has been studied, but no research has used national data to estimate the age of AR. Previous studies about the timing of AR in the U.S. were based on local data and specific race/ethnicities (Freedman et al., 2001; Skinner, Bounds, Carruth, Morris, & Ziegler, 2003; Whitaker et al., 1998). Thus, the generalizability of the results from the previous studies of AR is limited. Therefore, the purpose of this study is to identify the timing of AR for U.S. children using a national survey data set, the National Health and Nutrition Examination Survey (NHANES). NHANES represents a diverse sample of the civilian, non-institutionalized U.S. population that allows identification of subgroups of children who display different timings of AR by gender and race/ethnicity. These diverse AR timings could help health care providers to develop a better understanding of this important period in the development of obesity by U.S. children. Also, this information would be useful in designing gender and race/ethnicity specific obesity prevention strategies for early aged children.

B. Background

1. AR Mechanism

AR is recognized as a period of rapid growth in body fat where adipocytes increase in both size and number (Rolland-Cachera et al., 1984). A number of studies have presented potential mechanisms underpinning the AR phenomenon that could contribute to the development of obesity. Taylor, Gouding, Lewis-Barned, and Williams (2004) used dual energy X-ray absorptiometry (DXA) to determine body composition in girls during AR. They found that
children with early age of AR had been shown to gain body fat more than two times faster than children with late age of AR (Taylor et al.). Changing BMI in children during AR was associated with increasing body fat rather than lean mass or slowing in rate of height gain (Taylor et al.). In a larger cohort, early age of AR was associated with greater subscapular and triceps thickness (Williams & Goulding, 2008). These findings suggested that early age of AR is associated with a change in body fat content. In short, children with early and late age of AR demonstrate different patterns of development. Early age of AR is driven by fat tissue rather than lean tissue. Rapid accumulation of body fat in children with early age of AR might contribute to the development of later obesity compared to children late age of AR.

Several factors have been reported as potentially contributing to an early age of AR. For example, in a study in the United Kingdom (UK) by Dorosty and colleagues (2000), early AR was associated with parental obesity (Dorosty, Emmett, Cowin, & Reilly, 2000). Adiposity rebound occurs earlier in children whose parents had high rather than low BMI. Janz and colleagues (2002) found that low levels of vigorous physical activity and high levels of television viewing are related to fatness in young children during the AR period. In a Finnish study (Eriksson et al., 2003), the age of AR was related to body size at 1 year. The age of AR occurred earlier in children who were thin at 1 year and had low weight gain during the first years of life. In addition, there was conflicting evidence for the relationship between high protein intakes and early AR. Rolland-Cachera, Deheeger, Akrout, and Bellisle (1995) found that high protein intake at age 2 increased body fatness at 8 years of age was associated with early AR in children. On the other hand, the relationship between high protein intake and early AR was absent in larger cohorts in the UK (Dorosty et al., 2000) and Germany (Gönther, Buyken, & Kroke, 2006). Gönther and colleagues found that a higher habitual protein intake between the ages of 1 and 2 was related to
higher BMI values at AR in girls only but not in boys. Taken together, it is possible that both genetic and behavioral factors might be involved in driving an early AR in children.

Although early AR associated with the development of future obesity was reported by many investigators, different opinions about AR have been presented in literature. Cole (2004) argued that AR is not considered a critical period for the development of future obesity. Early AR contributes to later obesity because it only reflects children with currently high BMI centiles and/or moving upwards across centiles on the BMI chart. Cole suggested that BMI centile crossing is a more direct indicator for predicting future obesity than age at AR and that this phenomenon can occur in any age, not just during the AR period. Rolland-Cachera and colleagues (2006), however, stated that children with early AR seem to have a normal or low adiposity level in early life before AR and developed fatness only from the timing of AR. A low BMI followed by high BMI after AR demonstrated the particular BMI trajectory of early AR. This pattern was associated with the development of coronary heart diseases and diabetes (Rolland-Cachera et al., 2006). Thus, Rolland-Cachera et al. (2006) recommended that AR should be used as an indicator for predicting adiposity. Williams and Goulding (2008) found a significant relationship between timing of AR and bone age at 7 years in boys. Boys with early AR had higher bone age than late AR > 6 months. Earlier age at AR was also associated with earlier menarche in girl (Williams & Dickson, 2002; Williams and Goulding, 2008). Hence, timing of AR could also be associated with both skeletal and physical maturation and not only obesity.

2. **Age at AR Identification Method**

AR has been defined using two indices: (1) the velocity of weight and height, and (2) serial measurement of BMI. First, weight and height velocities were used to identify the age at AR because the context of weight and height velocities could provide the rates of change in body
composition for children during the AR period. The age at AR was estimated using the velocity curve. AR occurs when the ratio of log (weight) to log (height) changes from <2 to > 2 (Taylor et al., 2004; Williams, 2005). Next, the longitudinal serial measurement of BMI has been the predominant measure in the literature. The BMI index was found to be correlated with percentage of body fat (% BF) and was appropriated to estimate body composition during the AR period (Eisenmann, Heelan, & Welk, 2004). With the BMI index, two methods are widely used to identify the age at AR: a visual inspection and application of a statistical model (Kroke, Hahn, Buyken, & Liese, 2006). Several published articles (Günther et al., 2006; Skinner et al., 2004) used the visual inspection method described by Rolland-Cachera et al. (1984) and Dorosty et al. (2000) to identify the age of AR where serial measurement of BMI values were plotted as a curve and the age at which the lowest value of BMI occurs is identified as the age of AR. To describing the upward trend and to avoid random fluctuations of BMI, additional criteria were applied in which the lowest point of the BMI needed to show an increase of at least equal to or exceeding 0.1 kg/m². When there is a plateau in the BMI-curve, the last value represents the AR (Dorosty et al., 2000). The application of a statistical model involves fitting the polynomial equations to the BMI data of the children and then the age at which AR is identified based on the minimum point of the fitted curve (Kroke et al., 2006; Whitaker et al., 1998). In the statistical model, three- or four-parameter polynomial equations were used to identify the age at AR. Three-parameter polynomial equations took the form of log (BMI) = β₀ + β₁ x age + β₂ x age² (Kroke et al., 2006). Four-parameter polynomial equations took the form of log (BMI) = β₀ + β₁ x age + β₂ x age² + β₃ x age³ (Kroke et al., 2006; Whitaker et al., 1998; Williams et al., 1999).

A visual inspection and statistical model approach each provides a different estimation of the age of AR. In Kroke and colleagues’ (2006) study, the visual inspection yielded higher
estimates of age at AR than a statistical model. Hence, when AR was estimated using different methods, it is difficult to compare and interpret results across different studies (Kroke et al., 2006). However, each approach has its own advantage. The visual-inspection approach reflects the physiological basis of the AR because this method includes criteria that identify the upward trend of BMI and has few missing values (Kroke et al., 2006). On the other hand, in statistical models, the age at AR is estimated as one minimum BMI point of the fitted curve without considering other conditions of AR, especially when a plateau occurs in the BMI-curve. As a result, statistical models might not be entirely adequate for reflecting the nature of AR and to determine the age at AR (Kroke et al., 2006). Nonetheless, statistical models are still useful for estimating the ages at AR when there are missing BMI values.

C. Materials and Methods

Data from the NHANES between 1999 and 2008 were used to identify the age at AR. NHANES is a national health survey conducted by the CDC National Center for Health Statistics (NCHS). This survey was designed to assess the health and nutritional status of the civilian non-institutionalized population of the United States. The survey includes face-to-face interviews and physical examinations for participants from a wide range of age groups and racial/ethnic backgrounds. The NHANES uses a stratified multistate design for sample selection. The target populations are over samples from certain groups, for example, low-income persons, adolescents 12 to 19 years of age, persons 60+ years of age, African Americans, and Mexican Americans, in order to improve stability of the statistical estimates for these groups. For NHANES 2007–2008, not only Mexican Americans but entire Hispanic populations were oversampled. This study used the socio-demographics and anthropometric data of NHANES 1999–2008 in children ages 2 to 10 years old ($N = 8,813$).
1. **Statistical Analysis**

In this study, children data from all five cycles of NHANES cross-sectional surveys, 1999–2000, 2001–2002, 2003–2004, 2005–2006 and 2007–2008, were combined. Kruskal-Wallis nonparametric test was used to compare BMI values from all survey rounds. The test results indicated that overall children data in the five surveys had the same median BMI ($x^2 = 9.45$ with 4 $df$, $p = 0.51$). Thus, all survey data were combined to increase sample size and produce greater statistical reliability. All children with missing BMI data were excluded from the analysis.

The complex survey design and unequal probabilities of sample selection in NHANES were taken into account for data analyses. Mean BMI was estimated by using the "svy" commands in the Stata software package, version 11 (Stata, College Station, TX). The series of mean BMI were plotted as a curve. The visual inspection method was used to identify the age at AR using the following criteria: (1) the lowest mean BMI of ages 2 to 10, (2) all subsequent mean BMIs after the lowest point showed an increase at least equal to or exceeding 0.1 kg/m² (Dorosty, et al., 2000; Rolland-Cachera et al., 2006), and (3) use of the last value when the mean BMI-curve has a flat shape (Kroke et al., 2006). For the purpose of this analysis, age at AR was identified using all participants while the age at AR by race/ethnicity was categorized as non-Hispanic White, non-Hispanic Black, and Mexican American. The samples from other races/ethnicities were excluded because they were too small for meaningful analysis.

D. **Results**

Participants were 50% male ($n = 4,433$) and 50% female ($n = 4,380$). Samples were 31% Mexican American ($n = 2,730$), 6% other Hispanic ($n = 535$), 29% non-Hispanic White ($n = 2,520$), 29% non-Hispanic Black ($n = 2,557$), and 5% other, including multiracial ($n = 471$). Age
at AR and mean BMI related to this age are presented in Table I. An average of the adiposity rebound in children occurred at age 5 years. Girls tended to rebound earlier than boys. Adiposity rebound occurred earlier in non-Hispanic Black children than in Mexican-American and non-Hispanic White children (Figure 1).

Mexican American children and non-Hispanic White children had the same age at AR (5 years). However, on average, Mexican American children were heavier than non-Hispanic White children at age at AR. Comparing the timing of AR among boys, non-Hispanic Black boys’ AR occurred earlier than Mexican American and non-Hispanic White boys (Figure 2). Although Mexican American and non-Hispanic White boys had the same age at AR (5 years), Mexican American boys also were found to be heavier than non-Hispanic White boys at age at AR. For girls, non-Hispanic Black girls reached AR earlier than Mexican American and non-Hispanic White girls respectively (Figure 3).

E. Discussion

This study reports different timings of AR in U.S. children by sex and race/ethnicity. Ages at AR of U.S. children have been reported in previous studies (Freedman et al., 2001; Skinner et al., 2004; Whitaker, 1998). This study was different from other studies of AR because it used population-based survey data that includes children of both sexes and from different racial/ethnic backgrounds rather than longitudinal local cohort data. These data allow investigations of subgroups of children who demonstrate different timings of AR.

The AR of children in this study occurred earlier than was reported in the retrospective cohort by Whitaker and colleagues (1998), who used a polynomial equation to identify the age at AR. Comparing cohorts born between January 1, 1965, and January 1, 1971 (390 subjects with mostly non-Hispanic White children) (Whitaker, 1998) and this study, the estimated age of AR
decreased slightly from 5.5 to 5 years. The results from this study were consistent with Whitaker’s study in which girls tended to reach AR earlier than boys. In Freedman and colleagues’ study (2001), age at AR was determined using BMI data of children ages 5, 6, 7, 8 from a longitudinal cohort. Freedman et al. reported that AR occurred at age $\leq 5$ from one half of 105 children (41% Black children). With the remaining children AR occurred at age 6 or $\geq 7$. Since the BMI values before the age of 5 were unknown, in about half of the children in Freedman and colleagues’ study, age at AR was earlier or the same as in this study.

Using a longitudinal study design, Skinner and colleagues (2003) determined the age at AR for 70 White children who were born in 1992 using the same method used in this study. The average ages at AR for White children in this study were higher than reported by Skinner and colleagues (4.5 years for females and 4.7 years for males) (2003). However, the AR of children in this study occurred earlier than the data reported from the Finnish study of 8,760 subjects who were born in 1934–1944 (age at AR= 5.8 years both in boys and girls) (Eriksson et al., 2003), the New Zealand study of 922 subjects who were born in 1972–1973 (age at AR = 6.3 years for boys and 5.6 years for girls) (Williams et al., 1998) and the German study of 313 children who were born in the early 1980s (age at AR = 5.6 years for boys and 5.2 years for girls) (Gönther et al., 2006). Age at AR varies across studies; a difference that might occur because of the population and the method used to assess the age at AR.

Given the absence of reported studies of age at AR by sex and race, it is of interest that the NHANES data revealed differences between the sexes and between races. In this study, the age of AR in U.S. children occurred slightly earlier in the current generation than in cohorts born in the 1960s. The changing age of AR might be the result of differences in biological, genetic, social, and environmental factors. The strength of this study is the use of national data, which provided a
large sample size and involved participants from different ethnic backgrounds, including non-Hispanic White, non-Hispanic Black, and Mexican American children as well as providing a national estimate for the U.S. population. Therefore, the findings may be generalizable to the population of U.S. children aged 2 to 10. The identification of age at AR based on sex and race/ethnicity in this study contribute to the better understanding of the different timing of obesity development among U.S. children.

This study identified that the age of AR was earlier in girls than in boys. Further study of girls during the AR period is suggested. In addition, it is possible that race/ethnicity might drive the very early timing of AR for some children. In this study, non-Hispanic Black children represented an earlier AR and might need special attention as a target group for intervention in the early years. Besides the age at AR, BMI related to timing of AR is also important. In this study, although Mexican American and non-Hispanic White children presented with the same age at AR, Mexican American children had higher BMIs than non-Hispanic White children during the AR period. Mexican American children being heavy at AR could pose a higher risk for adult obesity and also indicate a special need for intervention at an early age for children in this ethnic group. In addition, further study is needed to better understand the mechanisms or factors that influence the timing of AR differences by sex and race/ethnicity. In such studies, assessment and identification of potentially modifiable risk factors according to sex and race/ethnicity for the development of AR are needed in order to better understand this critical period and improve our ability to prevent or manage obesity in children. There are some limitations that need to be considered for this study. Since age at AR in this study did not derive from within-child comparisons, BMI levels across children might influence and vary with age at AR. In addition, the use of the cross-sectional survey data of this study was limited to determine factors that could
be associated with timing of AR. Thus, there is the need for future research to explore factors in both environmental and genetic factors that could be associated with this period.

F. Implications for Nursing Practice

Because obesity is one of the major national health problems for U.S. children, pediatric nurses in primary care and in schools can play important roles to address this problem. The evidence from tracking the timing of AR in this study demonstrates that children 3 to 5 years of age represent a critical period associated with early adiposity rebound. During the early childhood period, children experience adiposity rebound; nurses can help to identify children at risk for developing obesity and target the children in this group for obesity prevention, by regularly monitoring the child’s weight, height and BMI, especially in girls and racial/ethnic minority children. In clinical practice, body mass index-for-age percentile charts (children age 2 to 20 years) can be used to track the child’s BMI at multiple points in time during the AR period. By using this chart, nurses should consider both the child’s BMI trajectory and BMI centiles. Children who experience early age of AR and/or have high BMIs at age at AR need appropriate obesity prevention education. Nurses should work closely with children and their families to integrate active living and healthy dietary habits in their daily life. In particular, during the AR period, physical activity plays an important role for both boys and girls. Moore and colleagues (2003) found that children with a high level of physical activity experienced later AR compared with less active children. Active children also gained less body fat during childhood. Hence, promoting physical activities in children may delay the age AR and in turn prevent obesity and can reduce adverse health consequences in later life.

In conclusion, in this study, sex and racial/ethnic differences in adiposity rebound were identified at an early age. To address the obesity problem, it is important to start prevention and
intervention strategies in early childhood. Moreover, differences in timing of AR by sex and race/ethnicity should be considered in planning early and timely intervention efforts to prevent more effectively childhood obesity.
# TABLE I

## AGE AT ADIPOSITY REBOUND FOR U.S. CHILDREN BY RACE/ETHNICITY AND GENDER (NHANES 1999-2008)

<table>
<thead>
<tr>
<th>Race/Gender</th>
<th>Age at AR (years)</th>
<th>Mean BMI (kg/m²) ± SE</th>
<th>95% CI Lower Limit</th>
<th>95% CI Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys and girls combined</td>
<td>5</td>
<td>16 ± 0.3</td>
<td>15.3</td>
<td>16.7</td>
</tr>
<tr>
<td>Girls</td>
<td>4</td>
<td>15.9 ± 0.3</td>
<td>15.2</td>
<td>16.5</td>
</tr>
<tr>
<td>Boys</td>
<td>5</td>
<td>15.9 ± 0.2</td>
<td>15.4</td>
<td>16.4</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys and girls combined</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>3</td>
<td>15.7 ± 0.2</td>
<td>15.2</td>
<td>16.2</td>
</tr>
<tr>
<td>Mexican American</td>
<td>5</td>
<td>16 ± 0.2</td>
<td>15.5</td>
<td>16.5</td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>5</td>
<td>15.6 ± 0.4</td>
<td>14.7</td>
<td>16.4</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>4</td>
<td>15.9 ± 0.1</td>
<td>15.1</td>
<td>18</td>
</tr>
<tr>
<td>Mexican American</td>
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<td>16.2 ± 0.3</td>
<td>15.5</td>
<td>17</td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>5</td>
<td>15.4 ± 0.3</td>
<td>14.7</td>
<td>16</td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>3</td>
<td>15.6 ± 0.2</td>
<td>15.3</td>
<td>16.3</td>
</tr>
<tr>
<td>Mexican American</td>
<td>5</td>
<td>15.7 ± 0.3</td>
<td>15.1</td>
<td>16.4</td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>7</td>
<td>15.6 ± 0.4</td>
<td>14.9</td>
<td>16.4</td>
</tr>
</tbody>
</table>

NHANES = National Health and Nutrition Examination Survey  
CI = confidence interval  
BMI = Body Mass Index  
SE = standard error  
AR = adiposity rebound
Figure 1. Age at adiposity rebound for U.S. children by race/ethnicity (NHANES 1999-2008)

NHANES = National Health and Nutrition Examination Survey

Figure 2. Age at adiposity rebound for U.S. boys by race/ethnicity (NHANES 1999-2008)

NHANES = National Health and Nutrition Examination Survey
Figure 3. Age at adiposity rebound for U.S. girls by race/ethnicity (NHANES 1999-2008)

NHANES = National Health and Nutrition Examination Survey
III. ECOLOGICAL INFLUENCES OF EARLY CHILDHOOD OBESITY:  
A MULTI-LEVEL ANALYSIS

A. Introduction

Over the last 30 years, the prevalence of childhood obesity has increased substantially in the U.S. From 1976 to 2008, the prevalence of obesity in children ages 2 to 5 increased from 5% to 10.4% and for ages 6 to 11, from 6.5% to 19.6% (Ogden & Carroll, 2010). The growing rise in childhood obesity prevalence, especially in the younger age group, raises considerable concerns about the short- and long-term negative health consequences for these children (Daniels, 2006) because obese children are more likely to develop severe obesity and chronic diseases as adults (CDC, 2011a). To address the obesity problem, previous research has identified the period of adiposity rebound (AR) that occurs at five to seven years of age as one of the critical periods in developing obesity (Dietz, 1994; Drohan, 2002). Obesity occurring at this period appears to persist into adulthood and increase risk of obesity-related complications (Dietz, 1994). To prevent obesity and its health-related problems, it is critical that children in the AR period receive special attention, and that health care providers understand potential factors for the development of obesity and how to manage these factors in early life.

A number of studies have identified the influential factors for childhood overweight and obesity. These previous studies generally examined simple relationships between childhood obesity and predictors (Davison & Brich, 2001; Hawkins & Law, 2006). These studies could not yet show the significance of the child’s multiple ecological contexts, such as family, school, and community, and their simultaneous influence on early childhood obesity. It is extensively acknowledged that childhood obesity is the result of a multifactorial etiology involving individuals and environmental factors (CDC, 2011b). Therefore, it is important to understand potentially contributing factors in the development of childhood overweight and obesity from the
multiple contexts in which children live. The purpose of this study was to determine the contributing factors for childhood overweight/obesity at kindergarten entry within the contexts of the child’s home, school, and community and to determine the degree to which each ecological context contributes to childhood overweight/obesity.

The theoretical framework of this study was developed from the ecological systems theory (EST) (Bronfenbrenner, 1979, 1989). In the EST, Bronfenbrenner considers a person as being at the center of nested structures of the ecological environment: the micro-, meso-, exo-, and macrosystems. Change in one level of ecological system could affect the other levels and could influence a child’s developmental outcomes directly or indirectly through multiple contextual changes (Bronfenbrenner, 1979, 1989). For children, an ecological environment includes the family and school, which in turn is surrounded by larger social contexts, including the community and society at large (Davison & Brich, 2001). For this study, Figure 4 illustrates the application of EST to early childhood overweight/obesity to guide this research. It presents a model of the variables of interest based on the results of previous research assessing early childhood obesity in combination with EST. Variables of interest are conceptualized in the family, school, and the community environment.

B. **Materials and Methods**

The study adopted secondary data analysis of the data set from the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), sponsored by the U.S. Department of Education, National Center for Education Statistics (NCES). The ECLS-B is a nationally representative sample of children born in 2001 (Bethel, Green, Kalton & Nord, 2005). Data were collected in five data-collecting waves, starting the cohort when children were about nine months of age, and followed the children until they entered kindergarten. The ECLS-B uses a multistage, stratified,
clustered design for data collection (Bethel et al., 2005). Samples were selected from U.S. birth certificates. Certain populations were oversampled, including low birth weight, very low birth weight, twins, American Indian/Alaskan Native, Chinese, and Asian/Pacific Islanders (Nord, Edwards, Andreassen, Green & Wallner-Allen, 2006). In this study, to identify unique variables during the prenatal period, the first year of life, and kindergarten entry, cross-sectional data from birth certificates, nine-months, kindergarten-2006, and kindergarten-2007 waves were used. The nine-month wave (data collected in fall 2001–02) of the original study included about 10,700 children (Snow et al., 2009). In the kindergarten-2006 wave (2006–07 school year), about 7,000 children participated, and about 1,700 children participated in the kindergarten-2007 wave (2007–08 school year) (Snow et al., 2009). To be eligible for data analysis in this study, children could not have any missing information on body mass index (BMI) at kindergarten entry and for any of the explanatory variables. Children with missing data were excluded from the analysis. According to the ECLS-B restricted-use data license, the unweighted sample size number must be rounded to the nearest 50 (NCES, n.d.). As a result, the reported sample size is an approximated number. For this study, all information in ECLS-B data set was accessed under the University of Illinois at Chicago’s license agreement, license control number: 06081116.

1. **Outcome Variable**

Child weight status (overweight/obesity vs. nonoverweight/obesity) at kindergarten entry was used as an outcome variable. From the ECLS-B original study, all physical measurements were determined multiple times by trained interviewers using standardized protocols (Najarian, Snow, Lennon & Kinsey, 2010). To determine the child’s weight, the child took off shoes and wore light clothes to stand unassisted on the SECA® scale. The child’s weight was recorded in kilograms (kg). The child’s height was measured in
centimeters (cm) with a SECA® portable stadiometer. Data on both weight and height were recorded into computer assisted personal interviewing (CAPI). The mathematical average for weight and height were used to determine BMI using the following formula: \( \text{BMI} = \frac{\text{weight (kg)}}{[\text{height (cm)}]^2} \times 1000 \) (Najarian et al., 2010). In this study, children’s BMIs from the 2006 and 2007 kindergarten waves were combined. Two binary categories were used for children’s weight-status classifications using the BMI-for-age weight status categories from CDC. While children with BMIs less than 85th percentile were identified as nonoverweight/obese, children who had BMIs equal to the 85th percentile or equal to or greater than the 95th percentile were classified as overweight/obese.

2. **Explanatory Variables**

Explanatory variables were drawn from the children’s family and school variables. Family variables included (1) child’s characteristics and early life factors, (2) child’s factors during kindergarten, and (3) child’s family and parental factors. These data were collected from birth certificates and parent questionnaires from the nine-month, kindergarten 2006, and kindergarten 2007 waves. For data analysis, most explanatory variables drawn from the original ECLS-B data file were reclassified (see Table III). Children’s race was classified as White, Black, Hispanic (including both Hispanic, race specified, and no-race-specified groups), and other (including Asian; Native Hawaiian/other Pacific islander; American Indian/Alaska Native; and more than one race, non-Hispanic group). Maternal weight gain during pregnancy was classified into a binary categorical variable based on the Institute of Medicine (IOM) pregnancy weight guidelines (IOM, 2009). Maternal weight status was determined using weight information from the kindergarten wave; using CDC criteria (CDC, 2011c) weight status was classified into four BMI categories: underweight (below 18.5), normal weight (18.5–24.9), overweight (25.0–29.9).
and obese (30.0 and above). In the child’s school level, variables were extracted from the
Common Core of Data (CCD), which collected the various data from the public schools. The
school variables used for data analysis included: total numbers of students, pupil/teacher ratio,
school type, and school location (see Table III).

3. Statistical Analysis

Multilevel modeling was used for the data analysis. As suggested by the EST,
children (first level) were conceptualized as being nested within schools (second level), and then
nested within communities (third level). In this study, we included child characteristics and family
factors in first level because the majority of data was derived from only one child in the family.
To determine the variation in childhood overweight/obesity between communities, the Federal
Information Processing Standard (FIPS) county codes was used as a community variable.
Multilevel logistic regression was used to explain the binary child weight status using three
models. Model 1 was the empty/unconditional model, which had no predictor variable at any
level. The empty model was used to determine how variations in childhood overweight/obesity
could be contributed by the three different levels: child’s family, school, and community level.
Next, the conditional models were estimated in Model 2 and 3. In Model 2, the child’s family-
level variables were included as predictors in a series of multilevel logistic regression model. In
Model 3, both the child’s family- and school-level variables were included. The aim of the
conditional model was to identify the variations in childhood overweight/obesity between schools
and communities after controlling for the child’s family and school variables.

Multilevel logistic models were estimated using “xtmelogit” commands in the STATA
software package, version 11 (STATA, College Station, TX). The intra-class correlation
coefficient (ICC) and the variance decomposition were used to present the effect of the school and
community contexts on childhood overweight/obesity, adjusted for individual children’s families
and school variables. The ICC for the multilevel logistic regression model can be defined as

\[
\text{ICC} = \frac{\sigma}{(\sigma + \pi^2/3)},
\]

where \(\sigma\) is the school or community variance; \(\pi^2/3\) is the fixed valued for level-1 variance, the
child’s family-level variance, which is 3.29 (Goldstein, Browne & Rasbash, 2002). In multilevel
modeling, the variance was split to explain the variation in childhood overweight/obesity in each
level. The total variance in the three-level model is the sum of the variance components at all
three levels:

\[
\sigma = \frac{\pi^2}{3} + \sigma_A + \sigma_B
\]

where \(\sigma_A\) is the variance at the school level, and \(\sigma_B\) is the variance at the community level.

The children’s demographic characteristic statistics were estimated by applying the sampling
weight to the file; the results were presented in both weighted and unweighted information.

C. Results

After excluding children with missing values, the number of children was 2,100, the
number of schools was 1,742, and the number of counties was 533. The sample size per school
ranged from 1–5, with an average of 1.2; the sample size per community ranged from 1–71 with
an average of 3.91. At the cluster level, the sample size with one observation was 83.2% and 45%
at the school and community level respectively. The children’s ages ranged from 58.1 to 81.9
months (mean age = 68 months; standard deviation (SE) = 0.09). The sample characteristics are
presented in Table II. By applying sampling weight to the data analysis, more than half the
children were non-Hispanic White (51.9%), with 32.6 % classified as overweight/obese. 65% of
the parents had achieved a vocation/tech program/some college or higher. The majority of
children (73.5%) came from households with incomes of more than $25,000.
The estimated results of the three-level model, with school and community variations for childhood overweight/obesity, and the estimated effects of the explanatory variables are presented in Table III. The \( p \)-value for the Wald-Chi-square test (fixed effect parameters) in Models 2 and 3 were less than 0.0001, which indicated that significant amounts of variance in the childhood overweight/obesity were accounted for by the explanatory variables in the model. From random effect parameters, the \( p \)-values for the likelihood-ratio test were less than 0.001, 0.0013, and 0.0012 for Model 1, 2, and 3 respectively; these results indicated that the proportion of variation in childhood overweight/obesity varied significantly by school and community. In Model 1, the empty model, the estimated variances in childhood overweight/obesity were 1.31 \( (SE = 0.55) \) at the school level and 0.18 \( (SE = 0.10) \) (ICC: 0.28, 0.05) at the community level.

In the conditional models, Models 2 and 3, after adjusting for the children’s family-level and school-level factors, there remained less unexplained school- and community-level variation, but the remaining variations between the school and community levels were still significant at less than the 5% level. In Model 2, after adjusting for the children’s family-level factors, the total remaining variance in childhood overweight/obesity was 1.19 \( (SE = 0.55) \) at the school level and 0.12 \( (SE=0.1) \) at the community level; the explained variance for childhood overweight/obesity with the children’s family-level factors was 25.87% at the school level and 2.61% at the community level. In the Model 3, after adjusting for children’s family- and school-level factors, the total variance in childhood overweight/obesity was 1.24 \( (SE=0.56) \) at the school level and 0.11\( (SE=0.1) \) at the community; the explained variance of childhood overweight/obesity with children’s family-level and school-level factors was 26.72% at the school level and 2.37% at the community level. The variance composition at the children’s family level was 68.8% in Model 1, 71.52% in Model 2, and 70.91% in Model 3.
According to the estimated results of Model 2 and Model 3, the variation in childhood overweight/obesity was explained mainly by the child’s family-level factors, including the child’s race, birth weight, fruit-eating behavior, maternal weight gain during pregnancy, maternal weight status, and household income (see Table III). Children were more overweight/obese if they were Hispanic or other minority races, their birth weight was more than 4,000 grams, they ate fruit fewer than 2 times per day, the maternal weight gain during pregnancy was more than the IOM recommendation (2009), the maternal weight status was categorized in the overweight and obese group, and the household income was $25,000 or less. However, in Model 3, the child school characteristics of number of students, student/teacher ratio, school type, and school location were not significant.

D. Discussion

This study reported the influencing factors for early childhood overweight/obesity within the contexts of the child’s home, school, and community. According to the results from the fixed effects part, factors that explained the variation in children’s weight status in this study were found to be consistent with the previous research on early childhood obesity. Hispanic children (Maher, Li, Carter, & Johnson, 2008; Salsberry & Reagan, 2005) were more likely to be overweight or obese than White children. High maternal weight gain during pregnancy (Li, Goran, Kaur, Nollen, & Ahluwalia, 2007) and high birth weights for the children were related to weight gain during the early childhood period (Dubois & Girard, 2006; Li et al., 2007; Maher et al., 2008). Children of overweight or obese parents were at increased risk for overweight or obesity (Dorosty, Emmett, Cowin, & Reilly, 2000; Dubois & Girard, 2006; Fernald & Neufeld, 2007; He, Ding, Fong, & Karlberg, 2000; Jouret et al., 2007). In addition, low household income also contributed to higher BMI in children (Maher et al., 2008) due to the limitations in resources.
and accessibility to affordable healthy foods.

The findings from this study confirmed the results of previous research about the influential factors for early childhood obesity and support the implementation of an existing guideline to prevent childhood obesity. Maternal weight and maternal weight gain during pregnancy were significantly related to childhood overweight/obesity at kindergarten entry. To prevent a child from having a weight problem, maternal weight gain during the pregnancy period should be monitored. Appropriate health education to prevent excessive weight gain should be provided for pregnant woman in order to maintain weight gain within the normal range based on IOM’s (2009) gestational weight guidelines. In addition, because mothers can play a critical role in children’s nutrition and can be role models for children’s eating and exercise behaviors, maternal weight problems can influence a child’s weight status. Thus, it is important for health care professionals to assess the dietary and physical activity of the family and design family interventions that include both mother and child in the intervention programs. In addition, the findings indicated that children from low income and/or ethnic minority families experience significantly greater risk of overweight/obesity. Thus, tailored health care interventions, that promote healthy nutrition and physical activity from an early age, should focus on children within these groups in order to prevent children developing weight problems and help them to achieve healthy weight status. This study also found that children who ate fruit fewer than two times per day were more likely to be overweight/obese. As a result, promoting children’s consumption of a diet rich in nutritional foods, such as fruit, might decrease the child’s risk of overweight/obesity.

The findings from the random effect part indicated that after adjusting for the children’s family factors, the variations in childhood overweight/obesity between school and community level were still significant. This result suggests that the variation in childhood overweight/obesity
between school and community level can be explained by a child’s family-level factors. Still, the children’s family factors explained the largest amount of variance in childhood overweight/obesity at kindergarten entry. However, the findings from this study still suggest the importance of the school environment in addressing the early childhood overweight/obesity problem. Although, when entering kindergarten children were partially exposed to school environments, school still explained almost 27% of a child’s weight status, even after controlling for the child and family factors. While analysis with the ECLS-B could not identify potential factors to explain the variation in childhood overweight/obesity at the school level, it is still important to explore more school factors associated with early childhood overweight/obesity. Understanding factors for childhood overweight/obesity during the early period of life in the school context might help health care providers to manage weight problem in younger children.

This study has identified various factors influencing children’s weight status; however some limitations still need to be considered. Early childhood is an important period when children start to be exposed to multiple outside environments other than family, and there are multiple players influencing the child’s body weight. These players include childcare providers both in centers and in other environments such as home care. This study still could not identify all the ecological contexts such as child care centers that could simultaneously influence early childhood obesity because of the limitation of data. In addition, the study could not include important measures for examining school and community effects on early childhood overweight/obesity. At the school level, domains such as physical education, school meals/snacks, school resources (e.g., playgrounds) and school programs that could help to promote good eating habits and active lifestyles for children need to include in the model. Because of these limitations, we could not identify school factors that can help to prevent obesity in children. At the community level,
contextual factors such as the availability and accessibility to a safe park or playground, safe sidewalks, paths, and trails; and accessibility to healthy food in the community were not included in the ECLS-B survey. Therefore, future research needs to explore the extended components of both school and community to explain the variation in early childhood overweight/obesity between schools and communities.

This study has identified influential factors for early childhood obesity by conceptualizing the development of childhood obesity within an ecological framework and applying multilevel modeling to explain the effect of each ecological context on childhood obesity. To the best of the researcher’s knowledge, there is no previous published research using multilevel modeling to study early childhood overweight/obesity in multiple ecological contexts simultaneously. Previous researchers (Li, Law, Conte, & Power, 2009; Ong, Preece, Emmett, Ahmed, & Dunger, 2002; Perez-Pastor et al., 2009) used multilevel modeling focused more on individual child and family context factors; these studies did not include non-family factors in the analysis. The current study included both family and non-family context factors in the model, which allowed us to concurrently determine the fixed effects and random effects of school and community on children’s weight status. This modeling also allows us to examine how each ecological environment explains overweight/obesity in young children. These advantages help us to determine the relative importance of each ecological level for early childhood obesity, which assists decision makers to allocate resources and prioritize various ecological-level interventions to prevent childhood obesity.

In conclusion, the findings from this study indicated that all three levels of children’s ecological environments explained early childhood overweight/obesity and provided rational for multilevel obesity interventions for young children. The early childhood period is an important
period of growth related to the timing of adiposity rebound. Children are also in the transition period between early childcare providers and school. They might be exposed to multiple childcare providers and educators and to different kinds of environment at the same time. Therefore, it is important to understand how all ecological contexts work together to influence early childhood overweight/obesity. From the study findings, multiple contexts explained early childhood overweight/obesity. As a result, to prevent childhood obesity, there is a need for multisector, multidisciplinary collaboration to identify the childhood obesity problem and design interventions to be implemented in multiple contexts that affect children, especially in the at-risk group.

Obesity-prevention interventions need to expand to target not only individual, child, or family levels, but also the children’s other contexts.
Figure 4. Ecological Systems Theory as Applied to This Study
TABLE II

CHILD’S DEMOGRAPHIC CHARACTERISTICS

<table>
<thead>
<tr>
<th>Demographic characteristics</th>
<th>Unweighted (%)</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
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</tr>
<tr>
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<td>50</td>
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</tr>
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<tr>
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<td></td>
</tr>
<tr>
<td>White</td>
<td>41.3</td>
<td>51.9</td>
</tr>
<tr>
<td>Black or African American</td>
<td>11.7</td>
<td>10.6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>23.4</td>
<td>29.8</td>
</tr>
<tr>
<td>Others</td>
<td>23.4</td>
<td>7.6</td>
</tr>
<tr>
<td><strong>Parents’ highest education level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>8.1</td>
<td>10.7</td>
</tr>
<tr>
<td>High school diploma/Equivalent</td>
<td>21.8</td>
<td>24.1</td>
</tr>
<tr>
<td>Vocation/Tech program/Some college</td>
<td>30.6</td>
<td>32.3</td>
</tr>
<tr>
<td>Bachelor’s degree and higher degrees</td>
<td>39.5</td>
<td>32.8</td>
</tr>
<tr>
<td><strong>Household income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$25,000 or less</td>
<td>23.7</td>
<td>26.5</td>
</tr>
<tr>
<td>$25,001 or more</td>
<td>76.3</td>
<td>73.5</td>
</tr>
<tr>
<td><strong>Child’s obesity status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight/Obese</td>
<td>31.2</td>
<td>32.6</td>
</tr>
<tr>
<td>Other</td>
<td>68.7</td>
<td>67.4</td>
</tr>
</tbody>
</table>

N = 2,100.
**TABLE III**

ADJUSTED ODD RATION (95% CONFIDENCE INTERVAL) OF THE THREE-LEVEL, MULTILEVEL LOGISTIC REGRESSION MODEL FOR OVERWEIGHT/OBESITY AT KINDERGARTEN ENTRY

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Child and family factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Child’s characteristics and early life factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>2.16 (0.88, 5.32)</td>
<td>2.15 (0.86, 5.34)</td>
<td></td>
</tr>
<tr>
<td>Black/African American</td>
<td>1.81* (1.20, 2.71)</td>
<td>1.91* (1.26, 2.89)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>1.61* (1.01, 2.56)</td>
<td>1.64* (1.02, 2.62)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s birth weight (grams)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 2500 grams</td>
<td>0.50* (0.37, 0.69)</td>
<td>0.5* (0.36, 0.69)</td>
<td></td>
</tr>
<tr>
<td>≥2500 - &lt; 4000 grams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥4000 and More</td>
<td>2.02* (1.21, 3.35)</td>
<td>2.02* (1.21, 3.37)</td>
<td></td>
</tr>
<tr>
<td>Breast-fed (Months)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4 months</td>
<td>1.16 (0.84, 1.6)</td>
<td>1.17 (0.85, 1.61)</td>
<td></td>
</tr>
<tr>
<td>≥4 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age first fed formula (Months)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4 months</td>
<td>0.92 (0.65, 1.3)</td>
<td>0.92 (0.65, 1.3)</td>
<td></td>
</tr>
<tr>
<td>≥4 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solid food introduction (Months)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4 months</td>
<td>1.30 (0.94, 1.79)</td>
<td>1.29 (0.94, 1.78)</td>
<td></td>
</tr>
<tr>
<td>≥4 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age given finger food (Months)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 4 months</td>
<td>3.16 (0.95, 10.48)</td>
<td>3.11 (0.94, 10.41)</td>
<td></td>
</tr>
<tr>
<td>≥4 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Put child into bed with bottle?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.94 (0.72, 1.22)</td>
<td>0.93 (0.71, 1.22)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Child’s factors during kindergarten</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soda daily?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0.95 (0.70, 1.28)</td>
<td>0.95 (0.70, 1.29)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit 2 times or more per day?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.40* (1.08, 1.81)</td>
<td>1.4* (1.08, 1.81)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fast food daily?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>0.88 (0.50, 1.54)</td>
<td>0.9 (0.51, 1.58)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participated in athletic activities?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.89 (0.68, 1.17)</td>
<td>0.89 (0.8, 1.17)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
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</tbody>
</table>
## Fixed effects

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participated in dance lessons?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.18 (0.89, 1.58)</td>
<td>1.19 (0.89, 1.59)</td>
<td></td>
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<tr>
<td>Child’s sleeping hours?</td>
<td>0.9 (0.77, 1.05)</td>
<td>0.9 (0.77, 1.06)</td>
<td></td>
</tr>
<tr>
<td>Child’s family and parental factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race of mother</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>0.65 (0.28, 1.48)</td>
<td>0.7 (0.30, 1.62)</td>
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<tr>
<td>Other</td>
<td>0.90 (0.57, 1.43)</td>
<td>0.90 (0.57, 1.43)</td>
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<tr>
<td>Maternal weight gain during pregnancy over IOM recommendation?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.32* (1.02, 1.71)</td>
<td>1.32* (1.02, 1.71)</td>
<td></td>
</tr>
<tr>
<td>Parents’ highest education level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>1.37 (0.84, 2.25)</td>
<td>1.35 (0.82, 2.23)</td>
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</tr>
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<td>High school diploma/Equivalent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocation/Tech program/Some college</td>
<td>1.18 (0.83, 1.68)</td>
<td>1.19 (0.83, 1.71)</td>
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<tr>
<td>Bachelor’s degree or higher degrees</td>
<td>1.2 (0.81, 1.78)</td>
<td>1.24 (0.83, 1.84)</td>
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</tr>
<tr>
<td>Household income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$25,000 or less</td>
<td>1.41* (1.01, 1.98)</td>
<td>1.41* (1.01, 1.99)</td>
<td></td>
</tr>
<tr>
<td>$25,001 or more</td>
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<td></td>
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<tr>
<td>Primary language of family</td>
<td></td>
<td></td>
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<tr>
<td>English</td>
<td>1.23 (0.86, 1.76)</td>
<td>1.29 (0.89, 1.87)</td>
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</tr>
<tr>
<td>Other languages</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Eating dinner as a family daily?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.20 (0.93, 1.55)</td>
<td>1.22 (0.94, 1.57)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother/female guardian-work status</td>
<td></td>
<td></td>
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<tr>
<td>35 hours or more per week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fewer than 35 hours per week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Looking for work</td>
<td>0.89 (0.49, 1.62)</td>
<td>0.90 (0.5, 1.64)</td>
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<tr>
<td>Not in the labor force</td>
<td></td>
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<tr>
<td>Maternal weight status (kindergarten wave)</td>
<td></td>
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</tr>
<tr>
<td>Underweight</td>
<td>0.43 (0.14, 1.36)</td>
<td>0.42 (0.13, 1.33)</td>
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<tr>
<td>Normal weight</td>
<td></td>
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<tr>
<td>Overweight</td>
<td>1.58* (1.15, 2.18)</td>
<td>1.57* (1.14, 2.16)</td>
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<tr>
<td>Obese</td>
<td>2.89* (2.04, 4.08)</td>
<td>2.85* (2.02, 4.04)</td>
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<tr>
<td>School factors</td>
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<tr>
<td>Total student, all grades</td>
<td>1.00 (0.999, 1.00)</td>
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<td></td>
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<tr>
<td>Pupil/teacher ratio</td>
<td>1.00 (0.97, 1.03)</td>
<td></td>
<td></td>
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<tr>
<td>School type</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Regular school</td>
<td></td>
<td></td>
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<tr>
<td>Other</td>
<td>4.32 (0.2, 95.39)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------</td>
<td>--------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td><strong>School location</strong></td>
<td></td>
<td></td>
<td>0.78 (0.57, 1.08)</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td>0.78 (0.57, 1.08)</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td>0.78 (0.57, 1.08)</td>
</tr>
<tr>
<td><strong>Random effects</strong></td>
<td></td>
<td></td>
<td>0.78 (0.57, 1.08)</td>
</tr>
<tr>
<td><strong>Variance (SE)</strong></td>
<td></td>
<td></td>
<td>0.78 (0.57, 1.08)</td>
</tr>
<tr>
<td>School level</td>
<td>1.31 (0.55)</td>
<td>1.19 (0.55)</td>
<td>1.24 (0.56)</td>
</tr>
<tr>
<td>Community level</td>
<td>0.18 (0.10)</td>
<td>0.12 (0.1)</td>
<td>0.11 (0.1)</td>
</tr>
<tr>
<td><strong>ICC</strong></td>
<td>0.28</td>
<td>0.27</td>
<td>0.27</td>
</tr>
<tr>
<td>School level</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Community level</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Variance decomposition (percentage by level)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s family level</td>
<td>68.83%</td>
<td>71.52%</td>
<td>70.91%</td>
</tr>
<tr>
<td>School level</td>
<td>27.41%</td>
<td>25.87%</td>
<td>26.72%</td>
</tr>
<tr>
<td>Community level</td>
<td>3.77%</td>
<td>2.61%</td>
<td>2.37%</td>
</tr>
<tr>
<td><strong>Model fit statistics</strong></td>
<td></td>
<td></td>
<td>0.78 (0.57, 1.08)</td>
</tr>
<tr>
<td>Wald test $X^2$ (df)</td>
<td>-</td>
<td>91.6 (31)</td>
<td>91.73 (35)</td>
</tr>
<tr>
<td>Prob&gt;chi</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>LR test vs. logistic regression $p$ value</td>
<td>&lt;0.0001</td>
<td>0.0013</td>
<td>0.0012</td>
</tr>
</tbody>
</table>

*p*<0.05  
N=2,100  
SE = Standard error  
df = Degree of freedom
CITED LITERATURE


APPENDICES
APPENDIX A

University of Illinois at Chicago IRB Approval letter

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (OVCR)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7127

Exemption Granted

November 2, 2010

Wannaporn Boonpleng, MSN
Health Systems Science
845 S Dusable Ave, 1142 NURS
M/C 802
Chicago, IL 60612
Phone: (312) 996-7061 / Fax: (312) 996-8945

RE: Research Protocol # 2010-0598
"Ecological Influences of Early Childhood Obesity: A Multi-level Analysis"

Dear Wannaporn Boonpleng:

Your Claim of Exemption was reviewed on November 2, 2010 and it was determined that your research meets the criteria for exemption. You may now begin your research.

Please note the following regarding your research:

Exemption Period: November 2, 2010 – November 1, 2013
Sponsor: None
Performance Site(s): UIC
Subject Population: Existing de-identified ECLS-B data set.
Number of Subjects: 14,000

The specific exemption category under 45 CFR 46.101(b) is:
(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy. Please be aware of the following UIC policies and responsibilities for investigators:

1. Amendments You are responsible for reporting any amendments to your research protocol that may affect the determination of the exemption and may result in your research no longer being eligible for the exemption that has been granted.

2. Record Keeping You are responsible for maintaining a copy all research related records in a secure location in the event future verification is necessary, at a minimum these documents

Phone: 312-996-1711 http://www.uic.edu/depts/ovcr/irb/ Fax: 312-413-2929
APPENDIX A (continued)

University of Illinois at Chicago IRB Approval letter

include: the research protocol, the claim of exemption application, all questionnaires, survey instruments, interview questions and/or data collection instruments associated with this research protocol, recruiting or advertising materials, any consent forms or information sheets given to subjects, or any other pertinent documents.

3. Final Report When you have completed work on your research protocol, you should submit a final report to the Office for Protection of Research Subjects (OPRS).

Please be sure to:

➔ Use your research protocol number (2010-0598) on any documents or correspondence with the IRB concerning your research protocol.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact the OPRS office at (312) 996-1711 or me at (312) 355-2908. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

Charles W. Hochhae, B.S., C.I.P.
Assistant Director, IRB # 2
Office for the Protection of Research Subjects

Enclosure(s): None

cc: Agatha Gallo, Health Systems Science, M/C 802
    Rosemary White-Trad, Nursing, M/C 802
University of Illinois at Chicago IRB Approval letter

APPENDIX A (continued)

University of Illinois at Chicago

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
200 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

Exemption Determination
Amendment to Research Protocol – Exempt Review
UIC Amendment # 1

September 8, 2011

Wannaporn Boonpleng, MSN
Health Systems Science
845 S Damen Ave, 1142 NURS
M/C 802
Chicago, IL 60612
Phone: (312) 996-7061 / Fax: (312) 996-8945

RE: Protocol # 2010-0598
“Ecological Influences of Early Childhood Obesity: A Multi-level Analysis”

Dear Wannaporn Boonpleng:

The OPRS staff/members of Institutional Review Board (IRB) #2 have reviewed this amendment to your research, and have determined that your research protocol continues to meet the criteria for exemption as defined in the U. S. Department of Health and Human Services Regulations for the Protection of Human Subjects [(45 CFR 46.101(b)].

The specific exemption category under 45 CFR 46.101(b) is:
(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

You may now implement the amendment in your research. Please note the following information about your approved amendment:

Exemption Approval Period: September 7, 2011 – September 6, 2014
Amendment Approval Date: September 7, 2011

Amendment:
Summary: UIC Amendment #1, dated and received August 30, 2011, involves the expansion of the ECLS-B data set being analyzed from 9 months through 2 years to 9 months through kindergarten (ages around 6-6 years). The research protocol (version 2, August 30, 2011) has been updated to reflect the proposed change.

Phone: 312-996-1711  http://www.uic.edu/depts/ovcr/oprs/  FAX: 312-413-2929
APPENDIX A (continued)

University of Illinois at Chicago IRB Approval letter

Page 2 of 2

You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy. Please be aware of the following UIC policies and responsibilities for investigators:

1. Amendments You are responsible for reporting any amendments to your research protocol that may affect the determination of the exemption and may result in your research no longer being eligible for the exemption that has been granted.

2. Record Keeping You are responsible for maintaining a copy all research related records in a secure location in the event future verification is necessary, at a minimum these documents include: the research protocol, the claim of exemption application, all questionnaires, survey instruments, interview questions and/or data collection instruments associated with this research protocol, recruiting or advertising materials, any consent forms or information sheets given to subjects, or any other pertinent documents.

3. Final Report When you have completed work on your research protocol, you should submit a final report to the Office for Protection of Research Subjects (OPRS).

Please be sure to:

► Use your research protocol number ( 2010-0598 ) on any documents or correspondence with the IRB concerning your research protocol.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact me at (312) 355-1404 or the OPRS office at (312) 996-1711. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

[Signature]

Sheilah R. Graham, BS
IRB Coordinator, IRB # 2
Office for the Protection of Research Subjects

cc: Arlene Miller, PhD, RN, Health Systems Science, M/C 802
Agatha M. Gallo, Faculty Sponsor, M/C 802
APPENDIX A (continued)

University of Illinois at Chicago IRB Approval letter

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 472)
203 Administrative Office Building
1737 West Palk Street
Chicago, Illinois 60612-7227

Exemption Determination
Amendment to Research Protocol – Exempt Review
UIC Amendment # 2

January 25, 2012

Wannaporn Boonpleng, MSN
Health Systems Science
845 S Damen Ave, 1142 NURS
M/C 802
Chicago, IL 60612
Phone: (312) 996-7061 / Fax: (312) 996-8945

RE: Protocol # 2010-0598
“Ecological Influences of early Childhood Obesity: A Multi-level Analysis”

Dear Wannaporn Boonpleng:

The OPRS staff/members of Institutional Review Board (IRB) #2 have reviewed this amendment to your research, and have determined that your research protocol continues to meet the criteria for exemption as defined in the U. S. Department of Health and Human Services Regulations for the Protection of Human Subjects [(45 CFR 46.101(b)).

The specific exemption category under 45 CFR 46.101(b) is:
(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

You may now implement the amendment in your research.

Please note the following information about your approved amendment:

Amendment Approval Date: January 25, 2012
Amendment: Summary: UIC Amendment #2 dated January 17, 2012 and submitted to OPRS on January 18, 2012 is an investigator-initiated amendment indicating that the research will be sponsored by Sigma Theta Tau International, Alpha Lambda Chapter.

Phone: 312-996-1711 http://www.uic.edu/depts/ovcr/oprs/ FAX: 312-413-2929
You are reminded that investigators whose research involving human subjects is determined to be exempt from the federal regulations for the protection of human subjects still have responsibilities for the ethical conduct of the research under state law and UIC policy. Please be aware of the following UIC policies and responsibilities for investigators:

1. **Amendments** You are responsible for reporting any amendments to your research protocol that may affect the determination of the exemption and may result in your research no longer being eligible for the exemption that has been granted.

2. **Record Keeping** You are responsible for maintaining a copy all research related records in a secure location in the event future verification is necessary, at a minimum these documents include: the research protocol, the claim of exemption application, all questionnaires, survey instruments, interview questions and/or data collection instruments associated with this research protocol, recruiting or advertising materials, any consent forms or information sheets given to subjects, or any other pertinent documents.

3. **Final Report** When you have completed work on your research protocol, you should submit a final report to the Office for Protection of Research Subjects (OPRS).

Please be sure to:

- Use your research protocol number (2010-0598) on any documents or correspondence with the IRB concerning your research protocol.

We wish you the best as you conduct your research. If you have any questions or need further help, please contact me at (312) 355-2908 or the OPRS office at (312) 996-1711. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,

[Signature]

Charles W. Hoehn, B.S., C.I.P.
Assistant Director, IRB # 2
Office for the Protection of Research Subjects

cc: Arlene Miller, Health Systems Science, M/C 802
    Agatha M. Gallo, Health Systems Science, M/C 802
Notice of Determination of Human Subject Research

June 25, 2010

Wannaporn Boonpleng, BSN
Women, Child, & Family Health Science
845 S Damen Ave, 1142 NURS
M/C 802
Chicago, IL 60612
Phone: (312) 996-7061 / Fax: (312) 996-8945

RE: Protocol # 2010-0569
Adiposity Rebound for United States' Children

Dear Ms Boonpleng:

☒ The UIC Office for the Protection of Research Subjects received your “Determination of Whether an Activity Represents Human Subjects Research” application, and has determined that this activity DOES NOT meet the definition of human subject research as defined by 45 CFR 46.102(f).

You may conduct your activity without further submission to the IRB.

If this activity is used in conjunction with any other research involving human subjects or if it is modified in any way, it must be re-reviewed by OPRS staff.
APPENDIX B

ECLS-B Training certificate

This certifies that

Wannaporn Boonpleng

has satisfactorily completed a training program on the

Early Childhood Longitudinal Study - Birth Cohort (ECLS-B)

Date

January 22, 2010

Gail M. Mulligan
Director, Data User Training Program

Stuart Kaczelysky, Ph.D.
Acting Commissioner, NCES
VITA

NAME Wannaporn Boonpleng

CURRENT POSITION
2000-Present Faculty, Boromarajonani College of Nursing, Nonthaburi
Nonthaburi, Thailand.

EDUCATION AND TRAINING
2008-2012 PhD in Nursing Science.
University of Illinois at Chicago, College of Nursing, Chicago, Illinois.
2006-2008 MS in Nursing Science.
University of Illinois at Chicago, College of Nursing, Chicago, Illinois.
1996-2000 BSN in Nursing
Boromarajonani College of Nursing, Saraburi. Saraburi, Thailand

HONORS AND AWARDS
2008, 2011 Virginia M. Ohlson Scholarship Award, College of Nursing, University of
Illinois at Chicago
2011 Graduate Research Award, Sigma Theta Tau International, Alpha Lambda
Chapter

PROFESSIONAL MEMBERSHIPS
2010-Present Member, of Sigma Theta Tau International
2008-2010 Member, Midwest Nursing Research Society
2000-Present Member, Thailand Nursing and Midwifery Council

PROFESSIONAL ACTIVITIES

College Service
2000-2006 Committee of Student Affairs, Boromarajonani College of Nursing,
Nonthaburi, Thailand
2000-2006 Committee of Fundamental Nursing Practice Department, Boromarajonani
College of Nursing, Nonthaburi, Thailand
2002-2006 Committee of Thai Arts and Culture Division (preserve Thai arts and
culture with an integrated use of Thai local wisdom for sustaining healthy
society), Boromarajonani College of Nursing, Nonthaburi, Thailand
2010-2012 College of Nursing Research Committee Representative, Graduate Student
Nurses Organization, University of Illinois at Chicago, Chicago, Illinois
Clinical Appointments
2000-2006  Clinical Supervisor, Surgical and Medical Ward, Pranangklao Hospital, Nonthaburi, Thailand
2004-2006  Clinical Supervisor, Community Health Care Center, Nonthaburi, Thailand

Teaching Appointments
2000-2006  Clinical Preceptor for Undergraduate Nursing Students. Boromarajonani College of Nursing, Nonthaburi, Thailand
2000-2006  Lecturer for Fundamental Nursing and for Health Promotion and Disease Prevention Nursing. Boromarajonani College of Nursing, Nonthaburi, Thailand

Continuing Education


Volunteer Service
2006-2010  Health Fair Screenings, Wat Thammaram, Chicago, Illinois
2008-2010  Health Fair Screenings for School Children, Josephinium Academy, Chicago, Illinois
2006-2008  Height and Weight Screenings for School Children, McAuliff Elementary school, Chicago, Illinois

Publications

PRESENTATIONS
