Original Article

Prevalence of Hyperglycemia in Pregnancy and Related Screening Practices in Rural Dehradun: The First Population-Based Study from Uttarakhand (PGDRD-1)

Surabhi Mishra, Jayanti Semwal, Abhay Srivastava, Surendra Kumar Mishra[1]

Department of Community Medicine, Himalayan Institute of Medical Sciences (HIMS), Swami Rama Himalayan University (SRHU), Swami Ram Nagar, Jolly Grant, Dehradun, Uttarakhand, [1]Department of Water Resources Development and Management, Indian Institute of Technology Roorkee, Roorkee, Uttarakhand, India

Abstract

Aims: Phase I of the **P**revalence of **G**estational **D**iabetes Mellitus in **R**ural **D**ehradun (PGDRD) project estimates hyperglycemia in pregnancy (HIP) prevalence and identifies gaps in the utilization of community-related services in rural areas of the Dehradun district (western Uttarakhand); a state where notably no prior population-based study has ever been conducted despite being an Empowered Action Group state for more than two decades. **Methods:** Using a multistage random sampling technique, 1,223 pregnant women locally registered in the rural field practice area of a block were identified. Those requiring HIP screening were subjected to a 2-h 75 g oral glucose tolerance test during the house visit irrespective of their period-of-gestation and last meal timings, diagnosed using the Diabetes in Pregnancy Study Group India (DIPSI) criterion (when indicated). Data were collected by personal interviews using a pretested data collection tool. Statistical Package for Social Sciences version 20.0 was used for analysis. **Results:** The overall HIP prevalence recorded was 9.7% (95% CI: 8.1-11.5%); the majority (95.8%) were GDM followed by overt DIP (4.2%). Less than 1% of the subjects (0.7%) self-reported pre-GDM. Despite this burden, more than three-fourths were never screened for HIP in their pregnancy. Of those tested, the majority availed secondary healthcare facilities. Few even had to bear expenses in private with a very handful being tested free-of-cost by ANM in the community; findings that altogether sharply contrast to those recommended by national protocols. **Conclusion:** Despite the high HIP burden, beneficiaries are unable to utilize community-related universal screening protocols as desired.

Keywords: Diabetes in pregnancy, DIPSI, gestational diabetes mellitus, oral glucose tolerance test, pre-GDM

Introduction

Hyperglycemia in pregnancy (HIP) has emerged as a silent public health problem.[1] International Diabetes Federation 2021 estimates HIP ill-effects every 1 in 4 pregnancies.[2] In India alone, it is complicating four million pregnancies annually representing a large population subset at high risk for adverse perinatal outcomes.[1] It has been estimated that most (80.3%) HIP cases globally are due to gestational diabetes mellitus (GDM); 10.6% are caused by *pre*-GDM and 9.1% are due to overt diabetes (including Type I and II) first detected during pregnancy.[2] Beyond perinatal implications, HIP also marks the beginning of Type II DM and obesity's vicious cycle among the mother-child-affected duos fueling their ongoing epidemic in any given population.[3,4]

Access this article online

Quick Response Code:

Website: www.ijem.in

DOI: 10.4103/ijem.ijem_459_22

Today, when HIP has a proven temporal association with Type II DM with India heading toward becoming the global capital of DM,[2] the early identification of HIP assumes national significance. Despite this, country-wide data on its prevalence and secular trends are still lacking. Most Indian studies reporting prevalence are sporadic in nature

Address for correspondence: Dr. Surabhi Mishra, Assistant Professor, Department of Community Medicine, Himalayan Institute of Medical Sciences (HIMS), Swami Rama Himalayan University (SRHU), Swami Ram Nagar, Jolly Grant, Dehradun – 248 016, Uttarakhand, India.
E-mail: surabhimanipal6@gmail.com

Submitted: 21-Dec-2022 **Revised:** 05-Mar-2023
Accepted: 09-Mar-2023 **Published:** 14-Apr-2023

How to cite this article: Mishra S, Semwal J, Srivastava A, Kumar Mishra S. Prevalence of hyperglycemia in pregnancy and related screening practices in Rural Dehradun: The First population-based study from Uttarakhand (PGDRD-1). Indian J Endocr Metab 2023;27:145-53.

and hospital/research center-study based; with only a few handfuls reporting community-based true HIP burden.[5-20] Notably, no population-based study has ever been conducted in Uttarakhand that has reported the State's HIP burden/prevalence.[21]

Uttarakhand, an Empowered Action Group (EAG) and an Aspirant state of India,[22] is still struggling with its poor maternal and child (MCH) indicators. As per NITI Ayog 2019-20 report, Uttarakhand is the only EAG state that has shown a slight increment in maternal mortality ratio (MMR) in 2018 compared to baseline 2017.[22] In more than two decades of statehood, the hilly state is now able to achieve an MMR of 103 in 2018-20, two points higher than 101 in 2017-19.[23] As per the Comptroller and Auditor General 2017 Report on the performance audit of the Reproductive and Child Health (RCH) program, Uttarakhand has been showing continuous rising trends in the prevalence of obstetric complications from 7.4% in 2011-12 to 9.8% in 2015-16 during delivery.[24] Due to the lack of overall HIP/GDM prevalence data in the state, it is probable that HIP/GDM might be potentially contributing to Uttarakhand's rising trends in intra-natal complications which may go undiagnosed during the antenatal period resulting in slow improvements in the State's MMR. This calls for urgent interventions that focus on early HIP identification to avert any chance of related complications that would otherwise appear if left undiagnosed.

Losing no opportunity to miss the diagnosis, the Government of India (GoI) mandated the rolling-out of HIP services for rural women in all districts including Dehradun (western Uttarakhand) providing nationwide coverage by the year 2023.[25,26] In this regard, the current population-based cross-sectional study—**PGDRD** (**P**revalence of **G**estational **D**iabetes Mellitus in **R**ural **D**ehradun)—was primarily designed with financial support from Uttarakhand State Council for Science and Technology (UCOST), Govt. of Uttarakhand to estimate HIP prevalence among pregnant women residing in rural areas of the Dehradun district (western Uttarakhand). Also, amid the simultaneous need to correct the background performance of the RCH program,[27] the extent of gaps in beneficiaries utilizing community-related services was also identified as a byproduct of the study. A population-based study of this kind was conducted for the first time in the land of Uttarakhand to assist policymakers in improving rural RCH services in this hilly terrain of India.

Material and Methods

Study design, setting, and participants

The present population-based cross-sectional study was carried out among locally registered pregnant women residing in rural areas of the Dehradun district (western Uttarakhand) by the Department of Community Medicine affiliated with a private medical teaching institute of Uttarakhand (North India).

Dehradun is identified as one of the better-performing districts in the Uttarakhand state. Located at the foothills of the Shivalik range of the Himalayas, the district falls under the administrative jurisdiction of the Garhwal region and is one of the plain districts situated on the State's western border. The District Fact Sheet under the National Family Health Survey 2019-21 (NFHS-5) reports most antenatal indicators of Dehradun[28] are almost comparable to Kerala[29]—the best-performing state in the entire country; recording 98.0% native pregnant women registered and received mother and child protection card (MCPC); 83.5% had an antenatal check-up in their first trimester; 75.3% completed minimum four ANC visits, and 57.7% consumed iron folic acid for 100+ days.[28] In addition, the district had achieved 91.7% of institutional delivery, with less than half (49.4%) occurring in public health facilities.[28] Census 2011 recorded Dehradun as the second most populous district in the entire state (N = 1,696,694; 16.8%),[30] with more than half (N = 1,008,885; 59.4%) residing in rural areas.

The district's entire rural area is divided into six blocks: Doiwala, Sahaspur, Vikasnagar, Raipur, Chakrata, and Kalsi. Within the Doiwala block, there exists one community health center (CHC), five primary health centers (PHCs), and 23 sub-centers, providing rural health services including MCH services to 5,221 antenatal women locally registered back in May 2019 [Table 1].

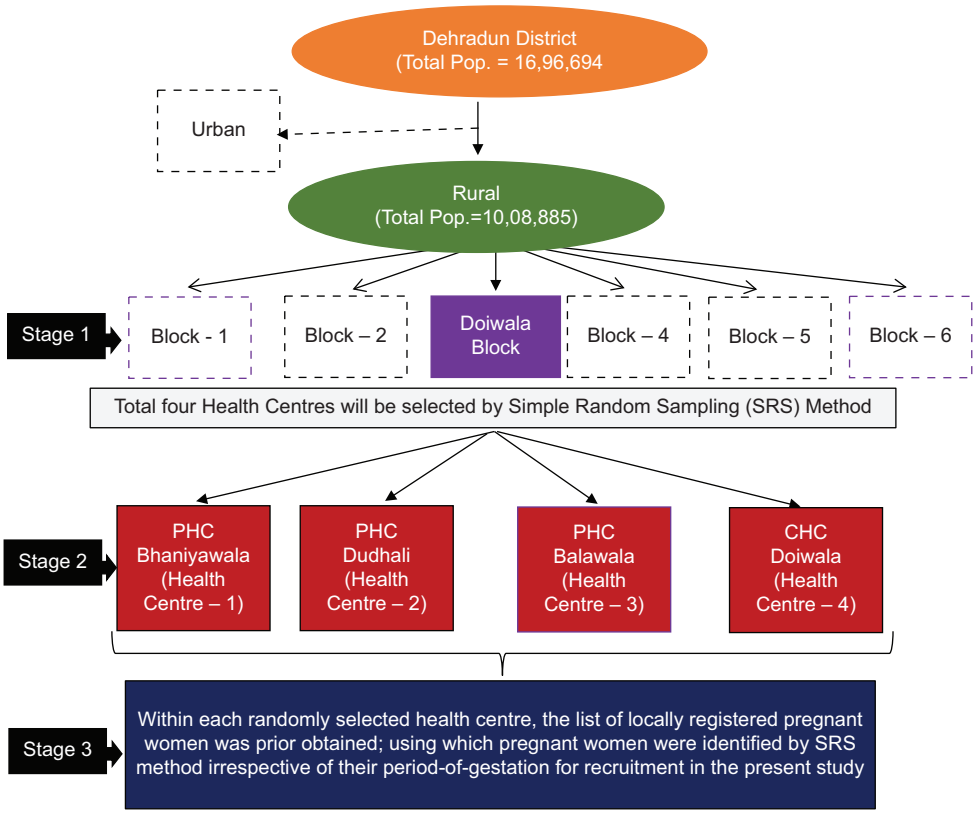
Employing a multistage random sampling technique, the present study was carried out in the rural field practice area of four government health centers within the Doiwala block, namely PHC Bhaniyawala, PHC Dudhali, PHC Balawala, and CHC Doiwala identified by the simple random sampling (SRS) method. Within each selected health center, the list of locally registered pregnant women was prior obtained; using which pregnant women were identified irrespective of their period-of-gestation by the SRS method for recruitment in the present study [Figure 1].

Assuming the finite population size of 5,221 in the Doiwala block of Dehradun district with HIP prevalence in rural areas as 10.1% (from interim analysis on 654 subjects), 95% confidence level, 20% relative precision, 1.5 design effect, total 1,103 subjects were required to be recruited in the study. On further adjusting for the 10% non-response rate, a minimum

Table 1: Geographical distribution of pregnant women registered in the Doiwala Block in May 2019* (*n*=5,221)

Name of Health Centre	SCs (*n*=23)	Total rural population [*n*=261,041; *n* (%)]	Total Pregnant women [*n*=5,221; *n* (%)]
PHC Chiddarwala	6	85,443 (32.7)	1745 (33.4)
PHC Bhaniyawala	6	48,168 (18.5)	907 (17.4)
PHC Balawala	4	43,250 (16.6)	778 (14.9)
PHC Dudhali	3	29,623 (11.3)	775 (14.8)
PHC Raiwala	3	32,853 (12.6)	594 (11.4)
CHC Doiwala	1	21,704 (8.3)	422 (8.1)

CHC: Community Health Centre; PHC: Primary Health Centre; SC: Sub-centre. *Source: CHC Doiwala office in May 2019



PHC: Primary health center
CHC: Community health center

Figure 1: Identification of study subjects by multistage random sampling technique

of 1,215 pregnant women were required to be recruited in the present study. Data were collected over a period of 18 months from December 2020 to April 2021, and September 2021 to October 2022 (excluding periods of state-wide lockdown amid the COVID-19 wave).

Study variables and instrument

Data were collected for both eligible and willing subjects by personal interview using a pretested data collection tool that consisted of four parts. The first part identified known cases of *pre*-GDM. The second part collected baseline information on prior HIP testing, if any, and identified potential candidates that require screening under the project. The third section collected HIP test results for both whether they were previously tested and screened under the project. The last part included descriptive socio-demographic details with socio-economic status (SES) assessed using the modified Udai Pareekh scale.[31] All parts of the tool were translated from the original English version into the local Hindi language by two Hindi-speaking multi-social workers, working independently of each other, after which both conversions were matched, and a common translation was finalized, pre-tested, and validated.

Operational definitions

1. **Pre-gestational diabetes mellitus (*pre*-GDM):** Subject self-reporting hyperglycemia during the pre-conception phase of the present or any of her previous pregnancies.
2. **Gestational Diabetes Mellitus (GDM):** Subject with capillary whole blood glucose (CWBG) values ranging between 140 and 200 mg/dL when tested in her present pregnancy during the house visit by 2-h 75 g oral glucose tolerance testing (OGTT) irrespective of her last meal timings and period-of-gestation, or those already known case of GDM irrespective of her period-of-gestation identified from her antenatal records available during the house visit.
3. **Overt Diabetes in Pregnancy (DIP):** Subject with CWBG values exceeding 200 mg/dL when tested in her present pregnancy during the house visit by 2-h 75 g OGTT irrespective of her last meal timings and period-of-gestation, or those already known case of overt DIP irrespective of her period-of-gestation identified from her antenatal records available during the house visit.
4. **Hyperglycemia in Pregnancy (HIP):** Subject with either GDM or overt DIP identified in her present pregnancy.
5. **SES class:** On the modified Udai Pareekh scale,[31] if a score is <40, SES class is low; if 40-70, middle; and if ≥70, high.
6. **Illiterate:** Subject who could not read and write with understanding in Hindi or English language.

Data collection methodology

Institutional ethical clearance (SRHU/HIMS/E-I/2019/117) was obtained before the initiation of the study. Following ethical clearance, the funding agency—Uttarakhand State Council for Science and Technology (UCOST), Department of Science and Technology, Govt. of Uttarakhand—was requested for funding support. Post-receipt of the approved funds (UCS&T/R&D-11/19-20/17657) and the opening of the medical college following state-wide lockdown amid the COVID-19 wave, the project was officially started; trained field investigators were recruited, equipment was purchased and data collection began.

Recruitment of pregnant women

The list of locally registered pregnant women along with their household contact details was prior retrieved from each sub-center of selected health centers with the aid of the local govt. health workers. Selected by the SRS method, pregnant women were recruited in the present study irrespective of their period-of-gestation. On the day of data collection, the trained field investigator made individual house visits to all available eligible subjects and distributed a subject information sheet to explain the purpose of the study. Those providing written informed consent to both personal interviews and OGTT were finally recruited into the study.

The subjects not available during the first visit were re-visited and those unable to be contacted following a third house visit were finally excluded from the present study.

Collection of preliminary information on HIP testing

Data were collected for both eligible and willing subjects by personal interview using a pretested data collection tool. Those requiring HIP screening under the project were identified and subjected to on-site OGTT as per the methodology discussed in Section 1.3. Indications and contra-indications for carrying out on-site OGTT under the project are illustrated in Box 1.1.

Box 1.1: Indications and contra-indications for carrying out on-site field OGTT under the project

Indications

- Subject didn't know if she has ever been checked for HIP in her present pregnancy.
- Subject knows she has never been tested for HIP in her present pregnancy.
- Subject self-reports she has been tested for HIP but reports are not available.
- She is already diagnosed with non-HIP in her present pregnancy documented on the available reports (*irrespective of the diagnostic criteria employed*), but ≥4 weeks have passed since the last testing.

Contra-indications

- Subject is already diagnosed with HIP in her present pregnancy documented on the available reports.
- Subject is already diagnosed with non-HIP in her present pregnancy, documented on the available reports, with a duration <4 weeks lapsed since the last testing.

Methodology for on-site OGTT

HIP was screened and diagnosed as per 2018 GoI national guideline protocols, i.e. a single-step procedure was employed using 2-h 75 g OGTT using CWBG samples.[25,26]

On the day of the house visit, the trained field investigator freshly dissolved 75 g of anhydrous glucose in approximately 300 ml of water in front of the subject and/or her family members. The prepared solution was then offered to the subject for its oral consumption irrespective of her last meal timings. The timing of its consumption was noted by the field worker. The intake of the solution was ensured to complete within 5-10 minutes. In case vomiting occurred within 30 minutes of oral glucose intake, the test was considered lapsed and repeated the next day; the test was continued if vomiting occurred beyond 30 minutes.

Following the lapse of 2-h post 75 g oral glucose load, the subject was tested for glucose values using a hand-held plasma-calibrated glucometer [Accu-Chek® Active (Roche Diabetes Care GmbH, Mannheim, Germany) blood glucose monitoring system]. The subject's right ring finger was pricked for pin-sized capillary blood drops obtained under aseptic precautions. Employing the Diabetes in Pregnancy Study Group India (DIPSI) criterion, those with 2-h glucose values exceeding the cut-off of ≥140 mg/dL irrespective of their last meal timings were diagnosed as HIP.

Their HIP test results were recorded irrespective of whether they were previously tested or originally screened under the project. Newly diagnosed HIP women under the project were referred to their parent antenatal centers for subsequent management. All bio-medical waste generated during field testing was managed as per the University standard protocols.

Data analysis

Data were entered and analyzed using Statistical Package for Social Sciences, version 20.0. The results were expressed as a proportion or mean ± standard deviation (SD) for categorical and continuous variables, respectively. The prevalence of HIP was documented as proportions with 95% CI.

Results

A total of 1,223 registered pregnant women were recruited in the present study. Table 2 shows the geographic distribution of the recruited pregnant women within the Doiwala block.

As seen, all subjects were recruited from 16 sub-centers of the selected CHC and PHCs. More than one-third were recruited from PHC Bhaniyawala (n = 492; 40.3%); representing recruitment from half of the target population (54.2%). Another one-third were enrolled from CHC Doiwala (n = 396; 32.4%) which stands for the majority (93.8%) of its native residents. Less than one-fourth (n = 288; 23.5%) from PHC Dudhali and the remaining (n = 47; 3.8%) from PHC Balawala—representing 37.2% and 6.0% of their target populations, respectively [Table 2].

Table 2: Geographical distribution of pregnant women recruited from the selected health centers of Doiwala Block (*n*=1,223)

Name of Selected Health Centers (PHC/CHC)	Name of SCs	No. of Pregnant Women Registered in May 2019* [*n*=2882; *n* (%)]		No. of Pregnant Women Recruited [*n*=1,223; *n* (%)]	
PHC Bhaniyawala	PHC Bhaniyawala	118		142 (28.9)	
	Shergarh	139	907 (31.5)	140 (28.5)	492 (40.3)
	Fatehpur	154		60 (12.2)	
	Jogiyana	102		48 (9.8)	
	Jolly grant	128		46 (9.3)	
	Khandarwala	164		39 (7.9)	
	Badonwala	102		17 (3.4)	
CHC Doiwala	CHC Doiwala	290	422 (14.6)	311 (78.5)	396 (32.4)
	Keshavpuri	132		85 (21.5)	
PHC Dudhali	Bullawala	215		162 (56.2)	
	PHC Dudhali	220	775 (26.9)	54 (18.8)	288 (23.5)
	Teliwala	150		51 (17.7)	
	Khairri	190		21 (7.3)	
PHC Balawala	Harrawala	219		40 (85.1)	
	PHC Balawala	219	778 (27.0)	4 (8.5)	47 (3.8)
	Nakronda	85		3 (6.4)	
	Nathuwala	121		---	
	Shamshergarh	134		---	

CHC: Community Health Centre; PHC: Primary Health Centre; SC: Sub-centre. *Source: CHC Doiwala office in May 2019

The baseline socio-demographic characteristics of the recruited subjects are illustrated in Table 3. Visibly, more than three-fourths of the subjects were Hindus (79.6%), aged below 30 years (82.0%); with 54 subjects (4.4%) in teenage pregnancy. The mean age of the participants was 26 ± 4.2 years, ranging between 18 and 52 years. More than two-thirds (70.2%) were educated between class 9th and above graduation. Most subjects were homemakers (96.5%), belonging to the low SES class (98.0%); though no single participant was in the high SES class. More than three-fourths (80.6%) were in the second trimester and beyond. Those in the second trimester (52.0%) were slightly higher than those in the third trimester (48.0%). Less than 1% of the total subjects (0.7%) self-reported *pre*-GDM; half before their present pregnancy (primigravid) and the remaining half before any of their previous pregnancies (multi-gravid).

Out of the total, more than three-fourths (77.4%) reported they were never prior tested for HIP during the present pregnancy [Figure 2]. Among them, less than half were in the second trimester (n = 419; 44.3%), followed by the third trimester (n = 327; 34.6%), and the remaining in the first trimester (n = 200; 21.1%).

Of the remaining (22.6%) who reported being tested for HIP, the majority belonged to the third trimester (n = 147; 53.1%), followed by the second (n = 93; 33.6%)], and lastly to the first (n = 37; 13.3%). Most availed public health facilities (n = 259; 93.5%) for testing services, the majority from secondary [CHC (n = 241; 93.1%) and district level facilities (n = 1; <1%)], and very few from the primary [PHC (n = 8; 3.1%), AWC (n = 5; 1.9%), sub-center (n=2; <1%)] and tertiary-level health facilities (n=2; <1%). Reportedly, most screening tests were performed during routine antenatal care by government-employed laboratory technicians (n=227; 87.6%), auxiliary nurse midwives (ANM) (n = 14; 5.4%), medical officers (n = 11; 4.2%), and lastly accredited social health activist (ASHA) (n=7; 2.7%). Those who sought testing services in private health facilities were called once (n = 6; 37.5%), twice (n = 7; 43.8%), and thrice (n = 3; 18.7%) and charged below Rs. 500 (n = 5; 31.2%), 500-1000 (n = 7; 43.8%), and ≥1000 (n = 4; 25.0%) for testing and seeking reports altogether. Despite this, less than half (48.4%) could not produce their blood sugar values noted on the MCPC to the trained field investigator on the day of the planned house visit [Figure 2].

Of those who had their reports available (51.6%), two-thirds (67.1%) had the DIPSI criteria employed. The remaining (32.9%) were diagnosed using criteria other than the DIPSI. On sub-group analysis, five (55.6%) out of nine subjects tested at the primary healthcare level and below had on their reports executing DIPSI criteria. The remaining 37 (30.1%) out of 123 tested at secondary healthcare and above, and six (54.5%) out of 11 tested at private healthcare set-ups showed their reports executing diagnostic criteria other than the DIPSI.

According to the previous reports, ten were already HIP-diagnosed (old cases) and were put on management (lifestyle and/or medical). Among those who tested negative (93.0%), a few (13.5%) had negative reports more than four weeks old**.** Thus, as seen in Figure 2, a total of 1,098 pregnant women (89.8%) were subjected to on-site OGTT under the present study while the remaining were barred for reasons summarized in Table 4. Visibly, 109 subjects (9.9%) were newly diagnosed as HIP (new cases) while remaining as non-HIP (90.1%) [Figure 2]. Thus, the overall prevalence of

HIP in the study setting was found 9.7% (95% CI: 8.1-11.5%) computed using the given formula as follows:

Table 3: Socio-demographic Characteristics of Study Participants (*n*=1,223)

Variables	Total *n* (%)
Age (in years)	
<30	1003 (82.0)
≥30	220 (18.0)
Trimester (in weeks)	
Ist (<13)	237 (19.4)
IInd (13-28)	512 (41.8)
IIIrd (≥28)	474 (38.8)
Pre-GDM	
No	1215 (99.3)
Yes	8 (0.7)
Religion	
Hindu	974 (79.6)
Muslim	230 (18.8)
Sikh	17 (1.4)
Christian	2 (0.2)
Education	
Graduation and above	284 (23.2)
Intermediate (Class 11-12)	324 (26.6)
High school (Class 9-10)	250 (20.4)
Secondary (Class 6-8)	136 (11.1)
Primary (Class 1-5)	110 (9.0)
Illiterate	119 (9.7)
Occupation	
Home-maker	1180 (96.5)
Professional (white collar)	23 (1.9)
Semi-skilled worker	8 (0.7)
Clerical, shop-owner/farm	6 (0.5)
Skilled worker	3 (0.2)
Student	3 (0.2)
SES Class*	
Middle	25 (2.0)
Low	1198 (98.0)
Health facility	
PHCs	827 (67.6)
CHC	396 (32.4)

CHC: Community Health Center; GDM: Gestational diabetes mellitus; PHC: Primary Health Center; SES: Socioeconomic status. *Using the Modified Udai Pareekh Scale 2019[31]; No subject was in the high socioeconomic class

$$Prevalence\ of\ HIP\,(\%) = \frac{\begin{pmatrix} Old\ HIP\ cases + \\ New\ HIP\ cases \end{pmatrix} \times 100}{Total\ Population\ under\ study}$$

$$Prevalence\ of\ HIP\,(\%) = \frac{(10+109)\times 100}{1223}$$

$$Prevalence\ of\ HIP\,(95\%\ CI) = 9.7\%\ (8.1\text{-}11.5\%)$$

It is worth mentioning here that out of 119 HIP women, the majority (n = 99; 83.2%) were diagnosed in their second trimester and above [45 (37.8%) in the second and 54 (45.4%) in the third trimester], remaining (n = 20; 16.8%) were diagnosed in their first trimester; with 114 (95.8%) having blood glucose values ranging between 140 and 200 mg/dL (GDM) and remaining five (4.2%) exceeding 200 mg/dL (overt DIP). It can be inferred that most HIP cases (95.8%) in the present study were GDM, followed by overt DIP (4.2%).

Discussion

The present population-based study was carried out for the first time among pregnant women of Uttarakhand to estimate HIP prevalence. Using a multi-stage random sampling technique, 1,223 locally registered pregnant women irrespective of their period-of-gestation were recruited from the rural areas of the Dehradun district (western Uttarakhand) during 18 months of study duration (2020-22). Of the total, ten were previously diagnosed with HIP while 109 were newly diagnosed following 2-h 75 g OGTT employed irrespective of their last meal timings during the house visit (when indicated) and identified using DIPSI criteria. The overall HIP prevalence recorded was 9.7% (95% CI: 8.1-11.5%); the majority (95.8%) were GDM, followed by overt DIP (4.2%). Less than 1% of the total subjects (0.7%) self-reported *pre*-GDM.

The present study findings on HIP prevalence in rural western Uttarakhand are comparable to the pooled prevalence of India [8.9% (7.1-11.1%)],[21] and those reported in rural Tamil Nadu[18] (9.9%), rural Haryana[15] (9.7%), and rural Maharashtra[12] (9.5%); lower than in rural Punjab[11] (31.9% on using WHO 2013), urban and peri-urban South Delhi[6] (19.2%), Tamil Nadu[10] (18.5% and 14.6% on IADPSG

Table 4: Indications and contra-indications of performing on-site field OGTT on the study participants (*n*=1,223)

Variables	Total *n* (%)
On-site OGTT Performed (*n*=1098)	
Women didn't know if she has ever been tested for HIP in her present pregnancy.	7 (0.7)
Women knew she was never tested for HIP so far in her present pregnancy.	939 (85.5)
Women self-reported that they had been tested for HIP but reports weren't available to them.	134 (12.2)
Women already diagnosed non-HIP in their present pregnancy on ≥4 weeks old available reports (irrespective of diagnostic criteria employed)	18 (1.6)
On-site OGTT Skipped (*n*=125)	
Women already diagnosed with HIP in their present pregnancy are documented on the available reports.	10 (0.8)
Women already diagnosed with non-HIP in their present pregnancy, documented on <4 weeks old available reports	115 (9.4)

HIP: Hyperglycemia in Pregnancy; OGTT: Oral glucose tolerance test

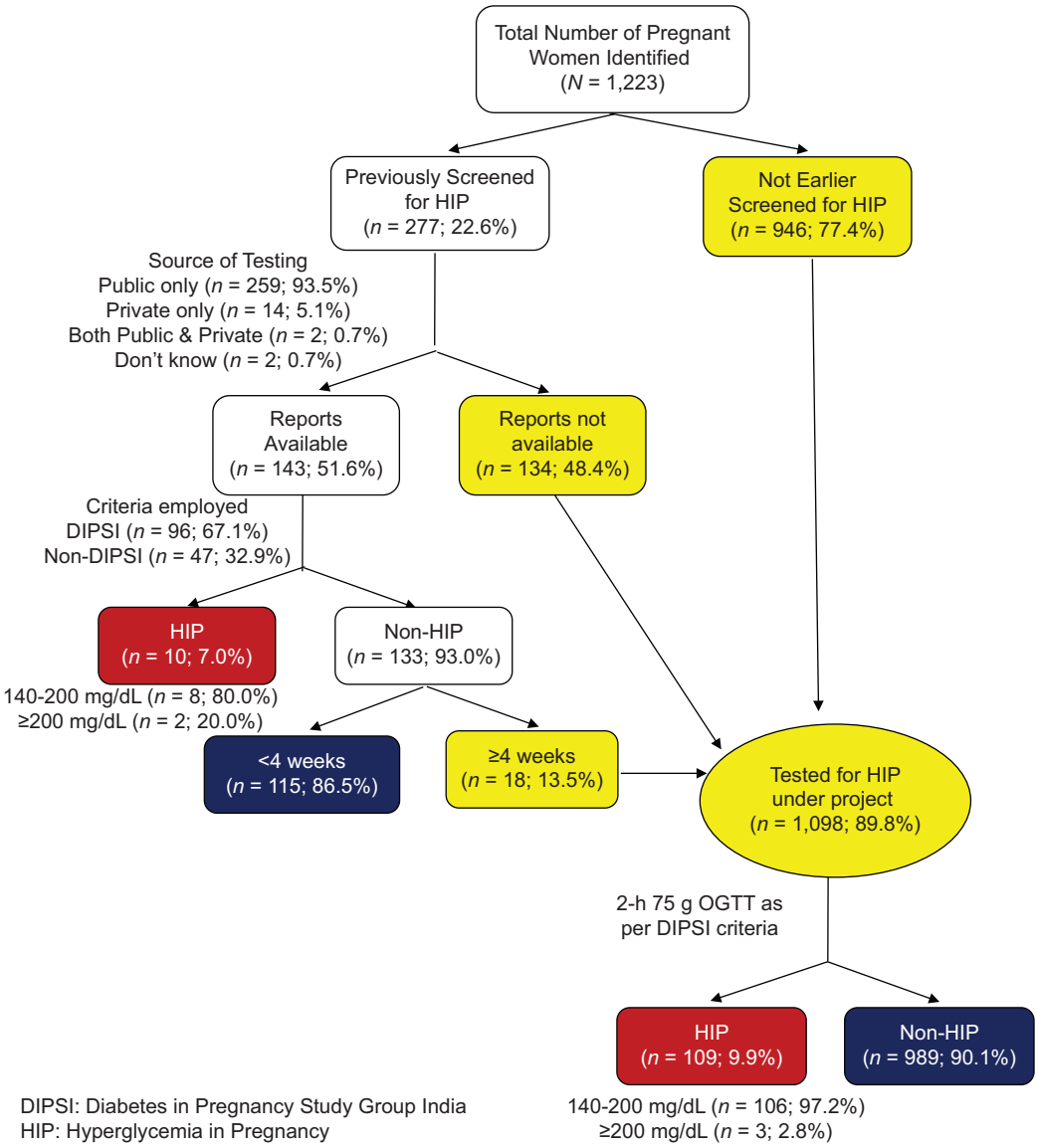


Figure 2: Prevalence of hyperglycemia in pregnancy among study subjects (N = 1,223)

and WHO criteria, respectively), rural Assam[8] (16.7%), Uttar Pradesh[14] (14.4%), Gujarat[5] (12.7%), but higher than those reported from rural Punjab[11] (7.9% on using WHO 1999), urban Kashmir (7.8),[13] rural Jammu (6.4%),[19] Kashmir[20] (3.8%), rural Karnataka[9] (3.7%), rural Assam[17] (3.0%), tribal and rural Chhattisgarh[7] (1.9%), and rural Gujarat[16] (1.7%).

Despite the above-said burden, more than three-fourths (44.3% in the second trimester, 34.6% in the third trimester, and 21.1% in the first trimester) were reportedly never tested priory for HIP during their present pregnancy; even when 83.5% of registered pregnant women in the district reportedly had their antenatal check-up done in the first trimester.[28] These findings sharply contrast with the recommended guidelines for Indian settings wherein HIP testing has to be mandatorily ensured at the earliest first antenatal contact for early diagnosis and treatment initiation.[25,26] In scenarios like this, late testing or no testing at all can result in eventful outcomes during labor and postpartum including maternal and fetal deaths. A pan-India survey conducted among 3841 healthcare providers [physician/diabetologists/endocrinologists and obstetrician/gynecologists (OB/GYNs)] covering 24 states showed more than half of them do not follow any of the recommended guidelines for HIP diagnosis.[32] Most OB/GYNs (84.9%) performed universal screening while 14.5% preferred to do only risk-based screening; with the remaining (0.6%) not screening pregnant women for diabetes at all.[32] Most OB/GYNs performed screening in the first trimester (18.8% at booking and 49% between 8 and 20 weeks) between 20 and 28 weeks by 40%, and beyond 28 weeks by 2.8%.[32]

Of those tested in the present study, the majority availed secondary healthcare facilities instead of primary. Notably, a few had to even bear their expenditure in private, with a very handful being tested free-of-cost by ANM in the

community. Community services under the MCH program in set-ups like this are intended to avoid out-of-pocket expenses while ensuring early diagnosis in their vicinity.[25,26] Availing secondary healthcare services for mere screening and ruling out HIP is not only burdening the higher public health system but also reflects questionable trust in the primary healthcare services including peripheral health workers. Despite the universal availability of MCPC, less than half could not produce the blood sugar values noted on their cards.[28]

Most HIP women diagnosed in the present study belonged to the second trimester and above for the majority of the recruited study subjects were in their second and third trimesters. In accordance with the global estimates,[2] most HIP cases in the present study were due to GDM, followed by overt DIP.

Notably, in the present study, diagnostic criteria other than DIPSI are been employed for half of the subjects screened for HIP in population settings at the primary healthcare level and below. It is, however, in sharp contrast with the recommended guidelines wherein DIPSI has been endorsed in Indian population settings as a single-step procedure for the sake of simplicity, economics, and feasibility.[25,26] Executing other diagnostic criteria at the population level will result in poor compliance rates and missed timely diagnosis and interventions. A pan-India survey conducted among 3841 healthcare providers covering 24 states showed DIPSI criteria were employed by 36.7% of the OB/GYNs and 29.4% of the physicians/diabetologists/endocrinologists.[32] The remaining were testing pregnant women in their fasting state.[32] On enquiring about the type of blood sample collected and the glucose load, the cut-offs of criteria revealed that only 12.7% and 3.8% of OB/GYNs and physicians/diabetologists/endocrinologists were correctly following the DIPSI criteria in their practice.[32] A systematic review and meta-analysis conducted by Li *et al*. (2018)[21] reflects the execution of a wide variety of screening tests/criteria besides DIPSI for GDM diagnosis despite national guidelines; the most commonly used criteria were the World Health Organization, followed by International Association of Diabetes and Pregnancy Study Groups, Carpenter and Coustan's, and then DIPSI.

Conclusions

The overall prevalence of HIP recorded was 9.7% (95% CI: 8.1-11.5%); the majority (95.8%) were GDM, followed by overt DIP (4.2%). Less than 1% of the subjects (0.7%) self-reported *pre*-GDM. Despite this burden, more than three-fourths were never tested priory for HIP during the present pregnancy. Of those tested, the majority availed secondary healthcare facilities; few even had to bear their expenditure in private, and a very handful was tested free-of-cost by ANM in the community. Despite MCPC's universal availability, less than half could not produce the blood sugar values noted on it. At the primary healthcare level and below, criteria other than DIPSI have been employed for HIP screening in population settings; findings that all together sharply contrast with the recommended GoI protocols.

Limitations

A lack of standard pre-conceptional care services within the study setting made retrieval of pre-GDM-related information recall-based. The present study considered CWBG values for HIP diagnosis using the national guidelines out of logistic limitations in population settings. However, it cannot be ruled out that CWBG values in the postprandial state are usually 10-25% higher than venous blood glucose values. In such a scenario, the prevalence reported might be an overestimation when compared to venous blood glucose cut-off values.

Recommendations

Uniformity in the universal execution of population-based screening of pregnant women as per national guidelines is recommended. Early HIP identification at the primary healthcare level calls for the implementation of the national guidelines under the RCH program of GoI. More population-based studies are needed from the hilly terrain of Uttarakhand, especially from districts located in the upper and mid-hills, preferably using venous plasma glucose samples.

Acknowledgments

The project was fully facilitated by the vice chancellor, the pro-vice chancellor, the director, the principal, the registrar, the department of finance, human resources, and material and management of Himalayan Institute of Medical Sciences and Himalayan Hospital, along with their office staffs at the Swami Rama Himalayan University. In addition, the project could be completed only because of the wholehearted support and dedication of the project staff. The appreciation of the faculty colleagues, residents, multi-social workers, and staff members was remarkable and is gratefully acknowledged.

Financial support and sponsorship

The present study has received funding support from the Uttarakhand State Council for Science and Technology (UCOST), Department of Information and Science Technology, Govt. of Uttarakhand under the Research and Development scheme.

Conflicts of interest

There are no conflicts of interest.

References

1. Guariguata L, Linnenkamp U, Beagley J, Whiting DR, Cho NH. Global estimates of the prevalence of hyperglycaemia in pregnancy. Diabetes Res Clin Pract 2014;103:176-85.
2. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Belgium: International Diabetes Federation; 2021. p. 135.
3. World Health Organization. Global Status Report on Non-Communicable Diseases 2010: Description of the Global Burden of NCDs, their Risk Factors and Determinants. World Health Organization; 2011. Available from: https://apps.who.int/iris/bitstream/handle/10665/44579/9789240686458_eng.pdf?sequence=1& isAllowed=y. [Last accessed on 2018 Jul 10].
4. Matyka KA. Type 2 diabetes in childhood: Epidemiological and clinical aspects. Br Med Bull 2008;86:59-75.
5. Nayak H, Gadhavi R, Solanki B, Aroor B, Gameti H, Shringarpure KS, *et al*. Screening for gestational diabetes, Ahmedabad, India. Bull World

Health Organ 2022;100:484-90.
6. Bahl S, Dhabhai N, Taneja S, Mittal P, Dewan R, Kaur J, *et al*. Burden, risk factors and outcomes associated with gestational diabetes in a population-based cohort of pregnant women from North India. BMC Pregnancy Childbirth 2022;22:32.
7. Chebrolu P, Kurbude R, Thakur M, Shah N, Jain R. Gestational diabetes in rural central India: low prevalence but absence of typical risk factors. Heliyon 2021;7:e07431. doi: 10.1016/j.heliyon. 2021.e07431.
8. Chanda S, Dogra V, Hazarika N, Bambrah H, Sudke AK, Vig A, *et al*. Prevalence and predictors of gestational diabetes mellitus in rural Assam: A cross-sectional study using mobile medical units. BMJ Open 2020;10:e037836. doi: 10.1136/bmjopen-2020-037836.
9. Sinha AK, Madhu B, Narayana Murthy MR. A community based screening of gestational diabetes mellitus within 16 weeks of pregnancy: A study from Mysuru district, Karnataka. Int J Community Med Public Health 2018;5:2266-70.
10. Bhavadharini B, Mahalakshmi MM, Anjana RM, Maheswari K, Uma R, Deepa M, *et al*. Prevalence of gestational diabetes mellitus in urban and rural Tamil Nadu using IADPSG and WHO 1999 criteria (WINGS 6). Clin Diabetes Endocrinol 2016;2:8.
11. Arora GP, Thaman RG, Prasad RB, Almgren P, Brøns C, Groop LC, *et al*. Prevalence and risk factors of gestational diabetes in Punjab, North India: Results from a population screening program. Eur J Endocrinol 2015;173:257–67.
12. Bhatt AA, Dhore PB, Purandare VB, Sayyad MG, Mandal MK, Unnikrishnan AG. Gestational diabetes mellitus in rural population of Western India-Results of a community survey. Indian J Endocrinol Metab 2015;19:507–10.
13. Raja MW, Baba TA, Hanga AJ, Bilquees S, Rasheed S, Haq IU, *et al*. A study to estimate the prevalence of gestational diabetes mellitus in an urban block of Kashmir valley (North India). Int J Med Sci Public Health 2014;3:191-5.
14. Jain R, Pathak RR, Kotech AA. Gestational diabetes: Perinatal and maternal complication in 24-28 weeks. Int J Med Sci Public Health 2014;3:1283-8.
15. Rajput M, Bairwa M, Rajput R. Prevalence of gestational diabetes mellitus in rural Haryana: A community-based study. Indian J Endocrinol Metab 2014;18:350-4.
16. Dave VR, Rana BM, Sonaliya KN, Chandwani SJ, Sharma SV, Khatri SO, *et al*. Screening of gestational diabetes and hypertension among antenatal women in rural west India. Cent Asian J Glob Health 2014;3:140.
17. Mahanta TG, Deuri A, Mahanta BN, Bordoloi P, Rasaily R, Mahanta J, *et al*. Maternal and foetal outcome of gestational diabetes mellitus in a rural block of Assam, India. Clin Epidemiol Glob Health 2014;2:9-15.
18. Seshiah V, Balaji V, Balaji MS, Paneerselvam A, Arthi T, Thamizharasi M, *et al*. Prevalence of gestational diabetes mellitus in south India (Tamil Nadu) – A community based study. J Assoc Physicians of India 2008;56:329-33.
19. Verma AK, Singh B, Mengi V. Gestational diabetes in rural women of Jammu. Indian J Community Med 2008;33:54-5.
20. Zargar AH, Sheikh I, Bashir MI, Masoodi SR, Laway BA, Wani AI, *et al*. Prevalence of gestational diabetes mellitus in Kashmiri women from the Indian subcontinent. Diabetes Res Clin Pract 2004;66:139-45.
21. Li KT, Naik S, Alexander M, Mathad JS. Screening and diagnosis of gestational diabetes in India: A systematic review and meta-analysis. Acta Diabetol 2018;55:613–25.
22. National Institution for Transforming India (NITI) Aayog, Government of India. Health States Progressive India: Report on the Rank of States and Union Territories. Health Index Round IV 2019-20. National Institution for Transforming India Aayog, Government of India. 2019-20. Available from: https://www.niti.gov.in/sites/default/files/2021-12/NITI-WB_Health_Index_Report_24-12-21.pdf. [Last accessed on 2022 Dec 06].
23. Sample Registration System (SRS)-Special Bulletin on Maternal Mortality in India 2018-20. New Delhi: Office of Registrar General, India; 2022. Available from: https://censusindia.gov.in/nada/index.php/catalog/44379.
24. Union Government (Civil). Ministry of Health and Family Welfare. Report of the Comptroller and Auditor General of India on Performance Audit of Reproductive and Child Health under National Rural Health Mission. New Delhi (India): Comptroller and Auditor General of India, Government of India; 2017. Report no: 25. Available from: https://cag.gov.in/uploads/download_audit_report/2017/Report_No. 25_of_2017_-_Performance_audit_Union_Government_Reproductive_and_Child_Health_under_National_Rural_Health_Mission_Reports_of_Ministry_of_Health_and_Family_Welfare.pdf. [Last accessed on 2019 Jun 30].
25. Government of India. Maternal and Health Division, Diagnosis and Management of Gestational Diabetes Mellitus: Technical and operational guidelines. New Delhi, India: Ministry of Health and Family Welfare, New Concept Information Systems; 2018.
26. Mishra S, Bhadoria AS, Kishore S, Kumar R. Gestational diabetes mellitus 2018 guidelines: An update. J Family Med Prim Care 2018;7:1169-72.
27. Mishra S, Rao CR, Bhadoria AS, Kumar R, Aggarwal P, Vyas S, *et al*. A step towards real-time implementation of GDM guidelines in India: Review of Gaps in RCH Programme. J Family Med Prim Care 2020;9:5837-45.
28. Government of India. National Family Health Survey – 5. District Fact Sheet: Dehradun, Uttarakhand (2019-21). Mumbai: Ministry of Health and Family Welfare. International Institute for Population Sciences. Available from: http://rchiips.org/nfhs/NFHS-5_FCTS/UT/Dehradun.pdf. [Last accessed on 2022 Sep 30].
29. Government of India. National Family Health Survey – 5. State Fact Sheet: Kerala (2019-20) [Internet]. Ministry of Health and Family Welfare. Mumbai. International Institute for Population Sciences. Available from: http://rchiips.org/nfhs/NFHS-5_FCTS/Kerala.pdf. [Last accessed on 2022 Sep 30].
30. Census of India 2011. Uttarakhand: District Census Handbook – Dehradun. Village and Town wise. Primary Census Abstract. Directorate of Census Operations. Uttarakhand. 2011. Series–06; Part XII-B.
31. Wani RT. Socioeconomic status scales-modified Kuppuswamy and Udai Pareekh's scale updated for 2019. J Family Med Prim Care 2019;8:1846-9.
32. Mahalakshmi MM, Bhavadharini B, Maheswari K, Anjana RM, Jebarani S, Ninov L, *et al*. Current practices in the diagnosis and management of gestational diabetes mellitus in India (WINGS-5). Indian J Endocr Metab 2016;20:364–8.