Original Article

Maternal social determinants of health and birth weight

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Abstract

Background: Social determinants of health (SDoH) affect health during pregnancy. Previous studies have looked at the association between individual SDoH among pregnant women and neonatal outcome. In this study we looked at the correlation between a cumulative SDoH score and birth weight.

Methods: Information on the social determinants of health (SDoH) among pregnant women was collected by using the electronic questionnaire. By using the color-coded wheel, generated by the electronic record system, we developed a SDoH score, ranging from 0-20. A SDoH color of green indicated no concern, while red indicated severe concern. The corresponding birth weight for the maternal SDoH score was noted after delivery. The data was analyzed using the MS excel program.

Results: A total of 130 women out of 159 (81%) completed the questionnaire during the study period of eight weeks. The mean SDoH score was 3.12 with standard deviation of 2.3 (range 0-13). The mean birth weight was 3048 grams with standard deviation of 563 grams (range 860-4215 grams). A weak negative correlation ($r = -0.14$, $R^2 = 0.0217$) was noted between the birth weight and SDoH score.

Conclusions: Maternal social determinants of health affect fetal growth. Further studies are needed to validate our findings.

Keywords: Birth Weight; Maternal Health; Pregnancy; Social Determinants of Health.

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Introduction

Socialdeterminants of health (SDoH), as defined by World Health Organization, are the non-medical factors that influence the health outcomes (1). SDoH includes the conditions in which people are born, grow, work, live, and age. Most important SDoH are financial condition, food insecurity, transport facility, physical activity, stress, social connections, housing stability, depression, tobacco, and alcohol use. Pregnancy changes the physiological needs of the body, so pregnant women are particularly vulnerable to SDoH (Figure 1). Financial and food constraints may lead to malnutrition in women affecting the fetal growth. Lack of transport may lead to decreased access to medical care resulting in poor prenatal care and fetal monitoring. Lack of physical activity may promote obesity which could affect the fetal growth. Stress, depression, and lack of social connection may lead to psychological issue resulting in lack of prenatal care. Poor housing conditions may lead to exposure to

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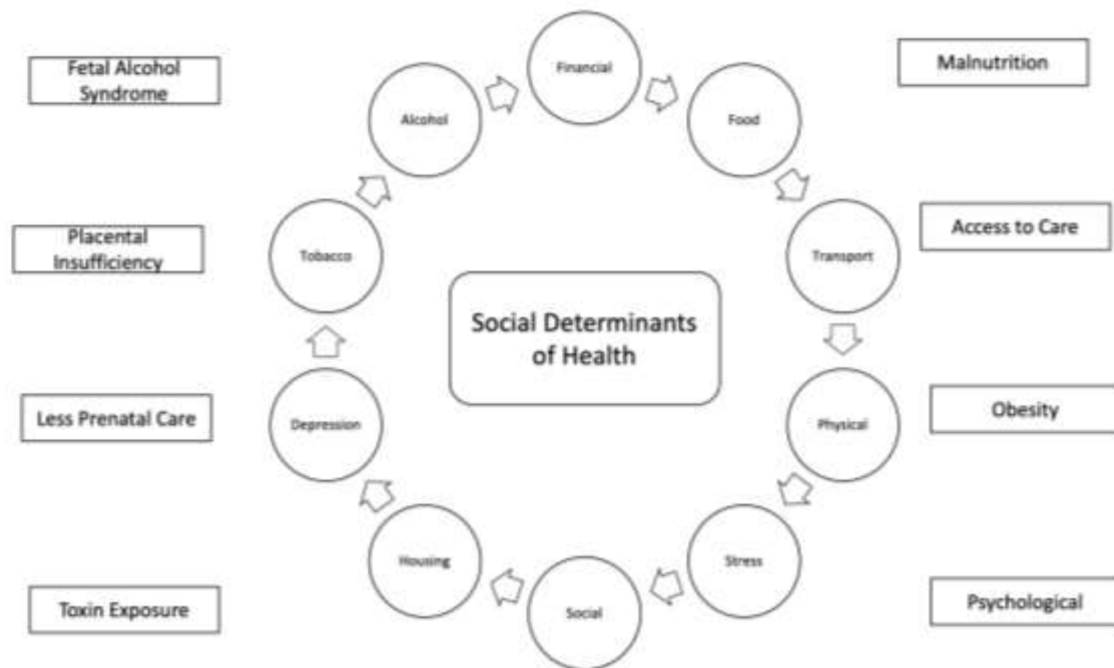

Figure 1: The connection of Social Determinants of Health

toxins that could affect the fetus. Chronic smoking causes placental insufficiency resulting in poor fetal growth (2). Alcohol consumption during pregnancy has been associated with fetal alcohol syndrome (3).

Birth outcome have been negatively associated with race, poverty, homelessness, and substance use (4). Maternal medication abuses and mental stress during pregnancy have been reported as risk factors for low birth weight (5). Looking at SDoH, DiTosto et al have shown housing instability and homelessness during pregnancy significantly associated with preterm birth, low birthweight neonates, neonatal intensive care unit admission, and delivery complications (6). Another important factor in SDoH is the psychosocial vulnerability of the pregnant women. Pregnant women with high psychosocial vulnerability face a higher risk of preterm birth (7). Healthy environments include neighborhood with low crime rate. Higher exposure to violent crimes in the close vicinity of pregnant women's residence has shown to be associated with substantial increases in the odds of low birth weight and prematurity (8).

Amjad et al (9) in their meta-analysis evaluated SDoH and found race and rural residence as predictors of preterm birth while low maternal socio-economic status and illiteracy as risk factors for maternal mortality and low birth weight infants. Maness and Buhi (10) in their systematic review of seventeen studies reported poverty and family structure as the most important SDoH in pregnancy.

These studies have described the effect of maternal SDoH individually. There is a gap in research looking at the cumulative effect of SDoH on the birth weight. The primary objective of this study was to look at the relationship between the cumulative SDoH and birth weight. We hypothesize a negative correlation between maternal SDoH and birth weight.

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Methods

The study was approved by the institutional review board and need for consent was waived as data was collected from the charts. We utilized the built-in feature of social determinants of health (SDoH) in the electronic health records (Epic©) (11). The target population were the pregnant women admitted to the university hospital during the eight-week period of November 15, 2021, and January 15, 2022. The inclusion criteria were all pregnant women in labor. The women were excluded if they were admitted for observation and did not deliver. SDoH assessment consisted of questionnaire on ten factors: Financial Resource Strain, Food Insecurity, Transport Needs, Physical Activity, Stress, Social connections, Housing stability, Depression, Tobacco use and Alcohol use.

On admission to the labor unit of the hospital, all pregnant women completed the SDoH questionnaire (Appendix A) assisted by the nurse assigned to the patient. When these questionnaires were completed, a color-coded wheel was generated by the electronic record system. Based on the color, we developed a SDoH score, ranging from 0-20 (Appendix B). The colors represented the severity of the concern. Green color denoted no concern, yellow meant moderate concern and red indicated severe concern.

After delivery, the corresponding birth weight for the maternal SDoH score was recorded. The infants were further divided into two groups based on their birth weights, group 1 were infants with birth weight < 2500 grams and group 2 were infants with birth weight > 2500 grams. All data were entered in the MS excel sheet by the principal investigator. MS excel program was used for all statistical analysis and chart generation.

Results

A total of 130 women out of 159 (81%) completed the questionnaire during the study period of eight weeks. The mean SDoH Score was noted to be 3.12 with standard deviation of 2.3 (range 0-13). The mean birth weight was 3048 grams with standard deviation of 563 grams (range 860-4215 grams). Table 1 showed the comparison between group 1 (infants with birth weight < 2500 grams) group 2 (infants with birth weight > 2500 grams). A significant difference was noted among the birth weights, while mean SDOH was noted to be higher among low birth infants. A weak negative correlation ($r = -0.14$, $R^2 = 0.0217$) was noted between the birth weight and SDoH score (Figure 2). Table 2 showed the results of further analysis of SDoH among infants with birth weight < 2500 grams based on color-coded alert. By applying the Pareto chart for the red alert (severe) determinants, we noted stress, physical inactivity, and food insecurity as the top three concerning determinants of health among pregnant women delivering infants of less than 2500 grams (Figure 3) (12,13).

Table 2: Severity of Alert Among < 2500-gram Infants

SDoH	Green n (%)	Yellow n (%)	Red n (%)
Financial	13 (81)	3 (19%)	0
Food	13 (81)	0	3 (19)
Transport	15 (93)	0	1 (7)
Physical	5 (31)	7 (43)	4 (26)
Stress	9 (56)	1 (7)	6 (37)
Social	9 (56)	5 (31)	2 (13)
Housing	15 (93)	0	1 (7)
Depression	16 (100)	0	0
Tobacco	12 (75)	4 (25)	0
Alcohol	15 (93)	0	1 (7)

SDoH: Social Determinants of Health; Green: No concern
Yellow: Moderate concern; Red: Severe concern

Table 1: Comparison between Group 1 and 2

	Group 1 Birth Weight < 2500 grams (n=16)	Group 2 Birth Weight > 2500 grams (n=114)	P value
Birth Weight	2008 ± 493 (860-2430)	3194 ± 393 (2510-4215)	2.5×10^{-20}
SDoH Score	3.5± 3.6 (0-13)	3 ± 2.2 (0-11)	0.25

Mean± Standard deviation (range); SDoH: Social Determinants of Health

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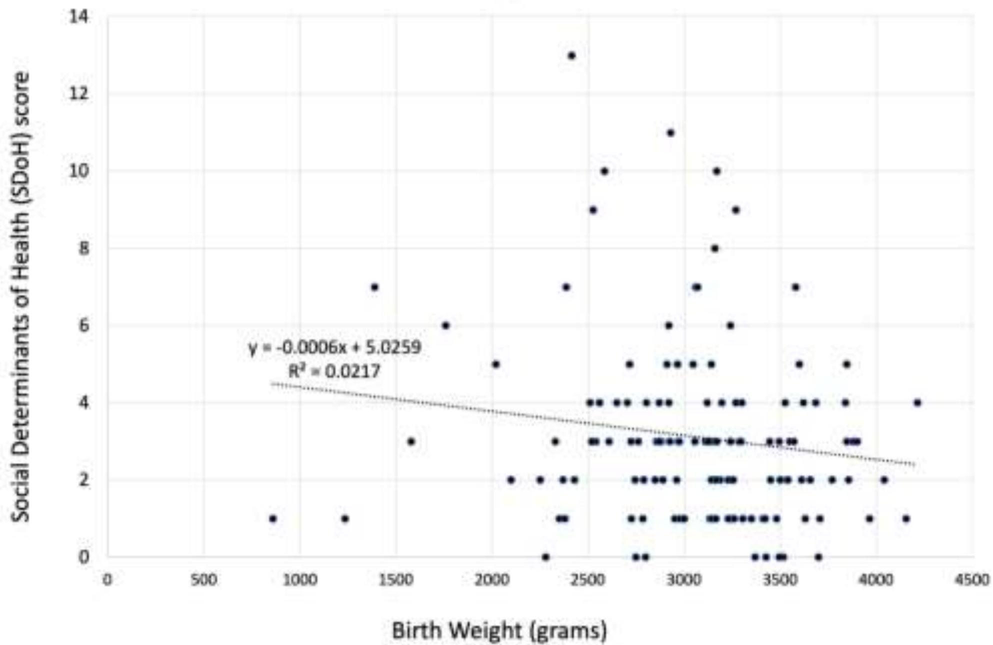

Figure 2: Graph depicting correlation between the social determinants of health (SDoH) Score and Birth weight

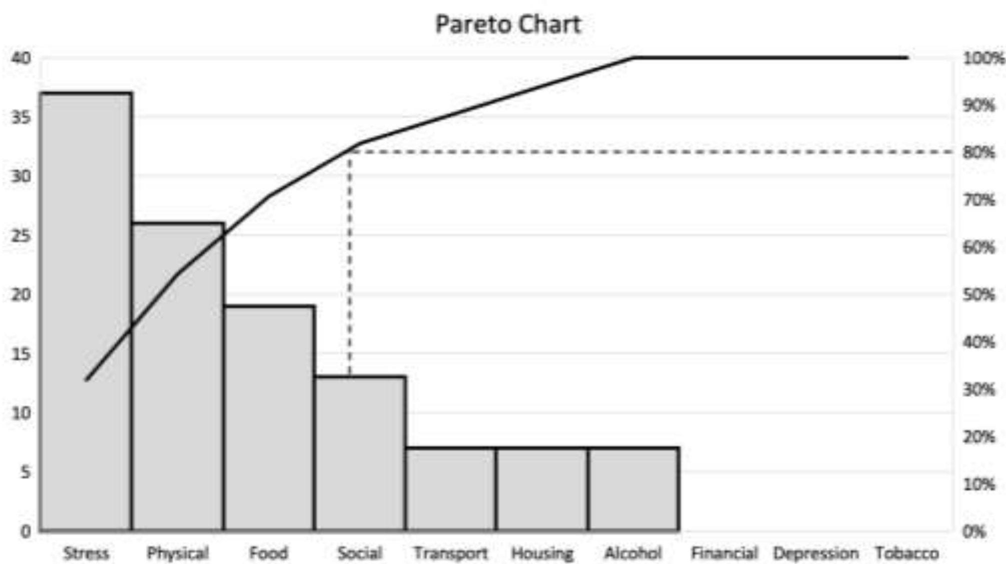

Figure 3: Pareto Chart showing the few important red alert determinants

Discussion

We were able to study the relationship between a cumulative maternal SDoH and neonatal birth weight and noted a negative trend, suggesting lower birth weight with higher SDoH score. Our findings suggest that cumulative SDoH score would be a better way to screen mothers at high risk of delivering smaller babies. For example, focusing on one determinant like physical activity may not achieve the desired results. Pathirathna et al (14) reported no relationship between physical activity during pregnancy and neonatal birth weight. Similarly, in a randomized control trial of exercise intervention among

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pregnant women, da Silva et al (15) found no differences between the intervention and control groups with regards to gestational age and birth weight.

The questionnaire-based generation of SDoH score has been used earlier. Palacio et al (16) used a survey questionnaire and showed an association between SDoH score and risk of cardiovascular disease. To derive the weighted SDoH score, they used linear regression and confirmatory factor analysis and estimated the coefficients of change of contributory variables on the dependent variable. In comparison, our SDoH score development was electronically generated, simple, and color based. The other cumulative SDoH format was described by Centers for Disease Control and Prevention (CDC). The CDC has developed a Social Vulnerability Index (SVI) (17). SVI is a publicly available online database tool that integrates 15 different community characteristics and groups them into 4 different themes to identify "at-risk" communities. Higher indices indicate high vulnerability. Given et al (18) have recently shown SVI as a value tool in identifying preterm births. They found a positive correlation between SVI and preterm births. In their study, the overall composite SVI was 0.46, while for term deliveries it was 0.43, for < 37 weeks 0.49, for < 34 weeks 0.51 and for < 28 weeks 0.54, respectively. We also note a similar negative trend in the birth weight with high SDoH.

The public health implication of the study stem from the observation of a negative relationship trend between maternal SDoH and birth weight. A healthcare provider or public health worker noticing a high SDoH score early in pregnancy could start timely counseling and monitoring for the potential effect on fetal growth. Those determinants with the red alert notification should be addressed on a priority and efforts should be taken to rectify the problems in early gestation.

The study had few limitations. The number of infants in low-birth-weight groups were small as most of the data were available on term pregnancies. One of the main reasons could be the urgency of care in premature birth and the time needed to complete the questionnaire. We did collect the details of the demographic data as a part of the study to keep the focus on SDoH. The other limitation has to do with the generalizability of the finding. The electronic system used in the study that generated the color-coded SDoH might not be available readily. The potential solution could be creating a weighted manual score based on the questionnaire responses. The strength of the study was the development of a unique simple cumulative SDoH score and using the color-coded severity alert. We applied the Pareto principle, frequently used in healthcare quality and management, to delineate the important determinants. No previous study on SDoH has used this concept.

In conclusion, maternal social determinants of health affect fetal growth and thereby affecting the birth weight. While attention should be given to all the determinants, efforts should be directed to alleviate stress among pregnant women. As healthcare providers and public health advocate, we should make sure that pregnant women in the community have access to good nutritious food and have environmental opportunities that encourage physical activity.

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