Role of Community on Overweight/Obese Trajectories during Early Childhood

Hyojun Park, MA
Department of Population Health Sciences
University of Wisconsin-Madison

Abstract (150)

The aims of this study are to determine the trajectories of obesity during early childhood, to identify the risk factors associated with the trajectories, and to examine how the community influences on the onset of obesity during early childhood. Data were from the Early Childhood Longitudinal Study, Birth Cohort and the *County Health Rankings*, nationally representative data at the individual and county level, respectively. Parametric survival modeling that account for multilevel structure and complex survey design shows that the baseline hazard of being overweight and obese (OW/OB) was the highest at 10 months, but decreased throughout early childhood. Black children and children with overweight mothers were more likely to experience the earlier onset of OW/OB, whereas children born VLBW and with moderate weight gain mothers experienced the delayed onset of OW/OB. Children born in counties with a worse health behaviors score experienced the *earlier* onset of obesity than their counterparts.

Introduction

Childhood obesity is one of the most salient health problems in the United States (CDC, 2011; Koplan, Liverman, & Kraak, 2005). Despite ample research on the adult obesity epidemic that covers obesity trajectories and risk factors associated with adult obesity in the United States, little research focused on the childhood obesity trajectory and its association with other covariates during the early life course, which is the gap to be overcome. Understanding the natural history of obesity and the role of other risk factors during the early childhood is very crucial due to the considerable impact of obesity epidemic in the current era and its implication in the life course perspectives.

The aims of this study are to determine the trajectories of obesity hazard during early childhood, to identify the risk factors associated with the onset of obesity, and to examine how the community influences on the onset of obesity during early childhood. The successful completion of this study will advance obesity research by filling the currently existing knowledge gaps, and provide empirical evidence about the onset, trajectories, and risk factors of the childhood obesity epidemic.

Literature review

Researchers have revealed the trend of obesity is uprising over time (Mokdad et al., 2001; Mokdad et al., 1999, 2000). Not only the increase has grown larger over time, but also disparities exist among minority groups (Lee, Lee, Guo, & Harris, 2011; Moss & Yeaton, 2011)). However, given the lack of biological data at a population level, the effect of biological variations is reflected in birth characteristics such as sex, race/ethnicity, birth weight, and other birth outcomes. The impact of adverse birth outcomes (e.g., low birth weights (LBW)) on childhood obesity is known as threefold (e.g., critical period or accumulation

model, or weathering or fetal-origin hypothesis). Firstly, LBW is positively associated with childhood obesity in that the brains of nutritionally deprived LBW infants are programmed to eat more by having fewer pathways for signaling fullness in the brain region that controls appetite that known as a fetal-origin hypothesis (Desai & Ross, 2011). Secondly, LBW is positively associated with later insulin resistance, hypertension and cardiovascular disease that are associated with obesity (e.g., weathering, critical period or accumulation models) (Gluckman, Hanson, Cooper, & Thornburg, 2008). Thirdly, accelerated weight gain in early childhood is also positively associated with childhood obesity (Casey et al., 2012). In the cross-sectional studies from Argentina and Australia at the population level, however, the association between LBW and childhood obesity was not empirically found (Hirschler, Bugna, Roque, Gilligan, & Gonzalez, 2008; Oldroyd, Renzaho, & Skouteris, 2011).

Methods

Data were from the Early Childhood Longitudinal Study, Birth Cohort (n=10,700) (ECLS-B) and the 2010 *County Health Rankings* (the *Rankings*), nationally representative data at the individual and county level, respectively. Dependent Variable was the duration of time for overweight/obese (OW/OB) onset. Independent variables and covariates include prenatal, demographic, birth outcomes, and county level composite scores (listed in Table 2). County level composite scores for health behaviors (HB), clinical care (CC), social and economic factors (SF), and physical environment (PE) come from the 2010 *Rankings*, which were calculated as the weighted sum of standardized measures. Several parametric survival models on τ_j were compared to determine the best-fit baseline hazard of overweight/obese during early childhood. The specific model specification is

$\ln(t_i) = x_j\beta_x + \ln(\tau_j),\ \tau_j = \exp(-x_j\beta_x)\,t_j$, where the distribution of τ_j determines the functional form of the baseline hazard.

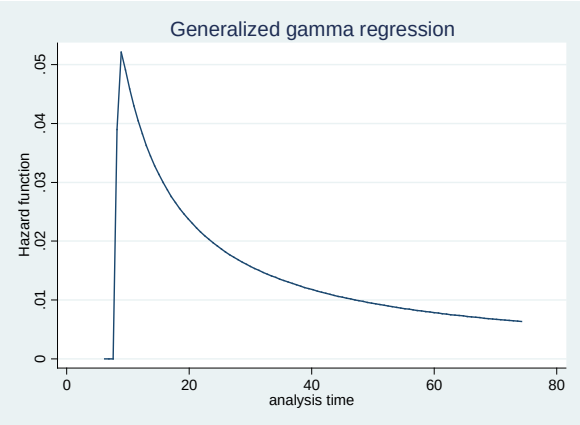
Longitudinal data, multilevel structure, and complex survey design were accounted for in the analyses.

Results

Previous studies have indicated that the BMI trajectory would be a gamma function (e.g., Adiposity rebound (Rolland-Cachera et al., 1984; Rolland-Cachera, Deheeger, Maillot, & Bellisle, 2006)). We also found that the generalized gamma function is the best fit model for baseline hazard on OW/OB, supporting the previous studies (Table is not shown). Figure 1 visualizes the OW/OB trajectories during early childhood, which was estimated using the generalized gamma function; the hazard is the largest around 10 months and gradually decrease during the early childhood.

Figure 1. The Estimated Trajectories of Obesity during Early Childhood

Overweight/Obese Hazard Trajectory Cumulative Overweight/Obese Hazard Trajectory



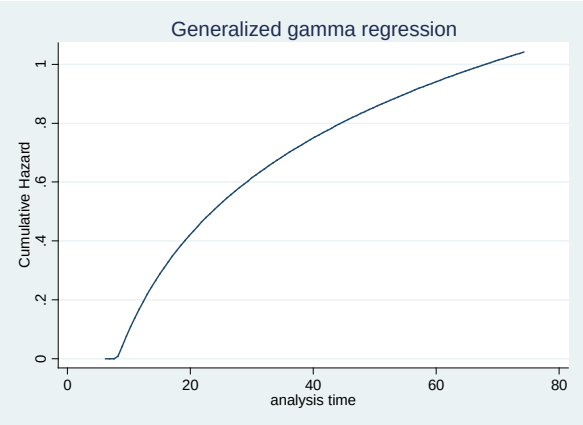


Table 1 summarizes the risk factors associated with the OW/OB trajectories identified in Figure 1. Compared to NH-White, NH-Black children experienced the earlier onset of OW/OB, whereas Hispanic children experienced the delayed onset. VLBW and HBW children experienced the delayed onset of OW/OB than NBW. Children with overweight and obese mother were more likely to experience the earlier onset of OW/OB. When the characteristics of birth place were included in the model (Model 2), the effects of child race, birth weight, and maternal overweight were attenuated, and the effects of ethnicity, HBW, and maternal obesity were disappeared. Children born in counties with a worse health behaviors score experienced the earlier onset of obesity than their counterparts.

Table 1. Generalized Gamma Regression (Accelerated Failure Time Metric) Model on the Onset of Overweight/Obesity during early Childhood

	Model 1: Individual			Model 2: Individual + County		
	b	LCI95%	UCI95%	b	LCI95%	UCI95%
Child's Race/Ethnicity (Ref= White(NH))						
Black (Non-Hispanic)	0.94	0.92	0.97	0.95	0.93	0.97
Hispanic	1.02	1.01	1.04	1.01	0.99	1.02
Else (Non-Hispanic)	1.01	0.99	1.02	1	0.98	1.02
Birth Weight (Ref=NBW (2500~3999g))						
VLBW (< 1499g)	1.07	1.04	1.1	1.05	1.01	1.09
LBW (1500~2499g)	1	0.97	1.02	0.99	0.97	1.02
HBW (4000g~)	1.01	1	1.03	1.01	0.99	1.03
Maternal Obesity before Pregnancy (Ref=Normal)						
Underweight	1.01	0.98	1.03	1.01	0.98	1.04
Overweight	0.97	0.96	0.99	0.98	0.97	0.99
Obese	0.98	0.97	0.99	0.99	0.97	1
Maternal Weight Gain during Pregnancy (Ref = ~15lb)						
16-30lb	1.04	1.01	1.06	1.03	1.01	1.05
31-45lb	1.03	0.99	1.06	1.02	0.99	1.05
45-98lb	1.02	0.99	1.05	1.02	0.98	1.04
County level Composite Scores (Birth place)						
Health Behaviors				0.9	0.87	0.93

Clinical Care				1.01	0.94	1.07
Social and Economic Factors				1.02	0.98	1.05
Physical Environment				0.97	0.9	1.06
Constant	9.12	8.76	9.5	8.83	8.18	9.53
ln_sig						
Children Sex (Male)	1.09	1.02	1.17	1.1	1.03	1.17
Constant	0.2	0.17	0.23	0.18	0.15	0.22
kappa						
Constant	0	0	0	0	0	0

Notes:

1. Dependent variable is the failure time (e.g., the time to be OW/OB).
2. Covariates included in both models were children's health status, mother's age, education, marital status, birth place, plurality, preterm birth, breast feeding, method of delivery, medical risk factors for pregnancy, obstetric procedure, complications of labor and/or delivery, abnormal conditions of the newborn, congenital anomalies of the child, prenatal tobacco and/or alcohol use.
3. The standard errors were adjusted within individuals (Model 1 and 2) and counties (Model 2).
4. To ease the interpretation, all coefficients in accelerated failure time metric were transformed b = exp(coefficient); b> 1 is interpreted as the delayed rates, whereas b<1 is the accelerated rates when compared to its reference group. Therefore, the appropriate interpretation of the coefficient is that "the expected time to be OW/OB for NH-Black children was 6% smaller (or earlier) than for NH-White children, whereas that for Hispanic children was 2% greater (or later) than for NH-White children."

Conclusions

The baseline hazard of being OW/OB was the highest at 10 months, but decreased throughout early childhood. Black children and children whose mothers were overweight before pregnancy were more likely to experience the earlier onset of OW/OB. Children born VLBW and children whose mothers gained moderate weight during pregnancy experienced the delayed onset of OW/OB. Children born in counties with a worse health behaviors score experienced the *earlier* onset of obesity than their counterparts.

Further research will be to include child-, parents-, family-level measures which vary by each wave; to take into account the lost follow-ups: current models take into account the initial survey weight but not the attrition of participants; and to better understand the childhood obesity epidemic, repeated and multi-states modeling on obesity status are required.

Reference

Casey, P. H., Bradley, R. H., Whiteside-Mansell, L., Barrett, K., Gossett, J. M., & Simpson, P. M. (2012). Evolution of obesity in a low birth weight cohort. *J Perinatol, 32*(2), 91-96. doi: 10.1038/jp.2011.75

CDC. (2011). Childhood overweight and obesity, 2012. 2., from http://www.cdc.gov/obesity/childhood/

Desai, M., & Ross, M. G. (2011). Fetal programming of adipose tissue: effects of intrauterine growth restriction and maternal obesity/high-fat diet. [Research Support, N.I.H., Extramural

Research Support, Non-U.S. Gov't

Review]. *Semin Reprod Med, 29*(3), 237-245. doi: 10.1055/s-0031-1275517
Gluckman, P. D., Hanson, M. A., Cooper, C., & Thornburg, K. L. (2008). Effect of in utero and early-life conditions on adult health and disease. [Research Support, N.I.H., Extramural

Research Support, Non-U.S. Gov't

Review]. *N Engl J Med, 359*(1), 61-73. doi: 10.1056/NEJMra0708473
Hirschler, V., Bugna, J., Roque, M., Gilligan, T., & Gonzalez, C. (2008). Does low birth weight predict obesity/overweight and metabolic syndrome in elementary school children? *Arch Med Res, 39*(8), 796-802. doi: 10.1016/j.arcmed.2008.08.003
Koplan, J. P., Liverman, C. T., & Kraak, V. I. (2005). Preventing childhood obesity: health in the balance. [Review]. *J Am Diet Assoc, 105*(1), 131-138. doi: 10.1016/j.jada.2004.11.023
Lee, H., Lee, D., Guo, G., & Harris, K. M. (2011). Trends in body mass index in adolescence and young adulthood in the United States: 1959-2002. [Historical Article

Research Support, N.I.H., Extramural]. *J Adolesc Health, 49*(6), 601-608. doi: 10.1016/j.jadohealth.2011.04.019
Mokdad, A. H., Bowman, B. A., Ford, E. S., Vinicor, F., Marks, J. S., & Koplan, J. P. (2001). The continuing epidemics of obesity and diabetes in the United States. *JAMA, 286*(10), 1195-1200.
Mokdad, A. H., Serdula, M. K., Dietz, W. H., Bowman, B. A., Marks, J. S., & Koplan, J. P. (1999). The spread of the obesity epidemic in the United States, 1991-1998. *JAMA, 282*(16), 1519-1522.
Mokdad, A. H., Serdula, M. K., Dietz, W. H., Bowman, B. A., Marks, J. S., & Koplan, J. P. (2000). The continuing epidemic of obesity in the United States. [Letter]. *JAMA, 284*(13), 1650-1651.
Moss, B. G., & Yeaton, W. H. (2011). Young Children's Weight Trajectories and Associated Risk Factors: Results From the Early Childhood Longitudinal Study-Birth Cohort. *American Journal of Health Promotion, 25*(3), 190-198. doi: DOI 10.4278/ajhp.090123-QUAN-29
Oldroyd, J., Renzaho, A., & Skouteris, H. (2011). Low and high birth weight as risk factors for obesity among 4 to 5-year-old Australian children: does gender matter? [Research Support, Non-U.S. Gov't]. *Eur J Pediatr, 170*(7), 899-906. doi: 10.1007/s00431-010-1375-4
Rolland-Cachera, M. F., Deheeger, M., Bellisle, F., Sempe, M., Guilloud-Bataille, M., & Patois, E. (1984). Adiposity rebound in children: a simple indicator for predicting obesity. *Am J Clin Nutr, 39*(1), 129-135.
Rolland-Cachera, M. F., Deheeger, M., Maillot, M., & Bellisle, F. (2006). Early adiposity rebound: causes and consequences for obesity in children and adults. *Int J Obes (Lond), 30 Suppl 4*, S11-17. doi: 10.1038/sj.ijo.0803514