Introduction

India, the world's second most populous country, is undergoing a demographic transition from rural to urban. India witnessed 35% urbanization in 2020[1] due to the possibility of better access to jobs, income, education, health care, and other services. The continuous urbanization adds an enormous burden on the infrastructure and leads to the development of a greater number of urban poor, especially those living in slum neighborhoods (socioeconomically backward). Nearly seventeen percent of Indians stay in slums.[2] Slum-dwellers are victims of inequitable distribution of service availability and utilization compared to the nonslum urban population. Evidence indicates

Abstract

Context: Studies on prepregnancy body mass index (BMI), gestational weight gain (GWG), and pregnancy outcomes among urban Indian slums are sparse. Aims: To study BMI during early pregnancy, GWG, and maternal and neonatal outcomes among slum-dwelling women in Pune, India. Design: A retrospective study among pregnant women attending antenatal care (ANC) facility. Methods and Material: Anthropometric and clinical data throughout pregnancy and pregnancy outcomes postdelivery were collected during hospitalization for delivery using ANC cards. Asian BMI cut-offs were used to define underweight (UW), normal weight (NW), overweight (OW), and obesity (OB). GWG was classified into insufficient, adequate, and excessive categories (2009 Institute of Medicine). Statistical analysis was performed using R (v 4.0). Results: Slum-dwelling pregnant women (n = 509, mean age 24 (3.6) years) were studied. Seventy-five percent of the women visited ANC clinics at least thrice during pregnancy. Only 17.5% (n = 89) of the women registered before 12 weeks of gestation, and higher education and being primiparous were the correlates. A total of 28% of the women were UW, whereas 25% of the women were OW/OB as per early pregnancy BMI. The highest percentage of preterm deliveries and cesarean/instrumental deliveries were observed in OW/OB categories. A total of 27% gained appropriate gestational weight. This cohort had 508 live births (mean BW- 2.8 kgs) and one stillbirth. One baby had macrosomia (BW >4 Kg), whereas 19% were low birth weight (LBW) (BW <2.5 Kg). Conclusions: Double burden of malnutrition (UW and OW) was observed among young slum-dwelling women. The proportion of slum-dwelling women attending ANC clinics during early pregnancy is still low. Increased uptake of government programs is required to enhance maternal and child health.

Keywords: Early pregnancy BMI, gestational weight gain, India, pregnancy outcomes, slum-dwellers, urban

Original Article

Maternal early pregnancy body mass index, gestational weight gain and pregnancy outcomes among urban slum dwellers in Pune, India–A retrospective analysis

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substantial differences between slum and nonslum populations in terms of education outcomes, hunger, and health.[9] They also face challenges of epidemiological and nutritional transition as of their nonslum counterparts.[10] Easy access to high energy-dense food, changing sedentary lifestyle, and physical inactivity are fuelling issues in urban India, and these are also experienced by slum dwellers.

Around 250 million (~ 50% of all) Indian women are 15–49 years old.[9] Urban Indian women have a dual burden of being underweight and rapidly increasing overweight. A National health survey reported 15.5% of underweight and 31.3% of overweight among women of 15–49 years in Urban India.[6] In women, extreme body weight increases the risks of infertility and adverse pregnancy outcomes, such as preterm births, gestational diabetes, pre‑clampsia, cesarean section, or fetal death.[7] Additionally, Indians have a higher risk of noncommunicable diseases at a lower body mass index (BMI) level compared to the white population.[8] Prepregnancy BMI and gestational weight gain (GWG) are important driving factors impacting maternal and fetal pregnancy outcomes.[6,9]

A study from Chennai among slum dwellers has reported a prevalence of underweight and overweight or obesity in 18.8% and 27.7%, respectively.[11] The Mumbai maternal nutrition study has reported around 32% of underweight and 15% of overweight among young slum dwellers.[12] However, studies of prepregnancy BMI among young women, with associated GWG and pregnancy outcomes among this largely spread economically poor sector of urban society are sparse. The studies among young urban slum-dwelling women would help health care providers to get an insight into the overweight-related challenges in the poor strata and guide policymakers to take appropriate action.

To meet this knowledge gap, we set out to perform a retrospective study to assess pre‑pregnancy BMI, GWG, and pregnancy outcomes among slum-dwelling women of reproductive age in Pune city, western India.

Pune is one of the fastest-growing cities in the western part of India. It has witnessed rapid growth in terms of in-migration and industrialization-induced urbanization, which has resulted in a rising proportion of slums in the city changing its social fabric significantly.[13]

**Subjects and Methods**

**Study design and participants**

Ours was a retrospective study where 730 women attending antenatal care (ANC) facilities from nearby slums for their delivery were contacted during December 2018 through August 2019. Six hundred fifty-five women consented for participating in the study. During hospitalization for delivery, face-to-face interviews were conducted to collect information on socio-demographic characteristics and monthly family income. Anthropometry (height and weight on date of enrolment till delivery) and clinical information (such as any previous illness/obstetric and medical history) were obtained retrospectively based on their ANC card by trained research staff using a structured questionnaire. Information on pregnancy outcomes was collected. After the delivery, maternal height and weight were recorded using a portable stadiometer (Seca Portable stadiometer, 20–205 cm, Hamburg, Germany) and digital weighing scale (Salter, India). Written informed consent was obtained in the local language from all the participants. The study was approved by the Institutional ethics committee. The place of residence as slums was confirmed from their hospital records and proof of residence. Slum conditions are defined by the United Nations as having inadequate access to durable housing, sufficient living areas, safe water, sanitation, basic services, and protection against forced eviction.[14]

**Categories of early pregnancy BMI and GWG**

Women registering to ANC clinics during or before 12 weeks of gestation were termed as “early ANC registering women.” Asian cut-offs defined by WHO were used to define underweight (<18.5 kg/m²), normal weight (18.5–23.0 kg/m²), overweight (23.0–27.5 kg/m²) and greater than 27.5 kg/m² as obese.[15] Gestational age (weeks) was computed from the actual date of delivery and the date of the last menstrual period. Gestational weight gain (GWG) was computed by subtracting weight before delivery and weight at first trimester (<12 week) for early ANC registering women. GWG was classified into insufficient, adequate, and excessive categories based on the 2009 Institute of Medicine recommendations.[16] Early pregnancy BMI was considered as a proxy for prepregnancy BMI as no information was recorded regarding prepregnancy weight on the ANC card. Underweight, overweight and obesity status determination and GWG were restricted to early ANC registering women only.

**Maternal and neonatal outcomes**

At birth, maternal outcomes such as type of delivery, intrapartum complications (premature rupture of membranes, signs of preeclampsia, obstructed labor, malpresentation, oligohydramnios, previous cesarean section, abdominal pain), and postpartum complications (postpartum hemorrhage, anemia, dizziness, palpitation) were recorded. Also, neonatal outcomes such as the gender of the baby, birth weight (Kg), and length at birth (cm) were measured using standardized equipment (infant digital weighing scale and infantometer). Low birth...
weight (LBW) was defined as birth weight <2.5 Kg, whereas macrosomia was defined as birth weight >4 Kg.

Sample size estimation
A sample size of 400 was estimated based on 30% overweight and 18% of underweight with 3%–4% allowable error among Pune resident women, at 95% confidence level. As the nature of the study was retrospective, we planned to collect data on a higher number of women to mitigate the risk of incomplete records.

Statistical analysis
Continuous data were presented using mean (standard deviation) or median (interquartile range), and categorical data were presented as numbers and percentages. Association of categorical socio-demographic factors with the status of early/late ANC registering women was tested using Chi-square test and independent t-test for continuous variables. Leven’s test was applied to test equality between variances before applying the t-test. Logistic regression analysis was performed to identify correlates of low birth weight status. Results of logistic regression analysis are presented as an odds ratio with a 95% confidence interval by exponentiating estimates. The level of significance (LOS) was considered as 0.05 for testing statistical significance. Data analysis was performed using R version “4.0.”

Results

Maternal socio-demographic characteristics
We collected data on 655 women attending ANC clinic between December 2018 and August 2019 for their delivery. Owing to the retrospective nature of the study, erroneous and missing data, we reported the data of 509 pregnant slum-dwelling women in the manuscript ahead. These women were 24 (3.6) years old, almost half of them (48%) had completed at least 10th grade of education, and the majority of them (87%) were housewives. Half of the women were from lower socio-economic class as per the Kuppuswami scale[19] where monthly family income was below 20,000 INR (285 USD/month). The median family size was six members per family. Seventy-five percent of (n = 381) women attended ANC clinics before 12 weeks of pregnancy (data not shown); however, only 17.5% women registered in ANC clinics before 12 weeks of gestation. [Table 1]

Maternal pregnancy outcomes
Forty-eight percent of women were primiparas, and the mean length of gestation was 37.5 (1.8) weeks. More than 80% had induced labors, and 38% underwent cesarean section. The percentage of intrapartum and postpartum complications was low (~3%). [Table 1]

Neonatal characteristics
This cohort had 508 live births with 260 boys to 248 girls of mean birth weight 2.8 (0.4) kgs and mean length 48.6 (2.9) cm, and there was one stillbirth (0.02%). There was 8% neonatal intensive care unit (NICU) admissions mostly due to late crying of babies followed by the presence of jaundice. Macrosomia was observed in one child (0.02%), whereas 19.1% were low birthweight babies. [Table 2]

Early vs. late registering pregnant women to ANC clinic
We observed that 89 (17.5%) women of mean age 24 years attended ANC clinics before 12 weeks of pregnancy. Higher percentage of women registering early in ANC clinics were more educated (Chi-squared = 5.495, \(P = 0.064\)) and primiparous (Chi-squared = 4.24, \(P = 0.039\)) compared to the late registering women. Age, occupation, and monthly family income did not differ significantly between these two groups.

BMI status during early pregnancy, gestational weight gain, and neonatal outcomes
Women registering in the first 12 weeks (n = 89) were classified as underweight, normal weight, overweight, and obese as per their early pregnancy BMI. Twenty-eight percent of women were underweight, 47% were normal weight, whereas 19.1% of the women were overweight, and 5.6% were obese. Mean gestational weight gain was 11.6 (5.3) kg among underweight women and 6.6 (5.5) kg among overweight/obese group. Thirty-seven percent of underweight women and 23%–24% among normal weight, overweight, and obese women gained gestational weight as per the Institute of Medicine (IOM) recommendations. Twenty-three percent of overweight/obese women gained excess weight. Twenty-seven percent of early ANC attendees gained appropriate gestational weight as per the IOM criteria. The highest percentage of cesarean/instrumental deliveries were observed in overweight and obese categories though not statistically significant. Babies born to underweight mothers were lighter and shorter compared to the babies born to normal and overweight or obese mothers. [Figure 1, Table 3]

Mothers belonging to the normal weight and overweight category had lower risk of LBW although statistically nonsignificant [OR = 0.36 (0.11–1.11) and 0.28 (0.06–1.12)] with \(P = 0.078\) and \(P = 0.089\), respectively] at 5% length of stay (LOS).

Figure 1: Gestational weight gain per the IOM criteria by maternal BMI during early pregnancy (n = 89)
We observed that seventy-five percent of women visited the ANC clinic at least thrice or more during pregnancy. This is one of the important recommendations made by the Govt of India for improved pregnancy outcomes. However, only 17.5% of women attended ANC clinics before 12 weeks of gestation. Parity and education were determinants of attending ANC clinics early. Twenty-eight percent

Table 1: Socio demographic characteristics and maternal pregnancy outcomes among slum dwelling women in Pune, India

| Parameters                      | Total          | Early ANC Registering women | Late ANC Registering women |
|---------------------------------|----------------|----------------------------|---------------------------|
| n                               | 509            | 89                         | 420                       |
| Age (years)                     | 24.0 (3.7)     | 24.1 (3.9)                 | 24.0 (3.7)                |
| Height (cm)                     | 153.6 (5.6)    | 153.5 (5.3)                | 153.7 (5.6)               |
| Early pregnancy BMI (Kg/m2)     | NA             | 21.1 (4.2)                 | NA                       |
| Early pregnancy weight (kg)     | NA             | 49.7 (9.6)                 | NA                       |
| Pre delivery weight (kg)        | NA             | 58.7 (9.6)                 | NA                       |
| Gestational weight gain (kg)    | NA             | 9.0 (5.3)                  | NA                       |
| Post-delivery weight (kg)       | NA             | 57.0 (10.2)                | NA                       |
| Level of Education (n=447)      |                |                            |                           |
| <10 years, n (%)                | 231 (51.7)     | 35 (45.5)                  | 196 (33.0)                |
| <12 years, n (%)                | 111 (24.8)     | 16 (20.8)                  | 95 (25.7)                 |
| ≥12 years, n (%)                | 105 (23.5)     | 26 (33.8)                  | 79 (21.4)                 |
| Occupation                      |                |                            |                           |
| Housewife, n (%)                | 392 (88.0)     | 66 (86.8)                  | 326 (88.1)                |
| Working, n (%)                  | 54 (12.0)      | 10 (13.2)                  | 44 (11.9)                 |
| Monthly Family income (INR)     |                |                            |                           |
| <20000 INR, n (%)               | 178 (48.8)     | 34 (50.7)                  | 144 (48.3)                |
| ≥20000 INR, n (%)               | 187 (51.2)     | 33 (49.3)                  | 154 (51.7)                |
| Total number of family members* | 6 (5, 8)       | 6 (5, 8)                   | 6 (5, 8)                  |
| Parity                          |                |                            |                           |
| Primiparous (=1), n (%)         | 242 (48.0)     | 51 (58.6)                  | 191 (45.8)                |
| Multiparous (>1), n (%)         | 262 (42.0)     | 36 (41.4)                  | 226 (54.2)                |
| Length of gestation (weeks)     | 37.5 (1.8)     | 37.1 (1.7)                 | 37.5 (1.8)                |
| Type of delivery                |                |                            |                           |
| Spontaneous- Yes, n (%)         | 89 (17.6)      | 14 (15.7)                  | 75 (18.0)                 |
| Induced - Yes, n (%)            | 417 (82.4)     | 75 (84.3)                  | 342 (82.0)                |
| Mode of Delivery                |                |                            |                           |
| Vaginal -Yes, n (%)             | 307 (61.6)     | 50 (56.8)                  | 257 (62.7)                |
| Instrumental/Caesarean Yes, n (%)| 191 (38.4)    | 38 (43.2)                  | 153 (37.3)                |

Maternal Pregnancy Outcomes

Intrapartum complications†

- Yes, n (%) 16 (3.1) 2 (2.2) 14 (3.3)

Postpartum complication‡

- Yes, n (%) 15 (2.9) 2 (2.2) 13 (3.1)

Data presented as mean (SD)/median (IQR)/n (%). *Working ‑ daily wages, service, and self-employed, †median (IQR). ‡Intra partum complications such as premature rupture of membranes, signs of preeclampsia, obstructed labor, malpresentation, oligohydramnios, previous caesarean section, abdominal pain. †Post partum complications such as postpartum hemorrhage, anemia, dizziness, palpitation.

Table 2: Neonatal size and Neonatal complications among slum dwellers in Pune, India

| Parameters                      | Total          | Early ANC Registering women | Late ANC Registering women |
|---------------------------------|----------------|----------------------------|---------------------------|
| n                               | 509            | 89                         | 420                       |
| Birthweight (kg)                | 2.8 (0.4)      | 2.8 (0.4)                  | 2.7 (0.4)                 |
| Birth length (cm)               | 48.6 (2.9)     | 48.7 (2.1)                 | 48.6 (3.1)                |
| Head circumference (cm)         | 33.1 (2.5)     | 33.4 (2.9)                 | 33.0 (2.4)                |
| Boys/Girls, n (%)               | 260 (51.2)/248 (48.8) | 52 (58.4)/37 (41.6)       | 208 (49.6)/211 (50.4)     |
| NICU admission (Yes), n (%)      | 38 (7.6)       | 4 (4.6)                    | 34 (8.2)                  |
| Macrosomia (Birth weight ≥4 kg) Yes, n (%) | 1 (0.20)       | 0                         | 1 (0.20)                  |
| Low birthweight (<2.5 Kg)       |                |                            |                           |
| Yes, n (%)                      | 97 (19.1)      | 19 (21.3)                  | 78 (18.6)                 |

Discussion

We observed that seventy-five percent of women visited the ANC clinic at least thrice or more during pregnancy. This is one of the important recommendations made by the Govt of India for improved pregnancy outcomes. However, only 17.5% of women attended ANC clinics before 12 weeks of gestation. Parity and education were determinants of attending ANC clinics early. Twenty-eight percent
of the women were in the underweight category, whereas 25% of the women were overweight or obese during early pregnancy in this economically deprived sector of urban society. More than half of 89 women (n = 52) gained inadequate gestational weight, whereas 27% percent gained appropriate gestational weight. One baby had macrosomia, whereas 19% were LBW.

Kumar et al[19] have reported that 28% women attended ANC clinics during the first trimester, on the other hand, we observed that a lower percentage (17.5%) of women attended clinics during the first trimester. A study among slum dwellers in Varanasi has reported only 18% of women attending ANC clinics more than thrice during pregnancy including one in the first trimester, an observation similar to ours.[20] Government programs and health policies recommend pregnant women to register the pregnancy as soon as possible for safe pregnancy outcomes. Although recent studies have shown significant improvement in the frequency of attending ANC clinics, our study calls for strengthening the awareness campaign regarding the timing of ANC clinic registration, preferably as soon as women suspect pregnancy. Our study suggests that a mere increase in awareness may not translate into increased utilization of the facilities and targeted efforts are needed, especially for groups of illiterate and multiparous women.

We had to restrict primary analysis of early pregnancy BMI status to 17.5% of early ANC registering women. Our study participants were young (mean age 24 years). Higher body weight is generally considered a problem of the affluent class, but 25% of the participants exhibited overweight or obesity. The PRESUME study observed a similar percentage of overweight and obesity in young women in a South Indian city.[21] Only 25–35 percent of Indian pregnant women gain weight according to the IOM recommendation, and the same is also observed in our study of poor women residing in urban slums.[22,23] Pre-pregnancy BMI and gestational weight gain (GWG) are two modifiable risk factors. Health care providers may thus guide young women to a normal BMI range in pre-pregnancy phase so as to gain appropriate weight during pregnancy.

A large percentage of women were induced for delivery, and 40% underwent cesarean section. One baby had macrosomia, whereas nearly one among five babies was LBW. A higher number of induced labor and cesarean sections is indicative of a higher economic burden on the health sector among slum-dwelling families. These are also clear evidence of the dual burden that an urban Indian society possesses even in the poor stratum.

There are very few studies conducted among pregnant women residing in slums. Despite the low number of women available for analysis of our primary objective, it serves as an important pilot study for assessing early pregnancy BMI status, GWG in each of the BMI categories, and association of GWG with pregnancy outcomes. Our study has important public health implications, we report that more than half the young women were either underweight or overweight indicating evidence of the dual burden of malnutrition in this poor stratum of society. Furthermore, only one out of four women gained appropriate weight during gestation. Also, our study emphasizes the need for conducting community programs for early ANC clinic registration focusing, especially on illiterate and multiparous women.

Our limitations include that we used weight at or before 12 weeks of gestation as a proxy for pre-pregnancy weight and due to the nature of the study, we could not collect pre-pregnancy weight which would have added more precise information for assessing GWG. We did not observe any statistically significant association between early pregnancy maternal overweight and adverse neonatal outcomes, but the likely reason could be the small sample size available for the analysis. Also, the collection of diet and physical activity data would enhance the understanding of GWG; these aspects were not included in the study due to its retrospective nature.

To conclude, the dual burden of being over and underweight in young women of childbearing age is seen in urban slums. The proportion of slum-dwelling young women attending ANC clinics during early periods of pregnancy is low; increased uptake of government programs is thus required to enhance maternal and child health. A large proportion of pregnant women do not gain adequate weight during pregnancy. It is important for health care workers and policymakers to conduct awareness programs focusing on the timing of attending ANC clinics, appropriateness of preconception maternal weight and weight gain during pregnancy in the underprivileged stratum of young women of childbearing age in urban India.

**Key Points**

- Our study calls for urgent targeted efforts towards early registration in ANC clinics of uneducated and
• The study emphasizes the double burden of malnutrition among young slum-dwelling women.
• Inappropriate gestational weight gain and the need for intervention poses a higher economic burden on the health care sector.

Compliance with ethical standards
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee.

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Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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