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Original article

An Institutional Based Cross Sectional Analytical Study on Nutritional Determinants of Low Birth Weight

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Abstract

Background: Maternal nutrition during pregnancy is a key factor influencing birth outcomes. Pregnant women are at increased risk of various nutritional deficiencies, particularly in developing countries. Besides, most LBW infants in these countries are full-term newborns with intrauterine growth restriction due to maternal malnutrition and poor gestational weight gain. ***Objective:*** To study distribution of new-borns' according to nutritional determinants of mothers' and its association with low birth weight. ***Methods:*** An institutional based cross-sectional analytical study. New-borns delivered at study institute were considered as study participants. Estimated final sample size was 500. Sampling was done by Systemic random sampling method. Guardians (mothers) were face-to-face interviewed and also recorded data were collected from the case file and Mother and Child Protection (MCP) Card. ***Results:*** Majority newborns belonged to lower middle 194 (38.8%) and middle class164 (32.8%), More than two third (68.2%) newborns belonged to mothers who had pre pregnancy weight ≥45 kg, 86.4% from mothers whose height were ≥145 cm, 84.2% from mothers whose BMI ≥18.5 kg/m2, 65.6% newborns belonged to mothers whose weight gain were ≥ 9 kg, 18.2% from mothers who consume meals <3 times in a day, 82.8% from mothers who were anaemic, 85.2% and 79.4% taken regular IFA and calcium tablets respectively. Newborns belonged to mothers who were provided health education, supplementary nutrition, maternity benefits were 89%, 32%, 36.4% respectively. The odds of having LBW was significantly higher in lower and middle socioeconomic class, mothers with height <145 cm, BMI less than 18.5 kg/m2, weight gain less than 9 kg, consume <3 meals in a day and not received supplementary nutrition at anganvadi. ***Conclusion:*** The present study revealed that lower and middle socio-economic class, mothers with height <145 cm, BMI <18.5 kg/m2, <9 kg weight gain, consume <3 meals in a day and not received supplementary nutrition at anganvadi were statistically significant risk factors that associated for delivering LBW newborns.

Keywords: ***Low birth weight, nutritional determinants, Cross sectional analytical study.***

Introduction

Low birth weight is one of the most serious challenges in maternal and child health in both developed and developing countries [1]. It is an essential determinant of survival, mortality, morbidity and disability in infancy and childhood and also has a long-term impact on health outcomes in adult life [2]. It is a reliable indicator in monitoring and evaluating the success of maternal and child health programmes [3]. The World Health Organization (WHO) defines low birth weight (LBW) as "Birth weight less than 2500 grams" regardless of gestational age, the measurement being taken preferably within the first hour of life [4]. LBW babies are at an increased risk of asphyxia, hypoglycaemia, polycythaemia-hyper viscosity and hypothermia. There is increased risk of long-term disability, impaired development like delayed motor and social development, being enrolled in special education classes, having a lower IQ, and dropping out of high school among the low-birth-weight infants. LBW is a multifaceted problem that may result in a wide spectrum of diseases in later life such as hypertension, ischemic heart disease, stroke, metabolic syndrome, diabetes, malignancies, osteoarthritis and dementia [5]. Being born with a low birth weight also incurs enormous economic costs, including higher medical expenditures and social service expenses, and decreased productivity in adulthood [6].

WHO estimates that Babies born at a healthy weight are more likely to survive and thrive - while the 20.5 million babies born at low birthweight enter the world at a marked disadvantage. One in every seven newborns was born with low birthweight in 2015. This report indicates that nearly 15 per cent of all infants worldwide are born with low birthweight, jeopardizing their survival, health and development. Almost all of them – 95 per cent – are born in less developed regions. Southern Asia is the region with highest incidence (27%). The prevalence of low birthweight varied widely across regions – from 7.2 per cent in More Developed Regions to

17.3 per cent in Asia. Asia has the lowest mean birth weight babies in the world. Almost a third of the newborn in the South East Asia region is low birth weight. Of the 20.5 million low birthweight babies born in 2015, more than half were born in Asia. Indeed, Southern Asia accounted for nearly half of all low birthweight newborns in the world. Slow progress on reducing the prevalence of low birthweight in all regions and subregions threatens to undermine global efforts to end preventable newborn deaths and reduce the number of children suffering from stunting and wasting [7].

Various medical risk factors have been identified for LBW such as maternal malnutrition, maternal pre pregnancy weight, maternal weight gain during pregnancy, maternal height < 145 cm, inadequate dietary intake during pregnancy, inadequate antenatal check-up (<4 visits), anaemia, hypertension, multiple pregnancies, maternal intrauterine infection, high parity, close birth spacing, heavy work during pregnancy, rest, smoking and alcohol consumption during pregnancy and fetal chromosomal anomalies [8]. Maternal nutrition during pregnancy is a key factor influencing birth outcomes. Pregnant women are at increased risk of various micronutrient deficiencies, particularly in developing countries [9,10]. Besides, most LBW infants in these countries are full-term newborns with intrauterine growth restriction due to maternal malnutrition and poor gestational weight gain [11,12].

The problem of LBW, therefore, is a matter of public health concern worldwide and more serious in India. So, the present study was designed to study distribution of new-borns' according to nutritional determinants of mothers' and its association with low birth weight.

Material and Methodology

Study Setting, Study Design, Study Participants, Sample Size, Sampling Method

An institutional based cross-sectional analytical study design which was conducted from December 2020 to November 2021 in all three Post-natal wards of gynaecology department at Guru Govind Sinh tertiary care hospital. New-borns delivered at study institute were considered as study participants. Estimated final sample size was 500 based on equation N = Z2 (1-α/2) pq/ l2 (at 5% alpha error and 95% CI), Which is based on 27% prevalence of LBW in the studied institution in previous year, relative error which was 15% of p and taking non response rate as 5% of sample size. For the data collection post-natal wards were visited because mother and baby were put at least 48 hrs under observation after the delivery. Sampling was done by Systemic random sampling method. In which by considering total numbers of deliveries in previous 3 months of the study and sample size, the sampling interval (3) was obtained. In gynaecology department each unit was visited on post emergency day and every third study participants indoor in post-natal ward after delivery was selected. In case of non-respondent, next subject to non-respondent was selected for the study.

Inclusion and Exclusion Criteria

Singleton live newborns of Postnatal mothers', Newborns' mothers who were willing to participate, Informant and participants must be free from any sever, debilitating and mental illness were included. Newborns' mothers who were not willing to participate, Twins and Still births were excluded from the study.

Data Collection Tools

A predesigned, pre-tested and semi-structured questionnaire was used to gather the information. It was prepared after doing different works of the literature and prepared in English language. Pilot study was conducted for appropriateness of format and wording of questionnaire, time needed for data collection and feasibility of sampling procedure. The information regarding the study variables like Socio economic class (modified BG Prasad classification, revised for year 2020, CPI-330), Pre pregnancy weight, height, BMI, weight gain during pregnancy, diet, Meals per day, anaemia, iron folic acid tablet intake, Calcium tablet intake, receiving health education, Supplementary nutrition provided at Anganvadi, Maternity benefits in terms of money were collected.

Data Collection, Data Storage and Data Analysis

Guardians (mothers) were face-to-face interviewed and also recorded data were collected from the case file and Mother and Child Protection (MCP) Card. The collected data were first checked for completeness and consistency and then it was compiled in Microsoft excel sheet and analysed in SPSS software version 26. Both descriptive and inferential statistics were used in the analysis. In descriptive statistics frequency and percentage were computed to show the results. Proportion of low birth weight was determined first and LBW proportion associated with each factor was computed by chi-square test. Variables which were significant in chi-square, enrolled in binominal multivariate logistic regression model for identification of actual predictors. Statistical significance was set at the probability value ($P < 0.05$).

Ethical Clearance and Consent

This study was started after getting ethical clearance from institutional ethics committee with Ref. No. IEC/Certi/85/03/2020. The participant's consent was obtained first after explaining the purpose of the study.

Result

The proportion of low birth weight in study institute was 29.2% and mean weight of new born babies was 2.7 kg.

Table I shows distribution of newborns' according to nutritional determinants. Majority newborns belonged to lower middle 194 (38.8%) and middle class164 (32.8%) according to Modified BG Prasad classification (Revised for year 2020). More than two third (68.2%) newborns belonged to mothers who had pre pregnancy weight ≥ 45 kg. Majority (86.4%) of newborns belonged to mothers whose height were ≥ 145 cm. For mother's body mass index category Indian cut-off was used. More than four fifth (84.2%) newborns belonged to mothers whose BMI ≥18.5 kg/m2. Nearly two third (65.6%) newborns belonged to mothers whose weight gain ≥9 kg. during the pregnancy. Out of 500 newborns' 62.6% newborns belonged to mothers who were vegetarian while 37.4% from mix diet. Mothers consuming ≥3 meals in a day were 81.8% while 18.2% consumes <3 meals. Majority (82.8%) newborns belonged to mothers who were anaemic while only 17.2% from non-anaemic mothers. More than three forth of the newborns belonged to mother who were taken IFA and calcium tablets regularly which were 85.2% and 79.4% respectively. Newborns belonged to mothers who were received health education, supplementary nutrition, maternity benefits were 89%, 32%, 36.4% respectively.

Table II shows association between nutritional determinants and newborns' birth weight. The proportion of low-birth-weight newborns was 41.22% in lower socioeconomic class, 46.5% in mothers' pre pregnancy weight less than 45 kg, 72.1% in mothers' height less than 145 cm, 50.63% in mothers with BMI less than 18.5 kg/m2, 56.98% in mothers with less than 9 kg. weight gain during the pregnancy, 34.2% in mothers with vegetarian by diet, 53.85% in mothers consume <3 meals in a day, 31.6% in anaemic mothers, 52.7% in mothers consume irregular IFA tablet, 47.6% in mothers consume irregular calcium tablet, 33.8% in mothers who were not received supplementary nutrition at anganvadi and all above mention variables shown statistically significant risk for delivering LBW babies as compared their contrary part. Received health education during antenatal care and maternity benefits in terms of money did not show any significant risk for delivering LBW babies.

Variables which were statistically significant in the bivariate analysis were included in the multivariate logistic regression model to identifying the actual predictors and to exclude the confounding

factors (**Table III**). The Odds of having LBW were significantly higher in middle (AOR=4.38; 95% CI: 1.21-15.86) and lower socioeconomic class (AOR=10.26; 95% CI: 2.84-37.07) as compared to higher socioeconomic class. The odds of having LBW 7.91 (AOR=7.91; 95% CI: 3.75-16.66) time higher in mothers with height <145 cm, 3.70 (AOR=3.70; 95% CI: 1.69-8.08) times higher in mothers with BMI <18.5 kg/m2, 5.34 (AOR=5.34; 95% CI: 3.04-9.37) times higher in mothers whose weight gain <9kg, 3.22 (AOR=3.22; 95% CI: 1.74-5.96) times higher in mother who consume <3 meals per day, 2.59 (AOR=2.59; 95% CI: 1.39-4.81) times higher in mothers who were not received supplementary nutrition at anganwadi while mothers pre pregnancy weight, type of diet, anaemia, IFA and Calcium tablet intake did not show any significant risk for delivering LBW babies.

Table I: Distribution of newborns' according to nutritional determinants.

Variables	Category	Frequency	%
Socio economic class*	Upper class (I)	35	7
	Upper middle class (II)	56	11.2
	Middle class (III)	164	32.8
	Lower middle class (IV)	194	38.8
	Lower class (V)	51	10.2
Pre pregnancy weight	<45 kg.	159	31.8
	≥45 kg.	341	68.2
Height	< 145 cm	68	13.6
	≥145 cm	432	86.4
BMI (In kg/m^2)	<18.5	79	15.8
	≥18.5	421	84.2
Weight gain (In kg.)	<9	172	34.4
	≥9	328	65.6
Diet	Vegetarian	313	62.6
	Mix	187	37.4
Meals Per Day	<3	91	18.2
	≥3	409	81.8
Anaemia	Yes	414	82.8
	No	86	17.2
IFA tablets intake	Regular	426	85.2
	Irregular	74	14.8
Calcium tablets intake	Regular	397	79.4
	Irregular	103	20.6
Health education	Yes	445	89
	No	55	11
Supplementary nutrition received at Anganvadi	Yes	160	32
	No	340	68
Maternity benefits	Yes	182	36.4
	No	318	63.6

**According to modified BG prasad classification*

Table II: Association between nutritional determinants and newborns' birth weight.

Variables	Category	Birth weight (in grams)				Total		χ^2 Value	P Value
		<2500		≥2500					
		n	%	n	%	n	%		
Socio economic class	Higher	5	14.29	30	85.71	35	7	33.82	<0.001
	Middle	40	18.18	180	81.82	220	44		
	Lower	101	41.22	144	58.78	245	49		
Pre pregnancy weight	<45 kg.	74	46.5	85	53.5	159	31.8	33.91	<0.001
	≥45 kg.	72	21.1	269	78.9	341	68.2		
Height	< 145 cm	49	72.1	19	27.9	68	13.6	69.93	<0.001
	≥145 cm	97	22.5	335	77.5	432	86.4		
BMI (In kg/m^2)	<18.5	40	50.63	39	49.37	79	15.8	20.85	<0.001
	≥18.5	106	25.18	315	74.82	421	84.2		
Weight gain (In kg.)	<9	98	56.98	74	43.02	172	34.4	97.85	<0.001
	≥9	48	14.63	280	85.37	328	65.6		
Diet	Vegetarian	107	34.2	206	65.8	313	62.6	10.06	0.002
	Mix	39	20.9	148	79.1	187	37.4		
Meals Per Day	<3	49	53.85	42	46.15	91	18.2	32.69	<0.001
	≥3	97	23.72	312	76.28	409	81.8		
Anaemia	Yes	131	31.6	283	68.4	414	82.8	6.95	0.008
	No	15	17.4	71	82.6	86	17.2		
IFA tablets intake	Regular	107	25.1	319	74.9	426	85.2	23.21	<0.001
	Irregular	39	52.7	35	47.3	74	14.8		
Calcium tablets intake	Regular	97	24.4	300	75.6	397	79.4	21.18	<0.001

	Irregular	49	47.6	54	52.4	103	20.6		
Health education	Yes	126	28.3	319	71.7	445	89	1.53	0.22
	No	20	36.4	35	63.6	55	11		
Supplementary nutrition received at Anganvadi	Yes	31	19.4	129	80.6	160	32	10.99	0.001
	No	115	33.8	225	66.2	340	68		
Maternity benefits	Yes	48	26.4	134	73.6	182	36.4	1.11	0.29
	No	98	30.8	220	69.2	318	63.6		

Table III: Logistic regression output of nutritional determinants of LBW birth.

Variables	Category	Adjusted odds ratio	95% CI	P value
Socio economic class	Higher	Reference		
	Middle	4.38	1.21-15.86	0.03
	Lower	10.26	2.84-37.07	<0.001
Pre pregnancy weight	<45 kg.	0.95	0.48-1.90	0.88
	≥45 kg.	Reference		
Height	< 145 cm	7.91	3.75-16.66	<0.001
	≥145 cm	Reference		
BMI (In kg/m^2)	<18.5	3.70	1.69-8.08	0.001
	≥18.5	Reference		
Weight gain (In kg.)	<9	5.34	3.04-9.37	<0.001
	≥9	Reference		
Diet	Vegetarian	1.41	0.80-2.48	0.23
	Mix	Reference		
Meals Per Day	<3	3.22	1.74-5.96	<0.001
	≥3	Reference		
Anaemia	Yes	2.00	0.93-4.34	0.08
	No	Reference		
IFA tablets intake	Regular	Reference		
	Irregular	1.44	0.44-4.72	0.54
Calcium tablets intake	Regular	Reference		
	Irregular	1.40	0.49-4.03	0.53
Supplementary nutrition received at Anganvadi	Yes	Reference		
	No	2.59	1.39-4.81	0.003

Discussion

Maternal nutritional factors are important predictors of nutritional status of newborn baby. So present study was aiming toward finding the association between nutritional determinants and birth weight of baby.

In this study majority of mothers belong to lower/upper lower class which was followed by middle/upper middle class and upper class, similar presentation observed in study by Pal A et al [13]. A study by Pal A. et al. [13] shows 37.7% mothers presented with <45 kg. weight which was nearer to our study finding while in study by Kapil U et al. [14] it was 21%. For maternal height similar result seen in study by Ramesh S. et al. [15] in which 12.36% mothers presented with height less than 145 cm while in study by Kader M. et al. [16] shows that 7.31% women height was less than 145 cm. Underweight mothers in this study was 15.8% while in a study by Zaveri A et al. [17] 22.7%, in a study by Metgud CS et al. [18] 5.0% and in a study by Pal A. et al. [13] about 30% of the women were underweight (BMI < 18.5 kg/m2). In this study <9 kg. weight gain seen in 34.4% mothers while in study by Domple VK et al. [19] shown that ≤7 kg. weight gain during pregnancy was seen in 30%, 8-14 in 69.69% and ≥15 in 0.31%. A study conducted in the MCH Centre, Sevagram, 7.03% women gained weight ≤ 4 kg, 68.75% between 5-7 kg, 19.53% between 8-10 kg and 4.69% women gained weight more than 10 kg [20]. In our study 82.8% mothers were anaemic while in a study conducted by Zaveri A et al. [17] shown over half of them (55.6%) were anaemic. The study was conducted by Rajamouli J et al. [21] on 269 pregnant women among them 157 pregnant women (58.36%) suffered with mild, moderate and severe anaemia. Similar result for IFA consumption was seen in study conducted in Bangalore by Matthews Z et al. [22] in which 85% reported taking IFA tablets for 100 days. While only in 68% and 52.5% women were shown regular IFA consumption in studies by Metgud CS et al. [18] and by Pal A. et al. [13] respectively. In a study by Agrawal KN et al. [23] 38.67% mothers took supplementary nutrition in the ICDS block which was close to present study.

In this study odds of having low birth weight was 10.26 times higher in lower socioeconomic group, similarly a study by Pal A et al [13] has shown that the prevalence of low birth weight in lower/upper lower class was 23.69%, in middle/upper middle class was 21.7% and in upper class was 14.65%. This study showed that women from lower socioeconomic families were more prone to deliver LBW babies. (p<0.001) Similar result also seen in study by Jayaraj N et al [24] and Ramesh S et al [15]. Such an association may be related to several potential mechanisms. A poor maternal nutritional intake during pregnancy, which is more likely among low socioeconomic groups and also certain socio-cultural practices among them, may contribute to LBW. So, all above result along with comparisons support that prevalence of low birth weight higher as socioeconomic class moves towards lower.

In this study mothers' pre pregnancy weight did not show any significant risk for LBW while contrary result was seen in study by Pal A. et al. [13], Mavalankar DV et al. [25] and Kramer MS [26]. Maternal height <145cm shown 7.91 times risk for delivering LBW babies and supportive result seen in a study by Jayaray N. et al. [24] Also, a study by Kader M. et al. [16] shows that, the risk estimates for having an infant with LBW was significantly elevated for women with short stature (height <145 cm). (p=0.0001) Stunting is a consequence of long-term poor nutritional intake and is the best indicator of decreased growth in children over an extended period, Stunting has been associated with poorer cognition and school achievement in later childhood [27]. Stunting has also been linked to the perpetuation of the cycle of undernutrition by causing low birth weight among offspring of the stunted mother [28]. In this study odds

of having LBW were significantly higher in undernourished mothers. In a study Zaveri A et al. [17] also revealed that prevalence of low birth weight was 21.3% in underweight women which was higher than the normal weight and overweight/obese BMI categories in which it was 16.8%, 14.6% respectively and this difference was statistically significant. (p<0.001) In a study by Pal A. et al. [13] revealed that prevalence of low birth weight high in maternal undernutrition (BMI < 18.5 kg/m2) and it was significantly associated with LBW. (p<0.001) In a study by Ramesh S. et al. [15] shown that 37.5% of mothers with a low BMI and 16.2% of mothers with a normal BMI had LBW infants. The chance of an infant to be LBW was 3.1 times higher for those mothers with a low BMI compared to those mothers with a normal BMI and this was statistically significant (OR 3.1, 95% CI: 1.1–8.7, p=0.03). Deficiencies in protein, energy, and micronutrients result in depletion of body mass that can further lead to LBW of infants [17]. Low maternal BMI is a marker for marginal tissue nutrient reserves and a predictor of protein-energy malnutrition, which may affect fetal growth [16]. Low weight gain (<9 kg) shown 5.34 times risk for delivering LBW babies. Mumbare SS et al. [29] noted in his study that weight gain during pregnancy less than 6 kg. was associated with delivery of a low-birth-weight infants. In study by Domple VK et al. [19] mothers of most of the LBW babies (58.75%) had average weight gain of ≤7 kg whereas those of the NBW babies (98.13%) had average weight gain of 8–14 kg. This association was found to be statistically significant (P < 0.001). Odds of having LBW was 3.22 time higher in mothers who consume <3 meals in a day similar result seen in study by Narain S et al. [30] in which LBW rate was significantly higher in mothers taking less than 3 meals per day (38%) as compared to those who took more than 3 meals (16.2%).

No statistically significant differences were evident in study by KADER M et al. [16] for birth weight in children born to anaemic women, similar result also seen in study by Sema A et al. [31] which was supportive to present study finding. But in a study by Jayaraj N et al. [24] in which mothers who were anaemic during pregnancy (Hb<11gm%) had increased risk of delivering a LBW baby when compared to mothers having haemoglobin levels more than 11 g% and this was statistically significant. (p=<0.001). The study by Zaveri A et al. [17] also indicates that prevalence of low birth weight higher (17.8%) in anaemic women in respect to their counterpart (p<0.001). Odds of having LBW were 2.59 times in mothers who did not receive supplementary nutrition at anganvadi. In a study by Agarwal KN et al. [23] In spite of very low level of supplementation as compared to the unsupplemented group, the positive achievements were: (a) lower percentage of low-birth-weight deliveries (14.4% vs 20.4%); (b) more newborns weighted >3000g (16.2% vs 11.0%); (c) 100g extra gain in maternal weight; and (d) the gestational age increased by 0.3 Week (p<0.001). Nutrition supplement to pregnant women improved birth weight with reduction in pre-term and low birth weight deliveries.

There are some limitations of the study which includes, it was conducted only in a tertiary care hospital and Sample size was small so these findings cannot be truly representative of entire population. The study was cross sectional, so it is not possible to strongly demonstrate cause and effect relationships. Future research is needed by using longitudinal study to understand the mechanism behind the high occurrence of LBW children in India.

Conclusion

Low birth weight is still the matter of public health concern because there is large number of newborns enter in the world with low birth weight and face greater challenges in later stages of life. It is also important to breakdown the vicious cycle of this nutrition related problem. In this study 29.2% newborn babies born with LBW which was very high. The reason may be most of the high-risk pregnancies delivered in tertiary health care centres. The present study revealed that lower and middle socio economic class, height <145 cm, BMI less than 18.5 kg/m2, less than 9 kg weight gain during the pregnancy, consume <3 meals in a day, and not received supplementary nutrition at anganvadi were statistically significant risk factors that associated for delivering low birth weight newborns, while pre pregnancy weight, Diet, Anaemia, IFA and Calcium tablet intake, received health education and maternity benefits in terms of money did not shown any statistically significant risk for delivering low birth weight newborns.

So, present study finding likely to recommend: Special recognition should be given to mothers belonged to lower and middle socio-economic class. Women should be educated to take the proper quantity of the food to stimulate babies' growth and development. Targeted public health interventions to improve nutrition status of women in childbearing age group. No women should be missed by Food-distribution systems who are at risk of food insecurity.

Ethics approval and consent to participate

Study was approved by Institutional ethical committee, Shree M.P. Shah government medical college & Guru Gobind Singh Hospital, Jamnagar with reference number IEC/Certi/85/03/2020. Verbal Consent was obtained for each respondent.

List of abbreviations

AOR: Adjusted Odds Ratio
BMI: Body Mass Index
CI: Confidence Interval
CPI: Consumer Price Index
Hb: Haemoglobin
ICDS: Integrated Child Development Services
IFA: Iron Folic Acid
IQ: Intelligence Quotient
LBW: Low Birth Weight
MCH: Maternal and Child Health
MCP: Mother and Child Protection
NBW: New Born Weight
WHO: World Health Organisation

Data Availability

Readers can access the data by contacting the corresponding author via email on harsh1361994.hp@gamil.com

Conflicts of interest

The authors declares that there is no conflict of interest regarding the publication of this article.

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Authors' Contributions:

HP collected, analysed and interpreted the data regarding nutritional determinants of low birth weight. HP and BP contributed significantly to the writing and editing of the manuscript. JM, RR and MR contributed in study designing and manuscript review.

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