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Original Research Article

Necrotizing enterocolitis: what is the role of social determinants of health

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ABSTRACT

Background: Neonatal necrotizing enterocolitis (NEC) is a gastrointestinal emergency predominantly affecting premature and low-birth-weight infants. NEC mortality rates range from 20-40%, but can be as high as 100% in severe forms of the disease. Recent studies have examined social determinants of health (SDOH) in neonatal disease and emerging evidence suggests that they may also influence outcomes in NEC. This study aimed to evaluate the association between maternal socioeconomic disadvantage, measured by the Area Deprivation Index (ADI) and NEC in a community hospital setting (Queens, NY). We examined whether higher ADI levels in a diverse patient population were associated with disease presentation, severity index and adverse clinical outcomes.
Methods: We conducted a single-center retrospective study at Flushing Hospital Medical Center in Queens, NY of 21 neonates diagnosed with NEC between October 2012 and 2024; neonates without a confirmed diagnosis of NEC during this period were excluded. Utilizing state ADI from the Neighborhood Atlas, neonates were categorized into less disadvantaged (ADI <5) or more disadvantaged (ADI >5). Bivariate analysis determined differences among demographics and clinical characteristics, including maternal BMI and neonatal birth weight, laboratory values and treatments. IRB approval was obtained.
Results: 21 neonates with NEC between 2012 and 2024 were studied, 9 females and 12 males, with a median gestational age of 24-25 weeks and 6 days. Twenty mothers had government-provided insurance. Among 21 neonates with NEC, 18 were categorized as less disadvantaged and 3 as more disadvantaged based on ADI. The more disadvantaged cohort showed a median birth weight of 600-699 g and less acidosis with a base deficit (BD -3.7-7.8) compared to the less disadvantaged cohort: BW 650-750 g and more acidosis with base deficit (-12.5-16.1). The more disadvantaged maternal cohort was younger (20-29 y), of Hispanic descent, with a higher BMI (34-37.9) and 33% positive for Group B Streptococcus (GBS). The less disadvantaged cohort had a median age of 30-39 y, BMI 30-33.9 and 27.8% positive for GBS. The neonates from the less disadvantaged cohort underwent surgical intervention more than the more disadvantaged, 38.9% versus 33%.
Conclusions: Social determinants of health should be considered among risk factors associated with NEC. Surgeons may need to include them in their initial evaluation. We recognize that our small sample from a single center provided limited data, but replication could lead to earlier recognition and potentially improved outcomes.

Keywords: Gastrointestinal emergency, Necrotizing enterocolitis, NEC, Neonatal outcomes, Social determinants of health

INTRODUCTION

Neonatal necrotizing enterocolitis (NEC) is a gastrointestinal emergency predominantly affecting premature and low-birth-weight infants. NEC mortality rates range from 20-40%, but can be as high as 100% in severe forms of the disease. Generally, the clinical presentation of NEC may be nonspecific or manifest with gastrointestinal symptoms, multiorgan dysfunction and shock.

Beyond clinical findings, the radiographic presence of intramural gas (pneumatosis) and portal venous gas confirms the diagnosis of NEC. Treatment for NEC involves both medical and surgical intervention, depending on the severity of presentation.[1]

Overall, NEC is a severe neonatal condition that requires early recognition and prompt management. The pathogenesis involves an immature epithelial barrier and underdeveloped immune system that fail to manage luminal microbial exposure, resulting in intestinal inflammation and sepsis.[2] Recent studies have specifically examined social determinants of health (SDOH) in neonatal disease and emerging evidence suggests that they may influence NEC outcomes.

The purpose of this study is to evaluate the impact of maternal socioeconomic disadvantage, measured by the area of deprivation index (ADI), on NEC outcomes in a community hospital serving a diverse population in Queens, NY.

METHODS

Study design and population

Authors conducted a single-center retrospective cohort study of neonates diagnosed with NEC at a community hospital in Queens, NY between October 2012 and October 2024. Eligible patients were identified through institutional medical record review using diagnostic codes and confirmed by chart review. Inclusion criteria consisted of neonates with a clinical and/or radiographic diagnosis of NEC during the study period.

Neonates without a confirmed diagnosis of NEC or those diagnosed outside the specified time frame, were excluded from analysis. A total of 21 neonates with a clinical and/or radiographic diagnosis of NEC were included in the analysis. This study was approved by the institutional review board (IRB). Due to the retrospective nature of the study, the requirement for informed consent was waived.

Data collection

Demographic and clinical data were extracted from the electronic medical record. Variables collected included maternal characteristics (age and BMI), neonatal characteristics (gestational age, birth weight, sex), laboratory values at presentation and clinical management variables, including medical and surgical treatments. Disease severity and outcomes were assessed based on available clinical documentation. Maternal socioeconomic disadvantage was assessed using the ADI, an established composite measure of neighborhood socioeconomic conditions derived from census-based indicators.

ADI scores were obtained from the neighborhood atlas and assigned based on the maternal residential address at the time of delivery. Neonates were categorized into two groups based on ADI score: less disadvantaged (ADI<5) and more disadvantaged (ADI≥5).

Statistical analysis

Bivariate analyses were performed to compare demographic and clinical characteristics between ADI groups. Continuous variables were summarized using descriptive statistics and compared using appropriate parametric or non-parametric tests, while categorical variables were compared using chi-square or Fisher's exact tests, as applicable. Statistical significance was defined as a two-sided p value<0.05. All analyses were conducted using standard statistical software.

RESULTS

A total of 21 neonates diagnosed with NEC between 2012 and 2024 were included in the analysis. The cohort consisted of 9 females (42.9%) and 12 males (57.1%), with a median gestational age of 24–25 weeks and 6 days. Most mothers (95.2%, n=20) were insured through government-provided insurance programs. Eighteen of the 21 neonates (85.7%) were classified as less disadvantaged and three (14.3%) as more disadvantaged based on ADI categorization. In the less disadvantaged cohort, racial and ethnic distribution included non-hispanic white (n=2), black (n=6), hispanic (n=3) and other or unspecified race (n=3).

In contrast, the more disadvantaged cohort consisted of Black (n=1), Asian (n=1) and other or unspecified race (n=1). Although differences in racial and ethnic composition were observed between ADI groups, the limited sample size precluded meaningful statistical analysis to determine a clear association between ethnicity and socioeconomic disadvantage.

Mothers in the more disadvantaged group were younger, with a median age of 20–29 years, predominantly of Hispanic ethnicity and had a higher median body mass index (BMI 34.0–37.9). GBS colonization was present in 33% of mothers in this cohort. In contrast, mothers in the less disadvantaged cohort had a median age of 30–39 years, a lower median BMI (30.0–33.9) and a GBS positivity rate of 27.8%. Maternal and neonatal

demographic characteristics stratified by ADI group are summarized in Figure 1.

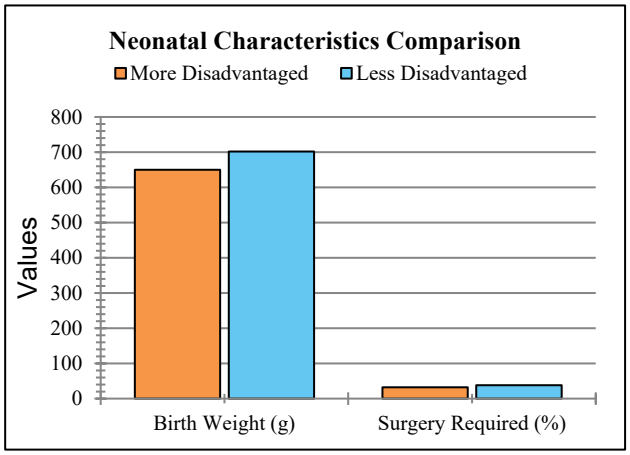

Figure 1: Neonatal characteristics for more vs. less disadvantaged cohort.

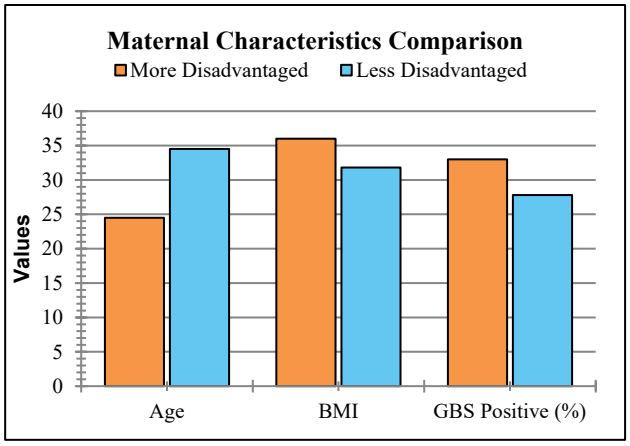

Figure 2: Maternal characteristics for more vs. less disadvantaged cohort.

Neonates born to mothers in the more disadvantaged cohort had a lower median birth weight range (600–699 g) compared with those in the less disadvantaged cohort (650–750 g).

Despite lower birth weight, neonates in the more disadvantaged group demonstrated less metabolic acidosis at presentation, with base deficit values ranging from -3.7 to 7.8. Conversely, neonates in the less disadvantaged cohort exhibited more severe metabolic acidosis, with base deficit values ranging from −12.5 to −16.1.

The distribution of base excess/deficit values between cohorts is illustrated in Figure 2. A higher proportion of neonates in the less disadvantaged group underwent surgical management compared to those in the more disadvantaged group (38.9% versus 33%). Indications for surgery were based on clinical deterioration and radiographic findings consistent with advanced NEC. Representative anteroposterior and lateral abdominal radiographs demonstrating classic features of NEC, including dilated bowel loops and pneumatosis intestinalis, are seen in Figure 3.

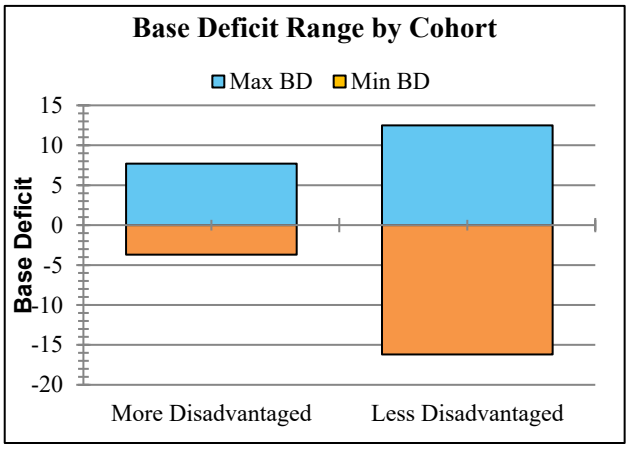

Figure 3: Base excess/deficit range for more vs. less disadvantaged cohort.

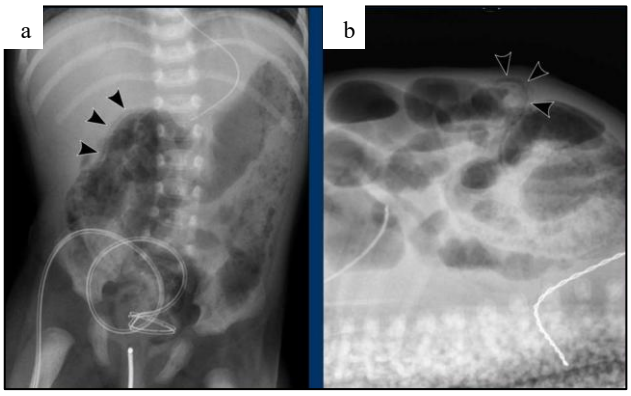

Figure 4 (a and b): AP and lateral views of abdominal X-ray demonstrating dilated loops of bowel and pneumatosis intestinalis, typical features of NEC.

Table 1: Overall patient and maternal demographics (n=21).

Characteristic		Value
Sex	Female	9 (42.9%)
	Male	12 (57.1%)
Median gestational age		24–25 weeks, 6 days
Maternal government-provided insurance		20 (95.2%)
ADI classification-Less disadvantaged		18 (85.7%)
ADI classification-More disadvantaged		3 (14.3%)

Table 2: Maternal and neonatal characteristics stratified by ADI group.

Characteristic	Less disadvantaged (n=18)	More disadvantaged (n=3)
Median maternal age	30–39 years	20–29 years
Predominant maternal ethnicity	—	Hispanic
Median maternal BMI	30.0–33.9	34.0–37.9
GBS colonization	27.8%	33%
Median birth weight	650–750 g	600–699 g
Base deficit range	−12.5 to −16.1	−3.7 to 7.8
Surgical management	38.9%	33%

DISCUSSION

NEC remains a severe neonatal condition requiring early recognition and prompt management, particularly among premature and extremely low-birth-weight infants. The pathogenesis of NEC is multifactorial and classically involves an immature intestinal epithelial barrier and underdeveloped immune response, which together fail to regulate exposure to luminal microbiota. This combination results in intestinal mucosal injury, inflammation, ischemia and progression to sepsis.[1,2] Despite advances in neonatal care, NEC continues to be associated with substantial morbidity and mortality, especially in infants requiring surgical intervention.

Gestational age and birth weight are well-established risk factors for NEC. Prior studies report NEC incidence rates of approximately 1% in low-birth-weight infants, increasing to 11% in very low-birth-weight (<1,500 g) infants and 22% in extremely low-birth-weight (<1,000 g) infants. NEC requiring surgery carries a particularly poor prognosis in extremely low-birth-weight neonates, with mortality rates exceeding 50%.[1,3] Although NEC predominantly affects premature infants, cases in term and near-term infants have been described. Maayan-Metzger et al reported an increasing incidence of NEC among full-term infants, particularly those born at 37–38 weeks' gestation, highlighting that NEC is not exclusive to extreme prematurity.[4] In our study, neonates with NEC were born at a median gestational age of 24–25 weeks and 6 days, with an extremely low birth weight: 600–699 g in the more disadvantaged cohort compared with 650–750 g in the less disadvantaged cohort.

Maternal factors have increasingly been recognized as contributors to NEC risk. March et al, demonstrated that maternal hypertensive disease was associated with a two-fold increased risk of NEC, supporting the hypothesis that impaired uteroplacental blood flow and chronic intrauterine hypoxia may predispose infants to intestinal injury.[5] Maternal gestational diabetes has also been linked to NEC. Zhang et al reported a 2.1-fold increased risk in very low-birth-weight infants born to diabetic mothers, while Grandi et al, found that advanced NEC (Bell stage II–III) was independently associated with maternal diabetes.[6,7] Markers of maternal systemic inflammation including elevated neutrophil-to-lymphocyte ratios, placental pathology and multiparity have also been implicated in NEC development.[8] Additionally, neonatal anemia and red blood cell transfusions have been associated with increased NEC risk in preterm infants.[9]

Beyond biological and clinical factors, SDOH have emerged as critical contributors to neonatal outcomes. SDOH encompasses the conditions in which individuals are born, live, work and age and their influence on health outcomes has been recognized for decades.[10,11] In neonatal populations, socioeconomic disadvantage has been associated with adverse outcomes, including preterm birth, low birth weight and increased infant mortality. Barfield et al described how social disadvantage such as low educational attainment, poverty and rural residence contributes to higher rates of preterm birth and low birth weight, with rural residents particularly affected by limited access to perinatal care.[11]

Recent studies have specifically examined SDOH in neonatal disease. Among infants with bronchopulmonary dysplasia, those residing in high-deprivation neighborhoods demonstrated significantly higher emergency department utilization compared to those from less deprived areas, with insurance status correlating with higher ADI and lower childhood opportunity index (COI) scores.[12] Similarly, Knaus et al found that social factors such as transportation reliance, non-traditional household structure and unmarried guardians were associated with increased rates of Hirschsprung-associated enterocolitis, underscoring the relevance of SDOH in gastrointestinal pathologies.[13]

Emerging evidence suggests that SDOH may also influence NEC outcomes. Young et al, evaluated the COI score in over 10,000 infants with NEC and demonstrated that lower opportunity scores were associated with increased mortality and prolonged hospitalization.[14] Racial and ethnic disparities have also been reported, with African American and Hispanic infants experiencing higher NEC incidence and mortality even after adjusting for gestational age and birth weight.[15,16] These findings suggest that structural and social inequities, rather than biological differences alone, may contribute to observed disparities. The area deprivation index (ADI) is a validated, census-based composite measure of neighborhood socioeconomic disadvantage encompassing

education, income, employment, housing and household characteristics. Shaffer et al demonstrated that while ADI was not significantly associated with NEC incidence among White infants, Black infants residing in the most disadvantaged neighborhoods had markedly higher rates of NEC, with over 40% affected in the highest deprivation group.[17]

These findings highlight the intersection of race, socioeconomic disadvantage and neonatal outcomes. In our study, we used ADI as a proxy for maternal socioeconomic status in a diverse community hospital population. Notably, neonates in the more disadvantaged cohort had lower median birth weights but demonstrated less severe metabolic acidosis at presentation compared to those in the less disadvantaged cohort. Additionally, infants from the less disadvantaged cohort underwent surgical intervention more frequently and exhibited more pronounced acidosis.

These findings were unexpected and may reflect differences in disease presentation, timing of diagnosis, thresholds for surgical intervention or unmeasured confounding factors. It is also possible that the limited sample size influenced these observations. Maternal characteristics differed between cohorts, with the more disadvantaged group consisting of younger mothers, predominantly of Hispanic ethnicity, with higher body mass indices and slightly higher rates of GBS colonization. These findings align with prior literature suggesting that maternal metabolic and inflammatory states may influence neonatal vulnerability to NEC.[6-8] Importantly, ethnicity in this context likely reflects broader structural and socioeconomic inequities rather than inherent biological risk. Determining optimal timing for surgical intervention remains a major challenge in NEC management. Surgical decision-making relies on clinical deterioration, radiographic findings and surgeon judgment, with procedures ranging from primary peritoneal drainage to bowel resection with ostomy or primary anastomosis.[3] Despite surgical advances, survivors of severe NEC remain at high risk for long-term complications, including neurodevelopmental impairment and intestinal failure.[18]

This study has several limitations, including its retrospective design, small sample size and single-center setting, which limit statistical power and generalizability. Residual confounding related to unmeasured clinical or social factors is also possible. A larger sample size and multivariate analysis would better explore our findings of worse presentation and outcomes associated with a less socioeconomically disadvantaged cohort.

CONCLUSION

NEC is a complex disease influenced by biological vulnerability, maternal health and social context. Incorporating measures of socioeconomic disadvantage, such as ADI, may enhance risk stratification and inform targeted interventions aimed at improving outcomes in high-risk neonatal populations. Nonetheless, our findings contribute to the growing body of literature highlighting the contribution of SDOH in presentations and outcomes of NEC in newborns.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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