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Is maternal body mass index associated with neonatal mortality? A pooled analysis of nationally representative data from nine Asian countries

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A B S T R A C T

Objective: Children born to mothers with abnormal body mass index (BMI) have increased risk for mortality. The aim of this study was to investigate whether maternal BMI is a risk factor for neonatal death in select Asian countries, including the nature of association between maternal BMI and the discrete timing of neonatal death.
Methods: Nationally representative, the standard Demographic and Health Survey data from nine Asian countries were used. In all, 55 629 mothers reported their index birth; 840 reported neonatal mortality. Descriptive statistics and multivariate logistic regression analyses were applied to attain the study objective.
Results: Overweight mothers had higher odds of neonatal mortality than mothers with optimum weight. No significant association was registered for obese mothers, possibly due to insufficient power. During the first 7 d (0–1 and 2–6 d) of birth, children born to overweight mothers had higher odds of dying, whereas for the remaining period (7–27 d), maternal underweight was the risk factor for neonatal mortality.
Conclusion: Interventions should target high-risk pregnancies to reduce the rate of neonatal mortality. With the help of community health workers or physicians, preconception counseling of prospective mothers with abnormal BMI should be devised. If conceived, underweight or overweight or obese women should be marked as high-risk pregnancy during their antenatal care visits, and they must be encouraged for delivery at an institution equipped with an emergency obstetric and neonatal care unit.

Introduction

To our knowledge, few studies exist on abnormal maternal body mass index (BMI) and its effect on adverse pregnancy outcomes in Asian countries. Neonates born to mothers with abnormal BMI are more likely to require admission into the neonatal intensive care unit [1–4]; encounter higher neonatal complications such as hypoglycemia, hyperbilirubinemia, respiratory distress syndrome [2, 5]; and have increased risk for stillbirth and perinatal death [6] than offspring of mothers with optimum BMI. Studies have shown that overweight or obese mothers are at increased risk for hypertensive complications, gestational diabetes, cesarean delivery, postpartum hemorrhage, and fetal macrosomia [7–10], whereas underweight mothers are at risk for preterm delivery and small-for-gestational-age infants [11]. Women who had low BMI as girls due to poor nutritional status, and who did not gain enough weight after conception and during pregnancy may deliver babies with low birth weight, which may increase susceptibility to infectious diseases and mortality of newborn [12].

In recent times, Asian countries have witnessed the coexistence of a high level of undernutrition and an increasing level of body weight [13]. However, a search of the literature did not reveal any studies that examined the association between maternal BMI and neonatal survival among the Asian population. We searched PubMed for articles published through January 16, 2017, in any language with the search terms *underweight* or *overweight* or *obesity* and *neonatal* or *perinatal* and *mortality* or *death*. None of the citations identified from the search investigated the association between maternal BMI and neonatal

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mortality, using the World Health Organization's (WHO) criterion of BMI for the Asian population [14]. Against this backdrop, using nationally representative data from nine Asian countries, the present study aimed to investigate whether maternal BMI is a risk factor for neonatal death, and the nature of the association between BMI and the discrete timing of neonatal death.

Methods

Data set

The present study is based on the Demographic and Health Survey (DHS) data available in the public domain for researchers with all identifying information removed; no ethical clearance is required.

The standard DHS data sets of nine Asian countries (i.e., Bangladesh, India, Maldives, Nepal, Pakistan, Cambodia, Timor-Leste, Kyrgyzstan, and Tajikistan) were used. The latest rounds of DHS data sets from each country (not preceding 2000) were considered. Data for some Asian countries—Afghanistan (2015), Philippines (2013), Yemen (2013), Indonesia (2012), Vietnam (2002), and Turkmenistan (2000)—were not available because of reasons such as restricted access to the data set, unavailability of the data set, and unavailability of the information on maternal BMI in the respective data sets. DHS gathers nationally representative high-quality data targeting health and demographic indicators, which often are used to frame the country's health policy [15]. Selected data sets recorded >90% of the response rate, and by virtue of its sampling design, the cross-country comparison of estimates are reliable. More information about the DHS data can be obtained from its official website and it online data retrieval portal.

Defining neonatal mortality and body mass index

Neonatal mortality is defined as the death of a live born infant during the first 28 d of life (days 0–27). To arrive at this, information was collected on birth histories on live births for each eligible woman. Questions were posed to women about the month and year of each birth, including multiple gestations, survival status of child at the time of survey, and current age or age of death, as applicable. Age at death was recorded in days if the child died within the first month of life, in months if the child died between 1 mo and the second birthday, or otherwise in years. This study used the data on neonatal mortality for the index singleton birth experienced in the 5 y preceding the survey.

Quetelet's index or BMI (defined as the ratio of the weight in kilograms to the square of the height in meters) is widely used as a measure of fatness or nutritional status. DHS follows standard tools to measure the height and weight of adults. Standard classifications of BMI for Asians, recommended by the WHO [14], were applied: underweight (<18.5 kg/m^2), optimum (18.5–22.9 kg/m^2), overweight (23–27.4 kg/m^2), and obese (≥27.5 kg/m^2). Analyses excluded women declared pregnant at the time of the survey as well as those with a birth in the 2 mo preceding the survey. DHS did not collect information on prepregnancy BMI; therefore, the study assumed that maternal BMI at the time of the survey measured the same as that before the index birth. Flagged cases (if a recorded measurement of height or weight was outside the acceptable range), and missing cases identified by DHS were removed from the study, as it could lead to a biased estimate.

Predictors

Along with maternal BMI, a range of potential predictor variables were selected. These included mother's age at birth, place of residence, wealth quintile, birth order, parity, birth interval, sex of the child, maternal education, maternal work status, information on safe delivery care, and time since the index birth reported. Direct self-reported information was obtained on mother's age at birth when the index child was born. Birth at an immature age was considered unsafe for the survival of mothers and children. Information on sociodemographic characteristics and health care utilization by mothers was self-reported. Mothers responded to queries regarding their children.

DHS provides the variable wealth index developed using standard household assets and durables. This relative index often is used as proxy for household economic status and considered a robust measure of poverty level [16]. To assess the differences in BMI changes after the index birth in women with live and diseased neonates, the variable time elapsed between the index birth and the survey was constructed. A dummy variable representing country of survey also was developed to understand the country-level variation.

Statistical analysis

To attain the study objective, both bivariate and multivariate analyses were deployed. Because some of the selected predictor variables seemed to have multicollinearity issues, a variance inflation factor (VIF) was estimated. All the VIF values were <5, suggesting that the possibility of high multicollinearity was low. To enhance the statistical power in fulfilling the study objective, all data sets of the nine Asian countries were pooled. The multivariable binary logistic regression was deployed to estimate the statistical association between maternal BMI and neonatal mortality. Instead of a linear probability model, a binary logistic regression function proved preferable to fit some kind of sigmoid curve when the response variable was dichotomous (binary or 0–1) and that portrayed the reality about outcome events reasonably. In the present study, the binary response (y, neonatal mortality or not) for each individual was related to a set of categorical predictors, X, and a fixed effect by a logit link function:

$$\text{logit}(\pi_i) = \log[\pi_i/1 - \pi_i] = \beta_0 + \beta(X) + \varepsilon$$

The probability of neonatal mortality is π_i. The parameter β_0 estimates the log odds of the outcome variables for the reference group, and the parameter β estimates with maximum likelihood, the differential log odds of neonatal mortality associated with the predictor X, compared with the reference group. The term ε represents the error term or residual in the model. The appropriate sampling weight was used. Data analyses were performed using the "svy" suite in statistical software (Stata version 12; StataCorp; College Station, TX, USA), which allows complex survey data analysis and adjusts sampling weights while estimating SE and confidence intervals (CIs). The variables found significant at $P < 0.05$ in the binary logistic regression model were discussed.

Results

The study included 55 629 women (Table 1). The largest group of women was from India (n = 29 855), and Nepal had the

Table 1
Percentage distribution of maternal BMI category by country and region

Country (Year of data collection)	n	Maternal BMI category			
		Underweight (<18.5 kg/m^2)	Optimum (18.5–22.9 kg/m^2)	Overweight (23–27.4 kg/m^2)	Obese (≥27.5 kg/m^2)
Southern Asia					
Bangladesh (2014)	6100	1390 (22.1%)	2716 (45.6%)	1491 (24.4%)	503 (8%)
India (2005–2006)	29 855	9955 (40.2%)	14 036 (44.9%)	4398 (11.3%)	1466 (3.6%)
Maldives (2009)	2345	212 (8.7%)	764 (32.3%)	839 (36.2%)	530 (22.7%)
Nepal (2011)	1725	305 (19.7%)	1034 (57.3%)	322 (19.7%)	64 (3.3%)
Pakistan (2012–2013)	2001	252 (17.2%)	704 (35%)	615 (27.5%)	430 (20.4%)
Southern pooled	42 026	12 114 (34.2%)	19 254 (44.4%)	7665 (15.5%)	2993 (5.9%)
Southeastern Asia					
Cambodia (2014)	3395	391 (11.5%)	1852 (55.1%)	893 (25.9%)	259 (7.5%)
Timor-Leste (2009–2010)	4792	1268 (26.1%)	2834 (59%)	590 (12.8%)	100 (2.2%)
Southeastern pooled	8187	1659 (20%)	4686 (57.4%)	1483 (18.2%)	359 (4.4%)
Central Asia					
Kyrgyzstan (2012)	2563	158 (6.4%)	1049 (41.7%)	882 (33.6%)	474 (18.2%)
Tajikistan (2012)	2853	273 (9.4%)	1297 (46.4%)	850 (30.3%)	433 (13.9%)
Central pooled	5416	431 (8.1%)	2346 (44.3%)	1732 (31.8%)	907 (15.8%)
All Asian pooled	55 629	14 204 (29.7%)	26 286 (46.2%)	10 880 (17.4%)	4259 (6.6%)

BMI, body mass index
All count data are unweighted, and percentage values are weighted