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Psychosocial Predictors of Being an Underweight Infant Differ by Racial Group: A Prospective Study of Louisiana WIC Program Participants

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Abstract *Objectives:* In order to prospectively identify psychosocial predictors of infants being underweight, we followed 3,302 low-income infants. These infants received well-baby care in health departments and were enrolled in the Women, Infants, and Children (WIC) Supplemental Food Program from the newborn period to 12 months of age. *Methods:* We linked risk factor data collected from newborn medical history records to anthropometric data from a WIC database. The unadjusted relative risk of being underweight at 12 months of age, defined as weight for recumbent length below the 5th percentile, according to current Centers for Disease Control and Prevention growth charts, for each group was calculated for the study population and for black and white racial groups. Using logistic regression, we calculated odds ratios measuring the effect of the newborn risk factors on underweight status at 12 months of age. *Results:* There were no psychosocial risk factors that were significantly associated with being underweight simultaneously in both racial groups. Among black infants, those whose mothers had an eighth grade education or lower were at greater risk of being underweight at 12 months of age (OR = 3.7, CI = 1.5–4.8), as were those whose mothers were married (OR = 2.7, CI = 1.5–4.8). Among white infants, those whose mothers initiated prenatal care in the third trimester were significantly more likely to have underweight infants at 12 months of age (OR = 4.5, CI = 1.6–12.4). *Conclusions:* Predictors of being underweight at 12 months of age in a low-income population differ by racial group. Further research of public health interventions targeting families of infants with the significant psychosocial risk factors is needed.

Keywords Failure-to-thrive · Infant being underweight · Psychosocial · Maternal and child health · Community-based

Introduction

Children with severe pediatric under-nutrition, or failure-to-thrive, are prone to acute and long-term physical and developmental deficits [1–4]. Failure-to-thrive is defined as a growth deficiency occurring in the first 3 years of life and is most commonly characterized by weight and height below the 3rd or 5th percentile for age, or a rapid decrease in weight crossing 2 major percentile lines, according to standardized, sex appropriate growth references [5–6].

Organic diseases severe enough to explain growth failure are found in a minority of cases [5, 7]. There is no single etiology of failure-to-thrive. The majority of data on the etiology of failure-to-thrive come from small cross-sectional studies of clinical samples. Together, these cross-sectional studies implicate maternal psychosocial characteristics [8–11], maladapted maternal-infant interaction [12–13] and infant psychomotor development problems [14–16], or a combination or interaction of these problems in the genesis of failure-to-thrive [5, 6, 17–19].

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There are far fewer large-scale longitudinal studies of failure-to-thrive. While socioeconomic status has been demonstrated to be a strong predictor of how well a child grows and develops [20], low socioeconomic status is now recognized to be associated both with failure-to-thrive [9, 21] and obesity in early childhood [22]. How more specific social and biological risk conditions predict failure-to-thrive in varying populations is less clear. Recent prospective data from the U.K. suggest that short parental height and high parity predict failure-to-thrive [23].

Community studies of infant growth problems that include a large, biracial population are rare [24]. The purpose of the study was to create, pilot and disseminate a psychosocial risk inventory with a low-income population in a public health setting, and to prospectively identify risk factors identified in the first few weeks of an infant's life that were associated with infants being underweight at 12 months of age.

Methods

Study design

A prospective cohort study was conducted over a two-year period, examining the relationship between family risk factors assessed in the first weeks of life of age and weight for length below the fifth percentile assessed at 12 months of age.

Setting and participants

The study sample included Louisiana families who met the following criteria: 1) received a well-baby check-up during the first four months of life in any of 89 local health department clinics across the state from July 1999 to July 2000, and 2) participated in the Women, Infants, and Children (WIC) Supplemental Food Program, as evidenced by a growth measure recorded in the WIC database between ages 8 to 18 months during the period July 2000 to September 2001. Information collected on 4,694 infants less than four months of age who received a well-baby check-up in local health department clinics between July 1999 and July 2000, was entered into the risk factor database. Of these infants, 1,117 (24%) were lost to follow up, resulting in 3,577 infants having had a follow up anthropometric visit at 8–18 months of age. A total of 199 infants were excluded from the analysis due to the lack of an exact match on sex or date of birth between the risk factor and WIC data sets. An additional 76 infants were removed due to an implausible weight-for-length as defined by the CDC Pediatric Nutrition Surveillance System [25]. The final data set included 3,302 infants, of whom 1,918 were black, 1,313 were white, and 71 were in other racial groups. Institutional Review Board approval was obtained from both the state Department of Health and Hospitals and Tulane University.

Measures

Public health nurses at local health department well-baby clinics interviewed primary caregivers during the first newborn visit as part of the standardized medical history. Data were recorded on a revised medical history form which had been implemented by the Louisiana Maternal and Child Health (MCH) Program to survey psychosocial risks during well-baby assessments. In order to standardize the collection of medical information as well as psychosocial risk factors, all nurses had undergone training using this medical history form in the 12 months prior to the study's initiation. The state MCH medical and nursing staff who developed the new form, trained the regional MCH nurse consultants who in turned trained each local health department nurse. Data such as whether the pregnancy was planned or wanted, whether the mother was abused as a child, whether there was child protection agency involvement or a history of parental criminal involvement were gathered (see Table 1). Most of these risk factors were assessed with yes/no responses to questions. This form is not a validated survey instrument. Weekly quality-control meetings were held between the principal investigator and the data-entry coordinator to review and resolve discrepancies in the double-entered data.

The information on the outcome measure of weight for length was extracted from the WIC Program database for all children up to 18 months of age who received a weight and length measure through the WIC Program. The WIC data set included the weight for length translated into z-scores, computed according to the Centers for Disease Control and Prevention (CDC) growth charts revised in 2000, representing the deviation of the value from the mean of the reference population divided by the standard deviation for the reference population, and the corresponding percentiles [26]. Underweight is defined as weight for height or recumbent length below the 5th percentile [27].

The risk factor and the WIC Program data sets were linked using a common clinic identification number required for all patients receiving services from Louisiana's local health department clinics. Infants with weights or lengths considered to be implausible as defined by the CDC Pediatric Nutrition Surveillance System were removed from the study [25].

Statistical analysis

We first determined the prevalence of the 20 early risk factors and underweight status at 12 months for the total study population and each of the 2 major racial groups, black and white. We then tested the unadjusted association between underweight and non-underweight infants and each of the risk

Table 1 Unadjusted association of risk factors obtained during neonatal period with underweight at 12 months of age in 3,302 infants and by white and black race

	Total			White			Black		
	n 3302	% underwt	Rel. Risk	n 1313	% underwt	Rel. Risk	n 1918	% underwt	Rel. Risk
Birth weight									
<2500 g	367	5.5	1.7*	96	9.4	3.0*	259	4.3	1.3
≥ 2500 g	2910	3.2	Ref	1210	3.1	Ref	1641	3.2	Ref
Gestational age									
<37 weeks	370	4.9	1.5	112	7.1	2.4*	245	4.1	1.2
≥ 37 weeks	2878	3.3	Ref	1173	3	Ref	1649	3.3	Ref
Trimester prenatal care began									
First	2148	3.2	Ref	979	2.7	Ref	1127	3.6	Ref
Second	788	3.8	1.2	240	4.6	1.7	529	3.6	1
Third	199	3.5	1.1	46	10.9	4.0*	149	1.3	0.4
None	61	6.6	2.1	12	-	-	47	6.4	1.8
Pregnancy planned									
Yes	929	3.4	Ref	490	2.2	Ref	407	4.4	Ref
No	2294	3.5	1	792	4.3	2	1463	3.1	0.7
Pregnancy wanted									
Yes	2974	3.5	Ref	1235	3.2	Ref	1673	3.6	Ref
No	241	3.3	0.9	44	9.1	2.8	193	2.1	0.6
Maternal education									
≤ 8th Grade	233	6.9	2.7*	103	5.8	1.9	107	6.5	2.7*
9–11 Grade	1010	3	1.2	354	2.3	0.8	636	3.3	1.4
12 Grade	1402	3.6	1.4	598	3.7	1.2	788	3.7	1.5
College	472	2.6	Ref	166	3	Ref	296	2.4	Ref
Currently married									
Yes	977	4.3	Ref	650	3.1	Ref	282	6.4	2.1*
No	2186	3.2	0.7	590	3.9	1.3	1571	3	Ref
Both parents care for baby									
Yes	2426	3.4	Ref	999	3	Ref	1371	3.5	Ref
No	650	4.2	1.2	215	5.6	1.9	424	3.5	1
Marital conflict									
Yes	528	3	0.9	220	3.2	0.9	300	3	0.9
No	2459	3.5	Ref	961	3.4	Ref	1437	3.5	Ref
Violence exposure									
Yes	74	1.4	0.4	35	2.9	0.8	35	0	Und
No	2939	3.6	Ref	1148	3.6	Ref	1726	3.6	
Mother abused as child									
Yes	146	3.4	0.9	90	5.6	1.6	53	0	Und
No	2811	3.7	Ref	1076	3.4	Ref	1677	3.8	
Child protection agency involvement									
Yes	130	0.8	0.2	56	1.8	0.5	70	0	Und
No	2762	3.9	Ref	1089	3.8	Ref	1616	3.8	

Table 1 Continued

	Total			White			Black		
	n	% underwt	Rel. Risk	n	% underwt	Rel. Risk	n	% underwt	Rel. Risk
	3302			1313			1918		
Maternal depression									
Yes	110	5.5	1.6	68	7.4	2.2	41	2.4	0.7
No	3192	3.4	Ref	1245	3.3	Ref	1877	3.4	Ref
Maternal mental disorders									
Yes	43	7	2.1	21	9.5	2.8	19	5.3	1.6
No	3259	3.4	Ref	1292	3.4	Ref	1899	3.4	Ref
Maternal smoking									
Yes	696	3.6	1	473	4.2	1.4	214	2.3	0.7
No	2606	3.5	Ref	840	3.1	Ref	1704	3.5	Ref
Maternal alcohol use									
Yes	58	5.2	1.5	20	10	2.9	38	2.6	0.8
No	3244	3.5	Ref	1293	3.4	Ref	1880	3.4	Ref
Public assistance									
Yes	1443	3.3	0.9	470	4	1.3	951	2.9	0.7
No	1484	3.8	Ref	673	3.1	Ref	771	4.2	Ref
Employed									
Yes	1948	3.6	Ref	865	3.7	Ref	1037	3.5	Ref
No	1017	3.5	1	306	2.7	0.8	696	3.7	1.1
Family or social support									
Yes	2993	3.4	Ref	1184	3.6	Ref	1744	3.4	Ref
No	99	7.1	2.1	35	5.7	1.6	61	4.9	1.4
Criminal justice involvement									
Yes	220	4.6	1.3	81	3.7	1.1	138	5.1	1.5
No	2637	3.6	Ref	1053	3.5	Ref	1524	3.5	Ref

Note. 2-tailed p value based on chi square, Fisher's Exact Test, or Chi Square for Trend.

$^*p < .05.$

factors both for the total population and separately for black and white infant groups, using the chi-square test. Finally, multivariate logistic regression was conducted to assess the combined effect of risk factors on being underweight versus non-underweight. The maximum likelihood method was used to calculate odds ratios and confidence intervals. Risk factors were entered into models stepwise, with the entry threshold set at $p < .20$. Predictors differed between racial groups and the multivariate analysis was conducted separately for black and white racial groups.

The known risk factor of low birth weight did not meet the $p < .20$ criteria for black infants in the unadjusted analysis. Thus, birth weight was included in all multivariate models as a continuous covariate. All statistical analyses were conducted using the Statistical Analysis Software (SAS Institute Inc., Cary, NC).

Results

The median age of the newborn infants at the time of the risk factor assessment visit was two weeks; 70% were less than three weeks of age. The median age at the time of the follow-up growth measure was 12.3 months; 73% were between 11 and 13 months of age. The overall incidence of being underweight at this follow-up visit was essentially similar among black and white infants at 3.5% in the total population; 3.4% among black infants and 3.5% among white infants. Compared to the study population, families lost to follow-up were characterized by higher infant birth weight, higher maternal education, and a higher proportion of married mothers. The distribution of psychosocial risk factors and pregnancy-related risk factors for the study population and for black and white racial groups are presented in Table 1. Unplanned pregnancy, unmarried status, public assistance, and smoking were common, though risk factors differed by race. White mothers were more likely to report having been abused as a child (7.7% vs. 3.1%), having smoked during pregnancy (36% vs. 11%), and experiencing depressive symptoms (5% vs. 2%). Black women reported more unplanned (78% vs. 62%) and unwanted (10% vs. 3%) pregnancies, and were more frequently unmarried (85% vs. 48%) and unemployed (40% vs. 26%). The proportion of families involved in the child protection system and indication of parental criminal involvement were not different between the races.

The unadjusted association between the individual risk factors and being underweight at 12 months for the full sample and for each of the racial groups is presented in Table 1. In the full sample, low birth weight infants had a higher risk of being underweight at 12 months of age compared to normal birth weight infants (RR = 1.7; p value = .034). Infants whose mother had an eighth grade education or less

had 2.7 times the risk of being underweight at 12 months of age compared to infants of mothers who had attended or completed college. For black infants, maternal education ≤ 8th grade (RR = 2.7; p value = .012) and being married (RR = 2.1; p value = .008) were significant predictors for being underweight at 12 months, while, for white infants, low birth weight (RR = 3.0; p value = .005), gestational age <37 weeks (RR = 2.4; p value = .046), and initiation of prenatal care in the third trimester (RR = 4.0; p value = .010) significantly predicted underweight status at 12 months. Multivariate models for strongest predictors of being underweight at 12 months of age, by race are shown in Tables 2 and 3. Among black infants, those with low birth weight were 30% more likely to be underweight at 12 months compared to those with normal birth weight after adjusting for maternal education and marital status (Table 2). Black infants whose mothers had an educational level of eighth grade or less were 3.7 times more likely to be underweight than black infants whose mothers attended or completed college. Black infants whose mothers were married at the time of the newborn risk assessment had 2.7 times the odds of being underweight compared to black infants whose mothers were not married.

Among white infants, those with low birth weight were 1.7 times more likely to be underweight compared to those with normal birth weight (Table 3). After adjusting for birth weight, infants of mothers initiating prenatal care in the third trimester had 4.5 times the odds for being underweight compared to those whose mothers began prenatal care in the first trimester.

Discussion

This study is one of only a few large prospective cohort studies of predictors of underweight infants in a community sample [8, 15, 16, 21, 23, 24]. We are not aware of other studies with the statistical power to examine race-specific differences in risk factors for infant growth problems. Predicting

Table 2 Adjusted odds ratio for underweight at 12 months of age for 1918 black infants

	Odds ratio	95% confidence interval
Birth weight	1.3	(1.05–1.60)
Maternal education		
≤ 8th grade	3.7	(1.50–4.84)
9–11th grade	1.7	(.73–3.96)
12th grade	1.6	(.72–3.58)
College	1	
Marital status		
Married	2.7	(1.50–4.84)
Not married	1	

Table 3 Adjusted odds ratio for underweight at 12 month of age for 1313 white infants

	Odds ratio	95% confidence interval
Birth weight	1.7	(1.29–2.11)
Trimester prenatal care began		
First	1	
Second	1.6	(.80–3.3)
Third	4.5	(1.6 –12.4)

infant growth problems in a population is important according to a meta-analysis on this subject, the best prospective studies suggest that severe infant growth problems such as failure-to-thrive is associated with later cognitive delays [2] and interventions for failure-to-thrive are costly, particularly if not well-coordinated [28]. It has been argued that failure-to-thrive may be best predicted by a cumulative risk index [29]; however, it is not clear that the same risk conditions are specifically predictive of failure-to-thrive in all populations.

Consistent with other studies, we found that low birth weight was associated with being underweight at 12 months of age for both black and white races [30–32]. Of the 17 psychosocial risk factors recorded from individual interviews of new mothers, however, no common factors were significantly associated with being underweight at 12 months of age in both race/ethnic groups. Instead, a total of three different factors were associated with being underweight at 12 months of age in the two race specific samples.

In our sample, black infants of mothers with an eighth grade education or lower were at much greater risk of being underweight at 12 months of age. Low maternal education has been shown to be a risk factor in other studies on failure-to thrive, but has been an inconsistent finding [9, 17, 33]. Our sample size was large enough to allow examination of maternal education at several levels and to document one of the potentially serious results of very low maternal education.

Surprisingly, we found that marriage appeared to increase the risk of being underweight for black infants. Most research shows that children fare better when raised by their married parents [34–35], even among poor populations. Lerman [36] found that material hardships such as food insufficiency and inadequate housing are mediated by extended family equally when comparing single mothers living with no other adults to married couples. Bennett's [37] data suggests that the protective effects of marriage are significantly lower for black as compared to white families: the infant mortality ratio of married to unmarried mothers was 1.3 for black women and 1.8 for white women. When low-income black women marry, they may experience a decrease in the financial support of their wider family support system. Parke [35] argues that "in low-income African American communities, the high rate of unemployment is one of the factors that explain why low-income women do not marry." In Louisiana, the material advantages associated with marriage are less likely to occur

for the black population than for the white population. The unemployment rate for white males during the study period in Louisiana was 3.7% in 2000 compared to 10.6% for black males [38].

By stratifying the analysis by race, we were also able to detect a risk factor that was specific to white infants; this factor would have been obscured without stratification by race. White mothers who initiated prenatal care in the third trimester were significantly more likely to have underweight infants at 12 months of age. Late initiation of prenatal care was important only for white infants.

There are significant limitations of this study, including the potential for error, both in the measures themselves and in the collecting and recording of the weight and length measures by community-based public health nurses. The risk factor measures came from yes/no questions on a medical history record, not from validated instruments. Given both the sensitive nature of some of the questions, varying personal definitions and the possibility that patients would respond in a socially desirable fashion, it is likely that under-reporting of some risk factors occurred. Methodological concerns raised by the use of small clinical samples for studying early childhood growth problems were avoided by our sampling strategy [39–40].

The implications of this study for state MCH Programs are important to note. It is interesting that only 3.5% of the population of infants were below the fifth percentile of weight for height at about 12 months. It may be that the mitigating effects of WIC services, including the provision of infant formula, breastfeeding support and other nutritional interventions kept the prevalence of underweight infants low in this high-risk population. The fact that specific risk conditions were still predictive of underweight infants in families receiving WIC services underscores the need for further research following infants of families with these psychosocial risk factors through the first year of life. Close follow-up of families with these risk factors, including more frequent visits to the WIC clinic or in the home should be evaluated.

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