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Quick Response Code:

Website: www.jehp.net
DOI: 10.4103/jehp.jehp_762_23

# Determinants of health literacy and its impact on glycemic control among women with gestational diabetes mellitus in a tertiary care hospital, Puducherry – A cross-sectional analytical study

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## Abstract:

**BACKGROUND:** Health literacy is vital during pregnancy, as maternal health knowledge and behavior have a significant impact on the health of both mother and child. Hence, this study aimed to assess the health literacy status of pregnant women diagnosed with gestational diabetes mellitus (GDM), as well as its associated factors and impact on glycemic control.

**MATERIALS AND METHODS:** The facility-based Cross-sectional analytical study was conducted among 200 pregnant women with GDM in a tertiary care hospital. The eligible participants were consecutively selected for the study. The study was conducted from September 2022 to March 2023. A validated semi-structured questionnaire, the Health Literacy Questionnaire (HLQ) for GDM, was used to measure health literacy status. Stata V.17 software was used for data analysis.

**RESULTS:** Out of 200 pregnant women with GDM, the mean (SD) age of the participants is 29.5 ( $\pm$ 5.5) years. It was observed that 164 (82%) of the participants had adequate health literacy, whereas 36 (18%) had inadequate health literacy about Gestational Diabetes. Adequate health literacy (HL) was observed among 88.5% of women with controlled blood sugar and 55.1% of women with uncontrolled blood sugar. Results of multivariate logistic regression analysis revealed that pregnant mothers' educational status (PR: 1.8; 95% CI: 1.2-2.5) and glycemic control (PR: 1.4; 95% CI (1.2-1.7)) were associated with adequate HL.

**CONCLUSIONS:** In conclusion, this study supports the association between adequate HL and glycemic control in pregnant women with GDM. Addressing this gap is essential for healthcare officials and planners to implement programs that promote women's HL during pregnancy, with a focus on low-educated groups.

## Keywords:

Gestational diabetes mellitus (GDM), glycemic control, health literacy, India

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Received: 31-05-2023  
Accepted: 05-12-2023  
Published: 28-03-2024

## Introduction

“Gestational diabetes mellitus (GDM)” is defined as impaired glucose tolerance with onset or first recognition during pregnancy.<sup>[1]</sup> Among the various

health conditions, GDM presents unique challenges for pregnant women, requiring effective self-management and adherence to complex medical regimens.<sup>[2]</sup> In India, GDM complicates 4 million pregnancies

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**How to cite this article:** Veerasetty NK, Venkatachalam J, Subbaiah M, Arikrishnan K, Soni B. Determinants of health literacy and its impact on glycemic control among women with gestational diabetes mellitus in a tertiary care hospital, Puducherry – A cross-sectional analytical study. J Edu Health Promot 2024;13:119.

each year, putting many mothers and their newborns at risk of perinatal morbidity and mortality if not properly diagnosed and managed.<sup>[3]</sup> GDM prevalence ranges from 10% to 53.5% worldwide, with South East Asia having the highest prevalence.<sup>[4-6]</sup> GDM prevalence in India varies by geography, with 1.9% in Chhattisgarh, and 18.5% in Tamil Nadu.<sup>[7-10]</sup>

Glycemic control in pregnant women with GDM is influenced by multiple factors such as participant age, food habits, lifestyle behavior, and location differences. Health literacy (HL) in pregnant women with GDM is associated with improved awareness of GDM, prioritization of blood sugar control, understanding and implementation of dietary guidelines, accurate comprehension of medication instructions, effective communication with healthcare providers, and overall better glycemic control and their children's health.<sup>[11]</sup> Research has shown that low HL is linked to higher rates of mortality and hospitalization, decreased utilization of preventive healthcare services, and poor adherence to prescribed medications.<sup>[12-16]</sup>

The general literacy rate of Puducherry is 85.85%, the literacy rate among males is 91.26%, and females is 80.67%.<sup>[17]</sup> HL has now been introduced as a global issue in the last century.<sup>[18]</sup> Healthcare professionals often lack awareness of pregnant women's HL levels, posing challenges for healthcare systems. To address this, assessing the HL of pregnant women is crucial. Identifying pregnant women with low HL enables healthcare providers to offer tailored support and improve patient outcomes.

In spite of the significant prevalence of GDM and the critical role of HL in managing GDM, the assessment of HL status among pregnant women is not adequately integrated into routine antenatal services. There is a pressing need for evidence-based research on this topic in India. Numerous studies have demonstrated a positive association between adequate HL and glycemic control in pregnant women with GDM.<sup>[19]</sup> The aim of this study is to assess the HL status of pregnant women diagnosed with GDM, as well as its associated factors and impact on glycemic control. By examining the relationship between HL and blood sugar regulation, this research seeks to provide valuable insights into the role of HL in influencing and optimizing glycemic control among GDM mothers.

## Materials and Methods

### Study design and setting

The hospital-based cross-sectional analytical study was conducted from September 2022 to March 2023 at the Department of Obstetrics and Gynaecology (OBG),

JIPMER, Puducherry. The facility has an annual delivery rate of 15,000. It caters to pregnant women from neighboring three states and eight districts. Screening and treatment for GDM are free. GDM in this facility is diagnosed by using the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria. Ethical clearance was obtained from the Institutional Ethics Committee (JIP/IEC-OS/2022/352); date of approval of ethics is (23/01/202). Written informed consent was obtained from all the participants. Procedures were in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 2000.

### Study participants and sampling

Pregnant mothers (age >18 years) diagnosed with GDM who were receiving antenatal care (ANC) and admitted to the in-patient ward of the OB and G department in a tertiary care hospital were included. Pregnant mothers with pre-existing diabetes and cognitive impairment are excluded from the study.

The sample size was calculated using Open Epi version 3.01. Assuming the proportion of adequate HL among pregnant women is 45%, with an absolute precision of 7% and a 95% Confidence Interval. The sample size was calculated as 194. The final sample size was estimated to be 200. All the consecutive eligible women with GDM who reported during the study period were included.

### Study procedure

The study was conducted among pregnant women diagnosed with GDM through the oral glucose tolerance test (OGTT) involving the administration of 75 grams of glucose. A threshold value of a two-hour postprandial blood glucose level greater than 140 mg/dL was used to identify positive cases of GDM. The inclusion criteria involved pregnant women who routinely underwent antenatal check-ups as part of ANC services and pregnant women who were admitted to the in-patient ward within the Obstetrics and Gynaecology (OBG) department at JIPMER Women and Children Hospital (JWCH). Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was obtained from the eligible participants after explaining the purpose of the study in their local language (Tamil).

Information regarding sociodemographic characteristics was collected using the software (Epicollect5). Obstetrics-related information and treatment information were reported by the participant and cross-checked with individual case records to avoid information bias. Comorbidities, period of gestation (weeks), management profile, and present glycemic control status were collected from individual case records during the ANC visits or in-patient stay in a tertiary care center. After receiving

Medical Nutritional Therapy (MNT) treatment for at least two weeks, if the values of a person's Post-Prandial Blood Sugar PPBS taken two hours after a meal are above 120 mg/dL, it is considered as poor glycemic control.<sup>[1]</sup>

Data on health literacy in GDM was captured using a Health Literacy questionnaire (HLQ) on GDM.<sup>[20]</sup> The domains were selected from the original HLQ based on Richard H Osborne. Data was collected using interviewer-administered questionnaires. To prevent questionnaire fatigue, the HLQ of GDM was given by a trained interviewer in local language (Tamil) for the purpose of easy understanding and testing relative validity. The developed questionnaire was subjected to a critical evaluation and content validity assessment by experts from the community medicine, obstetrics, and gynecology departments. In light of this, four items were modified to enhance clarity, while six items were excluded due to redundancy or lack of relevance. Finally, the HLQ tool consists of 24 items with 2 sections. The first section of the questionnaire includes 17 statements, and each question was scored from 1 to 4 (Strongly Disagree = 1, Disagree = 2, Agree = 3, Strongly Agree = 4) and the second section contains 7 items; each question was scored from 1 to 5 (Cannot do or always difficult = 1, Usually, difficult = 2, Sometimes difficult = 3, Usually, easy = 4, Always easy = 5). HL levels among pregnant women were categorized using Bloom's cut-off criteria. Pregnant women scoring above 82 out of the total score were classified as having adequate HL, those scoring between 61 and 81 were classified as having moderate HL, and those scoring less than or equal to 60 were classified as having inadequate HL.<sup>[21]</sup> For better convenience, we consolidated the categories of moderate and adequate HL into a single category termed "adequate HL" for the purpose of conducting multivariable logistic regression.

The questionnaire's updated draft was pretested for face validity among 20 pregnant women who had been diagnosed with GDM in the second step to gauge its acceptability, relevance, and clarity. Relevant improvements were made with the advice of experts based on the input.

The administration of the test questionnaire took an average of 10 minutes(+5). Both questionnaires' subject acceptability and co-operation were good. At the end of each interview, the participant's scores were revealed to them and participants with poor glycemic control were advised accordingly.

### Data analysis

Data was entered in EpiCollect5 and was analyzed using Stata v17. All the categorical variables were summarized as frequency and percentage, and continuous variables were summarized as mean with standard deviation. The

normality of the continuous variables was assessed using Kolmogorov-Smirnov test. The proportion of adequate and inadequate HL was summarized as frequency and percentage with a 95% confidence interval. The association of categorical variables with adequate HL was carried out using the Chi-square/Fisher exact test. Univariate logistic regression analysis was conducted to determine potential factors associated with adequate HL among GDM mothers. The significant variables ( $P$  value  $< 0.2$ ) were considered in generalized linear regression model with Poisson as the family and log as the link function, and an adjusted prevalence ratio along with a 95% confidence interval was estimated. All the analysis was carried out at a 5% level of significance, and a  $P$  value  $< 0.05$  was considered statistically significant.

## Results

In this study, a total of 200 eligible participants with GDM were included for analysis. The mean (SD) age of the study participants was 29.5 (5.5) years. About 53% had obtained a graduate and above degree. The majority of the participants (79%) were homemakers, while 21% were employed. About 68% of participants were from rural areas, and 41.5% of participants were from nuclear families. Additionally, 13.5% had a previous history of GDM [Table 1].

A majority (60.5%) were categorized as multigravida, and significant proportion (29.5%) of the women were in the gestational age range of 33-36 weeks. About 44% were on MNT, and 56.5% of participants had controlled fasting blood glucose levels. Furthermore, 29% had one or more hospital admissions for sugar control [Table 2].

Out of 200 participants, the number of antenatal women with GDM having adequate HL on GDM was 51 participants (25.5%) with 95% CI: 19%-32%. At the same time, the majority (56.5%) had moderate HL with 95% CI: 49%-63% [Table 3]. In adjusted analysis, variables such as education level and glycemic control showed significant associations with adequate HL. So, Participants with adequate HL had 1.4 times higher odds of achieving glycemic control (aPR: 1.4, 95% CI: 1.2-1.7;  $P$  value: 0.001) compared to participants having inadequate HL. Participants who attained a higher education level, graduation or above, had 1.6-fold higher odds of having adequate HL (aPR: 2.95% CI: 1.4-2.7;  $P$  value: 0.01) compared to those with an education level ranging from class one to ten. Furthermore, the analysis of clinical and obstetric factors, including family history of diabetes mellitus, past GDM history, timing of GDM diagnosis, parity, gravida, coexisting illnesses, and ongoing treatment, did not show a statistically significant association with the HL level of the mothers [Tables 4 - 6].

**Table 1: Sociodemographic characteristics of antenatal women with Gestational Diabetes Mellitus at a tertiary care hospital, Puducherry, 2022 (n=200)**

Characteristics	Frequency (n)	Percentage
Age in years, Mean (SD)	29.5 (5.5)	
Age group (in years)		
19-25	48	24
26-30	80	40
>30	72	36
Education level		
Graduate and above	106	53
Intermediate or diploma	46	23
Class (1-10)	48	24
Occupation status		
Homemaker	158	79
Employed	42	21
Place of residence <sup>†</sup>		
Urban	63	31.5
Rural	137	68.5
Type of family		
Nuclear	83	41.5
Joint	117	58.5
Socio-economic status* (INR)		
Upper middle (4110-8219)	14	7
Middle class (2465-4109)	30	15
Lower middle (1230-2464)	73	36.5
Lower class (<1230)	83	41.5
Family history of Diabetes Mellitus		
Yes	84	42
No	116	58
Previous history of GDM		
Yes	27	13.5
No	80	40
Prime	93	46.5
Health personnel in family		
Presence	24	12
Absence	176	88

\*Modified BG Prasad Socioeconomic Status Scale (2022). <sup>†</sup>Puducherry and nearby districts of Tamil Nadu

**Table 2: Clinical and obstetric characteristics of antenatal women with Gestational Diabetes Mellitus at a tertiary care hospital, Puducherry, 2022 (n=200)**

Categories	Frequency (n)	Percentage
Gravida		
Primigravida	79	39.5
Multigravida	121	60.5
Parity		
Nulliparous	109	54.5
Multiparous	91	45.5
Present gestational age (weeks)		
8-28	49	24.5
29-32	57	28.5
33-36	59	29.5
37-40	35	17.5
Comorbidities <sup>‡</sup>		
Anemia	13	6.5
Hypertension	40	20
Thyroid disorder	52	26
PCOD	17	8.5
None	97	48.5
Others <sup>‡</sup>	3	1.5
Time of diagnosis of GDM		
First trimester	67	33.5
Second trimester	62	31
Third trimester	71	35.5
Current treatment		
Medical nutritional therapy (MNT)	88	44
Oral Hypoglycemic drugs with MNT	50	25
Insulin with MNT	43	21.5
Insulin, hypoglycemic drugs, and MNT	19	9.5
Glycemic control		
Controlled	113	56.5
Uncontrolled	87	43.5
Number of admissions for sugar control		
0	142	71
1 or more	58	29

<sup>†</sup>Not add up to 100%. <sup>‡</sup>Others include seizures, cardiovascular disease, asthma

## Discussion

The present study observed that 74% of pregnant women with GDM had sufficient HL regarding GDM. This finding aligns with a previous cross-sectional study conducted by Yvonne Frances Finn *et al.* (2017) in Ireland, which reported that 74.7% of participants diagnosed with GDM had adequate HL. The measurement of HL in these studies utilized tools such as the Newest Vital Sign (NVS) and the Health Literacy Survey Questionnaire.<sup>[22]</sup> However, a descriptive-analytical study by Ziba Taghizadeh *et al.* (2019) involving 270 pregnant women in Tehran revealed that only 48.9% had limited (inadequate) HL.<sup>[23]</sup> In contrast, Hailye Mamo Mogessie *et al.* conducted a cross-sectional study in Southeast Ethiopia, which showed that 41.8% of 402 diabetic patients had low diabetic HL.<sup>[24]</sup> Furthermore, Shiva Borzouei *et al.* (2019) conducted a

cross-sectional study in Iran and found that 36.5% of pregnant women with GDM had adequate HL based on the Iranian Health Literacy Questionnaire.<sup>[19]</sup> The difference in HL levels could be attributed to the difference in the study population's socioeconomic and cultural backgrounds, which affects HL. Shamsoddin Niknami *et al.* (2007) found that 47% of young pregnant women had low HL based on the Iranian Adult Health Literacy Questionnaire (HELIA). However, their findings were somewhat inconsistent with the earlier research conducted by Shamsoddin Niknami *et al.* (2017).<sup>[25]</sup> Although different tools were utilized in these studies to assess HL dimensions, content, and cut-off points, the variations in outcomes can be attributed to differences in subject characteristics, such as age, educational background, socioeconomic status, gestational age, number of pregnancies, and variations in the instruments employed.

The present study found a statistically significant association between educational status and adequate HL among pregnant women. Those with a graduate or higher level of education had higher odds of possessing adequate HL compared to those with an intermediate or diploma level of education. This finding aligns with the results of a descriptive-analytical study conducted by Ziba Taghizadeh *et al.* (2021) in Tehran, which also identified education level as a significant predictor of adequate HL among 270 pregnant women. Furthermore, the findings of a cross-sectional study conducted by

Abbas Ali Husseini *et al.* in Afghanistan align with the present study. Their research demonstrates that maternal HL is associated with variables such as education level, age, number of gravidities, number of received care, and the timing of prenatal care initiation.<sup>[26]</sup> Additionally, our study's findings are consistent with previous research indicating that higher education levels are associated with HL.<sup>[27]</sup> These studies have demonstrated that individuals with higher educational attainment are more likely to have access to health information and possess a better understanding of it.

**Table 3: Health literacy status among antenatal women with Gestational Diabetes Mellitus at a tertiary care hospital, Puducherry, 2022 (n=200)**

Health literacy status	Frequency (n)	Percentage (95% CI)
Adequate	51	25.5 (19-32)
Moderate	113	56.5 (49-63)
Inadequate	36	18 (12-24)

Our findings indicate a significant association between mother's glycemic control and the adequacy of HL. Mothers with good glycemic control were 1.4 times more likely to have adequate HL. This finding aligns with a cross-sectional study conducted in Iran by Shiva Borzouei *et al.* (2019), which also demonstrated

**Table 4: Association of sociodemographic characteristics among GDM mothers with adequate health literacy status at a tertiary care hospital, Puducherry, 2022 (n=200)**

Variable	Health literacy status		Unadjusted PR (95% CI)*	Adjusted PR (95% CI)**	P
	Adequate n (%)	Inadequate n (%)			
Age group (in years)					
19-25	33 (68.8)	15 (31.2)	1.0 (0.8-1.3)	0.9 (0.7-1.2)	0.35
26-30	67 (83.7)	13 (16.3)	1.2 (1.0-1.5)	1.1 (0.9-1.3)	0.17
>30	48 (66.6)	24 (33.4)	ref		
Education level					
Graduate and above	93 (87.6)	13 (12.4)	2.0 (1.4-2.7)	1.8 (1.2-2.5)	0.01
Intermediate or diploma	34 (73.9)	12 (26.1)	1.6 (1.1-2.4)	1.6 (1.1-2.3)	0.001
Class (1-10)	21 (43.6)	27 (56.4)	ref	-	
Occupation status					
Homemaker/Unemployed	114 (72.1)	44 (27.9)	ref	-	
Employed	34 (80.9)	8 (19.1)	1.1 (0.9-1.3)	-	
Place of residence					
Urban	57 (90.5)	6 (9.5)	1.3 (1.1-1.5)	1.2 (1.0-1.3)	0.11
Rural	91 (73.3)	46 (26.7)	ref	-	
Type of family					
Nuclear	56 (67.4)	27 (32.6)	ref	-	
Joint	92 (78.5)	25 (21.5)	1.1 (0.9-1.3)	-	
Socio-economic status (INR)					
Upper middle (4110-8219)	11 (78.5)	3 (21.5)	1.1 (0.8-1.5)	-	
Middle class (2465-4109)	21 (70)	9 (30)	1.0 (0.7-1.3)	-	
Lower middle (1230-2464)	56 (76.6)	17 (23.4)	1.0 (0.8-1.3)	-	
Lower class (<1230)	59 (71.1)	24 (28.9)	ref	-	
Family history of Diabetes Mellitus					
Yes	61 (72.6)	23 (27.4)	ref	-	
No	87 (75)	29 (25)	1.0 (0.8-1.2)	-	
Previous history of GDM					
Yes	19 (70.4)	8 (29.6)	1.0 (0.7-1.3)	1.0 (0.8-1.3)	0.50
No	54 (67.5)	26 (32.5)	ref	-	
Prime	75 (80.6)	18 (19.4)	1.1 (1.0-1.4)	1.1 (0.9-1.3)	0.18
Presence of health professionals in family					
Yes	22 (91.6)	2 (8.4)	1.2 (1.0-1.4)	1.1 (0.9-1.3)	0.36
No	126 (71.5)	50 (28.5)	ref	-	

\*P≤0.2 included in the logistic regression model; PR=Prevalence ratio. \*\*Multivariable regression model (P<0.05 considered as significant)

**Table 5: Association of clinical and obstetric characteristics with health literacy of across Gestational Diabetes Mellitus status at a tertiary care hospital, Puducherry, 2022 (n=200)**

Variable	Health literacy status		Unadjusted PR (95% CI)**	Adjusted PR (95% CI)	P
	Adequate n (%)	Inadequate n (%)			
Gravida					
Primigravida	64 (81)	15 (19)	1.1 (0.9-1.3)	-	
Multigravida	84 (69.4)	37 (30.6)	ref	-	
Parity					
Nulliparous	84 (77.1)	25 (22.9)	ref	-	
Multiparous	64 (70.3)	27 (29.7)	1.0 (0.9-1.2)	-	
Comorbidities					
Yes	76 (73.1)	28 (26.9)	1.0 (0.8-1.2)	-	
No	72 (75)	24 (25)	ref	-	
Time of diagnosis of GDM					
First trimester	49 (73.1)	18 (26.9)	ref	-	
Second trimester	48 (77.4)	14 (22.6)	1.0 (0.8-1.2)	-	
Third trimester	51 (71.8)	20 (28.2)	1.0 (0.7-1.2)	-	
Current treatment					
Medical Nutritional Therapy (MNT)	67 (76.1)	21 (23.9)	1.0 (0.8-1.2)	-	
MNT with other treatment	81 (72.3)	31 (27.7)	ref	-	
Number of admissions for sugar control					
0	109 (76.7)	33 (23.3)	ref	-	
1 or more	39 (67.2)	19 (32.8)	0.8 (0.7-1.2)	-	

\*P≤0.2 included in the logistic regression model; PR=Prevalence ratio. \*\*Multivariable regression model (P<0.05 considered as significant)

**Table 6: Impact/effect of health literacy on glycemic control of mother with Gestational Diabetes Mellitus in a tertiary care hospital, Puducherry, 2022 (n=200)**

Variable	Health literacy status		Unadjusted PR (95% CI)**	Adjusted PR (95% CI)	P
	Adequate n (%)	Inadequate n (%)			
Glycemic control					
Controlled	100 (88.5)	13 (11.5)	1.8 (1.1-2.5)	1.4 (1.2-1.7)	0.001
Uncontrolled	48 (55.1)	39 (44.9)	ref	-	-

\*P≤0.2 included in the logistic regression model; PR=Prevalence ratio. \*\*Multivariable regression model (P<0.05 considered as significant)

a significant association between diabetes control and adequate HL.<sup>[19]</sup> Both studies suggest that individuals with good glycemic control are more likely to possess adequate HL skills. These findings imply that enhancing HL may contribute to improved diabetes management, and conversely, improving glycemic control may lead to better HL. However, further research is necessary to investigate the underlying mechanisms of this relationship and to identify effective strategies for enhancing HL to promote better diabetes management.

Our study found no significant association between mothers' residency and adequate HL. This finding contradicts the results of a similar cross-sectional study conducted by Abeer Abdulaziz Khaya *et al.* (2020) involving 292 Saudi women in Almadinah Almunawarah, which utilized a valid Arabic self-administered questionnaire.<sup>[28]</sup> One possible explanation for this discrepancy could be the availability of greater health education resources in urban areas, which may contribute to higher levels of HL.

### Limitations and recommendations for future studies

The study used a self-reported measure of HL, which may be subject to social desirability bias, and conducted in a single tertiary care hospital in Puducherry, which may limit the generalizability of the findings.

The study utilized the Epicollect5 software for data entry, minimizing the potential for data entry errors. Data collection was conducted through personal interviews and hospital records, enhancing internal validity. Additionally, the study had a low non-response rate, indicating a strength of the research.

The current body of research on HL among pregnant women is limited, and the existence of relevant studies in this area remains uncertain. Future research can focus on assessing the HL levels of pregnant women with GDM and exploring effective interventions to enhance their HL. Additionally, it is important to investigate the impact of interventions targeting improved HL on pregnant women and their pregnancy outcomes, including factors such as gestational weight gain, lifestyle

choices, and utilization of health services. This research can further examine the differences in health behaviors, health service utilization, and health outcomes between pregnant women with high and low HL levels in the context of a lifestyle intervention trial.

## Conclusion

This research study provides valuable insights into the HL levels of pregnant women diagnosed with GDM at JWCH. Approximately half of the participants demonstrated adequate HL regarding GDM. The study found significant associations between level of education, glycemic control, and adequate HL. These findings emphasize the importance of promoting health education for pregnant women, particularly during the critical period of pregnancy. However, the study also revealed a significant deficiency in HL among women with lower levels of education, highlighting the need for healthcare policymakers and planners to implement targeted programs aimed at improving HL among pregnant women.

## Acknowledgment

The authors would like to express their heartfelt appreciation to all female participants for their diligent involvement in the study. The research team extends their deep gratitude to the clinical and non-clinical staff members of the Department of Obstetrics and Gynecology, JIPMER, for their invaluable support in the successful execution of the study.

## Ethical consideration

All participants were provided with informed consent and ethical clearance was obtained from the Institutional Ethics Committee (JIP/IEC-OS/2022/352); date of approval of ethics is (23/01/202).

## Financial support and sponsorship

Funding for this study was provided by the JIPMER.

## Conflicts of interest

There are no conflicts of interest.

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