

# Changes in Knowledge and Management Skills of ANMs To Screen, Manage and Refer Pregnant Women with Five High-Risk Conditions: Results from A Pre-Post-Training and A Six-Month Follow-Up Assessment in Telangana, India

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## Abstract

**Background:** Auxiliary Nurse Midwives (ANMs) are key providers of maternal, newborn and child health services, and are the first point of contact for high-risk pregnancies (HRPs). In partnership with Government of Telangana, under Integrated High-Risk Pregnancy Tracking and Management (IHRPTM) program, all the ANMs of the state were trained to screen and manage five HRPs: anaemia; gestational diabetes-GD; pregnancy induced hypertension-PIH; ante-partum haemorrhage-APH; and quality-Antenatal care (ANC). Assessed pre- and post-class-room and six months after class-room training capabilities of ANMs.

**Methods:** Immediate-gains through class-room-training and six-months after class-room training knowledge/skills from 7,553 and 529 ANMs respectively, were assessed using a checklist of 15 questions per HRP-condition. Also obtained, qualitative insights about class-room training.

**Results:** Due to class-room training, there was 8-17% improvement in immediate-gain in knowledge/skills to diagnose, manage/refer women with HRPs. Improvement in mean correct responses (out of 15 questions per-HRP) between pre-and-post-training assessments was maximum for GD: mean 7.6 at pre-training, improved to 10.2 by post-training; APH: 9.7 to 11.7; quality-ANC: 10.2 to 11.7; PIH: 9.3 to 10.7; and anaemia: 11.0 to 12.3. Gain in knowledge/skills as Cohen's-d effect-size was large (0.7-0.8) for GD, APH, quality-ANC, PIH, and medium (0.6) for anaemia, as pre-training knowledge/skills was already better for anaemia. Mean gain per HRP was more than three questions in four districts and < 0.5 questions in two districts. Mean gain did not differ much according to age, work experience and training-time. As compared to pre-training level, retention of knowledge/skills, six-to-nine months after class-room training dropped substantially (Cohen's-d effect-size ≤ 0.2) for all HRPs,

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*except for anaemia (d=0.4). Training gave them confidence to stabilize emergency cases at sub-centre level before referring to higher facility!*

**Conclusion:** *Through IHRPTM's protocol-based training: screening, management/referral of HRP's by ANMs is feasible. Standardized-training supplemented with handholding leads to provision of obstetric care.*

**Keywords:** High-risk Pregnancies, Auxiliary Nurse Midwives, Class-Room Training, Immediate Gain in Knowledge/Skills, Change in Theoretical/Practical Skills, Knowledge Retention, Effect Size.

## 1. Introduction

Most of the maternal health complications that lead to maternal and/or newborn death develop during pregnancy, and with quality antenatal care (ANC) majority of these complications/high-risks are preventable or treatable [1]. Globally, prevalence of life-threatening complications during pregnancy were around 15% [2]. Around 50-60% women with maternal health complications undergo caesarean delivery [3]. High-risk pregnancies (HRPs) account for 75% of perinatal deaths in India [4]. Based on data available from different geographies, prevalence of HRP's in India range from 18.3% to 59% [5-8]. In India, as there is no standardized list, no facility-based standardized protocol to diagnose & manage, no standardized database on the burden of HRP's - the HRP figures differ substantially in these studies.

The World Health Organization (WHO) standards for improving quality of antenatal care for a positive pregnancy experience recommends, early assessment of HRP's, while the revised guidelines describe management of obstetric complications at district level, even though their use at different facilities and levels of referral system is not well understood [9-11]. For addressing HRP's, early screening, protocol-based management, regular follow-up, and quality antenatal, intra-natal and postnatal care are required [12]. In India, although, programs like Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA), Labour Room Quality Improvement Initiative (LaQshya), Surakshit Matritva Aashwasan (SUMAN), Live Saving Anaesthesia skills (LSAS), Emergency Medical Obstetric Care (EMOC), etc., address HRP's, their focus is on strengthening Basic Emergency Obstetric and Neonatal Care (BEmONC) and Comprehensive emergency obstetric and newborn care (CEmONC) services, with limited or no focus on primary (Health Sub Centres-HSCs) and secondary care facilities (Primary Health Centres-PHCs) [13].

Among the four levels of obstetric care in primary health care system of rural India, ANM is a village-level female health worker, and she is known as the first contact person between the community and the public health care system. ANMs works at HSCs, the lowest rung of the ladder in public health care system, and provides ANC primarily and birthing services rarely; next level being PHCs, which provide either BEmONC or only birthing services; followed by Community health centres (CHCs) that provide CEmONC care, but mostly only provide BEmONC or even less; and referral facilities at the fourth level, that provide CEmONC and specialist care. The ANC and birthing services provided by ANMs at HSC level are crucial for safe and effective

care of women in rural India, and mainly depending upon the quality of these services, targets of national health programmes will be met. By capacitating them on protocol-based screening and management of HRP's, women with HRP-conditions can be stabilized at HSC level and then can be referred to higher facilities for next level of management and/or follow-up.

Challenges in building capacities of ANMs in India are due to inadequate training resources, lack of need-based training, and poor quality of pre-service education [14-15]. Pre-service education and in-service training have been adversely affected by lack of competent faculty, teaching aids, and funds for practical training, leading to suboptimal outcomes from the training for service delivery [16]. In-service trainings are either not conducted or poorly implemented, and mostly in the form of a short orientation [17]. Studies on ANMs/ASHAs show that, these two functionaries are inadequately trained, poorly skilled and assigned only task-based work (e.g. immunisation, antenatal investigations etc) and fail to consider complication management in early pregnancy [18]. Hence, there is a critical need to train ANMs, especially through in-service training, to deliver quality antenatal and HRP screening and management - as poor primary care led to increased and delayed high-risk referrals, resulting in overburdening of tertiary facilities. With proper training and handholding, ANMs can play a key role in early screening and management of HRP's, particularly during the first two trimesters. However, there is limited data on the ANMs perspective of screening and management of HRP's in India [19,20].

In partnership with Government of Telangana, Advancing Reduction in Mortality and Morbidity of Mothers, Children and Neonates (ARMMAN), is implementing a five-year (2021-2026), Integrated High Risk Pregnancy Tracking and Management (IHRPTM) program. IHRPTM program is a comprehensive, multi-step, systemic approach for improved identification, tracking and end-to-end management of 20-HRP's. ARMMAN developed tailor-made protocols for each HRP according to specialist-gynaecologists at CHC, Medical Officers (MOs) at PHC and ANMs at HSC. Till August 2023, ARMMAN facilitated Government of Telangana to train all the three cadres of the state (specialist-gynaecologists, MOs and ANMs) on five HRP's: anaemia; gestational diabetes-GD; pregnancy induced hypertension-PIH; ante-partum haemorrhage-APH; and on quality-ANC. Training health functionaries is only one of the components of IHRPTM program, as it will be supplemented with continued handholding, learning-app, tracking-app, etc. More details about IHRPTM can

be found at <https://armman.org/high-risk-pregnancy>.

Aim of this paper is to measure changes in knowledge/management skills of ANMs to diagnose and manage/refer women with five HRP, because of class-room training. Specific objectives of this paper were:

1. To calculate immediate gains in knowledge/management skills of ANMs due to class-room training - according to each question of an HRP-condition and according to each HRP-condition.
2. To document variations in immediate gains in knowledge/management skills on five HRP due to class-room training - according to district and background characteristics of ANM.
3. To assess knowledge/management skills retention on five HRP, six-nine months after class-room training of ANMs.

## 2. Methods

As part of five-year implementation plan of IHRPTM program, under phase-1 of training, all the ANMs at HSC, all the Medical Officers (MOs) at PHC and all the specialist-gynaecologists at CHC were already trained on six HRP, by August 2023. They will be trained on remaining 14 HRP, in another two phases. Under phase-1, six HRP were covered: anaemia; gestational diabetes-GD; pregnancy induced hypertension-PIH; ante-partum haemorrhage-APH; quality-ANC; and COVID. ARMMAN developed protocol for each HRP provides, a structured algorithmic direction about identifying a pregnant woman with the HRP - through detailed history taking, management of the diagnosed HRP with treatment, appropriate counselling, referral (if needed), and follow-up. All these steps were tailored according to three levels of public health care system.

Since one-time training cannot provide complete knowledge on all aspects of an HRP-condition, a nudged learning management system (LMS) on six phase-1 HRP has been introduced in the state since September 2023 for ANMs and MOs, for continued learning. This nudged learning management system is expected to encourage behaviour change with a view to retain and apply the knowledge acquired through class-room training, as LMS consists of multimedia videos, quizzes and reading material with voiceover as relevant to ANM/MO on identification, management, and referral parameters for each HRP.

Other important handholding interventions under IHRPTM for ANMs and MOs include: '*ANM-support-system*', through which each ANM is tagged with her respective Trainer-of-Trainers (TOT) over WhatsApp, for raising questions and getting almost real-time responses on HRP. This intervention was introduced in September 2023. Currently developing a dash-board for ANMs and MOs to self-monitor their progress on HRP-cases, screening and management. Preparations are underway to develop '*a tracking app*' to integrate with '*e-Kavach, the state government database of all pregnancies, HRP, deliveries, etc.*', to review UpToDate status of each diagnosed HRP from anywhere in the state, and to take appropriate decision on treatment and/or management and/or follow-up of the case. This intervention will become operational by December 2024.

It may be noted, in the current paper, we assessed knowledge gained by ANMs on five key HRP, due to class-room training and to assess knowledge retention on these five HRP, six-to-nine months after class-room training.

For training 9,156 ANMs nominated by the state, from 33 districts, ARMMAN adopted a '*cascading approach*' in which 2-3 state-appointed TOTs per district were trained by master trainers (MTOs) of ARMMAN. The TOTs nominated by the state were specialist-gynaecologists or the senior MOs posted in district/area hospital. The TOTs in-turn trained the ANMs in batches of 45-60 ANMs per batch, on six phase-1 HRP, in their respective districts. In May 2021, initial training of the TOTs on six phase-1 protocols was held by three MTOs. *Two of the MTOs are practicing gynaecologists with public health background, and the third is a co-creator of the HRP guidelines.* A refresher training of the TOTs on six phase-1 protocols was again held in June 2022, just prior to initiation of class-room training for the ANMs.

Since, mid-September 2022, each batch of ANMs were trained on six phase-1 HRP, by district-TOTs, at district headquarter, for a day (or 8-9 hours of time), using '*instructor-led training*' as the method of training in a class of 45-60 ANMs. Prior to training color-coded, tailor-made protocols for three levels of health care facilities, for six HRP, in Telugu language were provided, as a reading material. Using the content in the protocol for the HRP, ARMMAN developed a simple power-point presentation and respective discussion points to be used by the TOTs during training, in Telugu language - to ensure standardized training content. Training was mainly given in Telugu. As, six HRP were covered in a day, the TOTs usually spent around one-and-half hours, per HRP-condition. For each HRP-condition, the MTOs developed a set of 15 questions on theoretical, diagnostic, management, and referral issues, in Telugu, to assess knowledge/skills due to training (*Please refer to additional files 1-5 for list of 15 questions for each HRP*). Prior to their use, developed questions were discussed, validated, and endorsed by creators of the HRP guidelines and government of Telangana.

Training of 9,156 ANMs nominated by state, in batches of 45-60, started in mid-September 2022. Due to a major state government initiative (*Kanti velugu*), training was put on hold for three-four months, and only by mid-August 2023 trainings of all the nominated ANMs in the state, in 188 batches, in 33 districts, on six phase-1 HRP was complete.

For each batch, pre-post-training assessment was done for the following five HRP: Quality ANC, Anaemia, GD, PIH and APH. Although, ANMs were trained on sixth HRP, namely COVID, Government of Telangana and ARMMAN decided not to do pre-post-training assessment for this HRP. HRP-condition-wise, pre-post-training assessment was done by research team of ARMMAN, by physically participating in the training sessions of each batch, and by administering a checklist of 15 questions, consisting of a mix of theoretical, diagnostic and management/referral skills of ANMs. All the questions have multiple responses

and ANM must tick the correct response, in google form, on her mobile. It took 8-12 minutes for answering a checklist with 15 questions per HRP-condition. Pre-training, knowledge/skills were assessed by administering the checklist prior to training ANMs on the HRP-condition. By administering the same checklist after training, post-training knowledge/skills were assessed. For each batch, a feedback form was also administered by research team of ARMMAN, to get ANM's views on the quality of the training.

During initial months of training, the research team also collected qualitative data about training, using a '*semi-structured tool*', by interviewing six randomly selected ANMs of varying years of work experience, per batch, from a district and in nine districts. Thus, 51 ANMs from nine districts were interviewed using semi-structured qualitative tool, at the end of each batch's training, during September-November, 2022. Through this tool in Telugu, we tried to explore ANM's views, on the following three dimensions: 1) methods used by TOTs to train ANMs, 2) effectiveness of the content on which they were trained and 3) value-addition of this training vis-à-vis their routine training. Each interview lasted for 15-20 minutes. Probes were used wherever extraction of more relevant information was possible and notes were taken during the interviews. Transcribed interviews were translated to English and back-translated to Telugu to verify accuracy of original translation. An inductive approach was used to identify patterns and themes, and analysis was done manually by the authors. The final themes were then summarized according to three dimensions.

Data of only those ANMs who have participated in both the pre- and post-training assessments of a particular HRP-condition was included in analysis. It implies those ANMs who have participated in either pre-test or post-test were excluded from the analysis. The cleaned data was imported to SPSS 22.0 for detailed analysis. Question-wise, pre-training and post-training performance was assessed using percentage of ANMs who provided correct response, out all ANMs. Question-wise immediate gains in knowledge/skills were assessed using 'percentage change' (*% of ANMs with post-training correct response - % of ANMs with pre-training correct response*). HRP-condition-wise gain in knowledge/skills was also assessed by subtracting mean number of correct responses (out of 15 questions) at post-test from the mean at pre-test. HRP-condition-wise significance of difference between mean correct responses was calculated using t-statistic.

To describe influence of class-room training on gain in knowledge/skills between pre- and post-training assessments, we used

Pearson's r and Cohen's d - as effect sizes. The effect-size value indicates how meaningful the relationship between two groups is. In this study, effect-size indicates practical significance of class-room training on gain in knowledge/skills. Among the two effect sizes, Pearson's r measures the strength of relationship between the groups while Cohen's d measures the size of difference between the two groups. Pearson's r ranges between -1.0 to +1.0, while Cohen's d can range from 0 to infinity. We used Cohen's-d for repeated measures, as it uses pooled standard deviation while controlling for the intercorrelation of the groups [21]. Cohen used 0.1, 0.3 and 0.5 to represent 'small', 'medium' and 'large' correlations, while Cohen's-d of 0.2 represent small effect-size, d of 0.5 represent medium and d of 0.8 represent large effect-sizes [22]. HRP-condition-wise variations in terms of number of correct responses was assessed using percentile-cut-offs.

Keeping in view class-room training of ANMs on five HRPs in Telangana started in mid-September 2022, the IHRPTM program team, that time felt, six months is a sufficient time for practicing the skills gained through class-room training, as in this duration, one ANM will cover 40-45 pregnant women and four-five women will with any of the five HRP-conditions. The IHRPTM team also felt, six months after initial class-room training is an ideal time to re-assess their skills. Re-assessment was done during August-October 2023, among a random sample of 901 ANMs from seven sampled districts of three geographic regions in Telangana, by ensuring these ANMs have completed at least six months since their class-room training. Randomly selected ANMs were re-approached, and the same pre-post-training assessment checklists were re-administered, to assess knowledge/skills retention.

### 3. Results

Government of Telangana provided a list of 9,156 ANMs, from 33 districts, for class-room training on six phase-1 HRPs (quality ANC, anaemia, GD, PIH, APH and COVID). Class-room training of ANMs by TOTs on six HRPs started in mid-September 2022. In the first five months since start of training, around 90% of ANMs were trained. Due to a government introduced program called '*kani velugu*' (*eye light*) in January 2023, ANM-trainings were halted for three months (February-April 2023). Even after resumption in May 2023, few trainings happened. Only by August 2023, all the 33 districts were covered by phase-1 training on six HRPs, in 188 batches, with batch-size ranging from 45-60. Pre-post-training assessments were conducted using the same checklist of 15 questions per HRP-condition only for five HRPs, namely: quality ANC (QANC), anaemia, GD, PIH, and APH.

District	Nominated for phase-1 training	Number of batches proposed	Participated in phase-1 training	% Participation in phase-1 training	% ANMs participated in pre & post assessments				
					QANC	Anaemia	APH	PIH	GD
Adilabad	246	5	75	30.5	100.0	76.0	100.0	100.0	94.7
Bhadradi Kothagudem	453	9	393	86.8	99.2	100.0	98.5	98.7	99.0
Hyderabad	405	8	318	78.5	89.6	90.6	77.0	85.5	84.0
Jagtial	299	6	246	82.3	87.4	94.3	95.1	95.9	88.6
Jangaon	195	4	171	87.7	95.9	91.8	95.9	95.3	93.6
Jayashankar Bhupalpalli	172	4	126	73.3	87.3	87.3	59.5	64.3	73.8
Jogulamba Gadwal	165	3	159	96.4	83.0	61.0	75.5	79.9	78.6
Kamareddy	295	6	261	88.5	88.5	95.8	76.2	92.0	95.8
Karimnagar	326	7	271	83.1	90.4	92.3	66.4	86.0	81.2
Khammam	404	8	375	92.8	99.5	96.5	95.7	96.3	92.0
Kumuram Bheem Asifabad	187	4	102	54.5	93.1	61.8	27.5	48.0	66.7
Mahabubabad	276	6	270	97.8	81.5	96.7	97.8	84.1	95.2
Mahabubnagar	277	5	230	83.0	93.9	96.1	93.0	97.4	89.6
Mancherial	260	5	246	94.6	97.6	97.2	94.3	92.7	96.7
Medak	260	5	205	78.8	96.6	78.0	82.9	89.8	54.6
Medchal-Malkajiri	278	6	189	68.0	85.7	94.2	97.4	95.7	96.7
Mulugu	123	3	105	85.4	44.8	79.0	36.2	80.0	29.5
Nagarkurnool	296	6	231	78.0	90.9	87.4	88.7	87.0	94.8
Nalgonda	432	9	431	99.8	97.9	89.3	67.5	73.8	71.0
Narayanpet	142	3	110	77.5	95.5	68.2	34.5	94.5	89.1
Nirmal	185	4	147	79.5	91.2	83.0	72.1	93.9	89.8
Nizamabad	454	9	378	83.3	95.8	94.7	94.4	95.8	96.3
Peddapalli	231	5	164	71.0	82.9	90.2	92.1	96.3	75.6
Rajanna Sircilla	168	3	126	75.0	96.0	96.8	88.9	86.5	88.1
Rangareddy	416	8	354	85.1	88.1	83.6	86.2	83.3	81.4
Sangareddy	378	8	310	82.0	92.3	90.0	95.2	99.4	98.1
Siddipet	328	7	266	81.1	95.1	99.2	85.3	94.0	94.4
Suryapet	315	6	299	94.9	97.3	99.7	97.7	99.7	98.7
Vikarabad	278	6	192	69.1	80.2	79.7	65.1	69.8	76.6
Wanaparthy	171	4	146	85.4	92.5	97.9	89.0	99.3	86.3
Warangal Urban	272	6	235	86.4	91.5	74.5	91.9	77.9	97.4
Warangal Rural	245	5	225	91.8	87.6	89.3	96.4	96.0	86.7
Yadadri Bhuvanagiri	224	5	197	87.9	95.4	97.5	80.2	97.5	98.0
Total	9,156	188	7,553	82.5	91.6	90.2	84.6	90.0	87.9

**Table 1: District-wise number of ANMs nominated and participated in phase-1 training, and HRP-condition-wise participation in pre-post-training assessments**



Table 1 presents district-wise number of ANMs nominated, participated in phase-1 training and HRP-condition-wise percent participation of ANMs in both pre- and post-training assessments. With district-wide variations, 82.5% of all the nominated ANMs participated in phase-1 training, and participation rates were better in Jogulamba Gadwal (96.4%), Mahabubabad (97.8%), Nalgonda (99.8%), and very poor/poor in Adilabad (30.5%) and Asifabad (54.5%) districts. Out of those who participated in phase-1 training, percent who took pre-post-training assessment ranged between 85-92%, for five HRPs, with some district-wide variations. Participation in pre-post-training assessments of five HRPs was particularly poor in Asifabad (27.5-93.1%) and Mulugu (36.2-80.0%) districts and for APH (34.5%) in Narayanpet district.

Additional files 1-5 provide list of 15 questions, percent correct responses during pre- and post-training assessments, and percent change in correct responses during post-test Vs pre-test – for each question of a HRP-condition. Fifteen questions of each HRP-condition were broadly categorized according to theoretical/knowledge and skill/management/referral-based questions. For a particular question or for a particular HRP-condition based on average correct response for all 15 questions, <50% correct response was considered as a ‘poor’ and >80% correct response was considered a ‘good’ knowledge/skill.

### 3.1 Quality ANC/History & Examination of Pregnant Woman

Out of the four theoretical questions, for questions on calculating expected date of delivery and ideal pregnancy weight gain, more than 80% ANMs have correct knowledge, prior to training. Pre-training correct knowledge was poor (41%) for an indirect question on ‘abnormal abdominal conditions’, and even after training, only 53% provided correct response to this question. For 11-management questions, mean pre-training correct knowledge of 66.6% improved to 77.8% by post-training. Even after training, correct responses were <65% for three questions: ‘different contents of pregnant woman’s history taking’, ‘right steps while doing UPT’ and ‘perception that swelling of legs is a normal condition in pregnancy’. On the topic of ‘how abdominal examination for uterine size and foetal well-being should be done’ gain in knowledge due to training was maximum 26% (from 56.5 to 82.3%).

**Anaemia:** For seven theoretical questions, mean pre-training correct knowledge was good at 81.0%, improved to 88.5% by post-training. Both pre- and post-training correct responses were  $\geq 90\%$  for questions on ‘influence of anaemia during pregnancy on the

*baby*’, ‘common symptoms of anaemia’ and ‘correct nutritional advice for a pregnant woman with anaemia’. Mean pre-training correct knowledge on eight management questions was 66.3%, improved only to 74.4% by post-training. Even after training, correct responses were <60% for two case study-based questions, implying need for reorientation on different case scenarios.

**APH:** Due to training, there is substantial gain in knowledge on four theoretical questions, from 58.6% to 76.2%. Gain was maximum 30.1%: (from 42.8 to 72.9%) for question on ‘definition of APH’. For two questions on ‘causes of APH’ and ‘mothers with previous history of C-section are at increased risk of placenta previa and uterine rupture’ – pre-training knowledge of 59% improved to around 75%, by post-training. On 11-management questions, knowledge improved from 67.2% to 78.9%, due to training. Even after training, correct knowledge was <34% for an indirect question on ‘correct signs/symptoms associated with APH’. Gain in knowledge was >20% for two case study-based questions.

**PIH:** Due to training, there is minimal gain in knowledge on five theoretical questions from 53.1% to 62.5%. Both pre- and post-training correct knowledge was >82% for questions on ‘effect of hypertension on baby’ and ‘definition of hypertension’. Even after training, correct knowledge was <15% for an indirect question ‘correct nutritional advice to woman with PIH’. Correct knowledge on ten-management questions improved from 66.0% to 75.5%. Gain in knowledge was almost nil/negative (-1.5% and -2.5%) for two questions on ‘warning symptoms associated with hypertension’ and ‘immediate next steps to be followed by ANM when a woman is detected with hypertension during ANC visit’. Even after training, correct responses were <55% for questions on ‘warning symptoms associated with PIH’ and a case study. Thus, if feasible it good to do re-orientation of ANMs on this HRP-condition.

**GD:** Due to training, there was substantial gain in six theoretical questions from 56.6% to 75.5%. Gain in knowledge was maximum 33.4%: (from 17.3 to 50.7%) for a question on ‘timing of oral glucose tolerance test (OGTT)’. Correct knowledge on nine-management questions improved from 41.7% to 63.2%. Gain in knowledge was negative (-5.2%) for a question on ‘tests to be done for a primigravida women with GDM’. Even after training, correct responses were <55% for a case study and ‘screenings for Gestational Diabetes Mellitus (GDM)’.

**Figure 1: HRP-condition-wise mean number of correct responses by ANMs during pre and post-training assessments out of total, only theoretical and only management based questions**

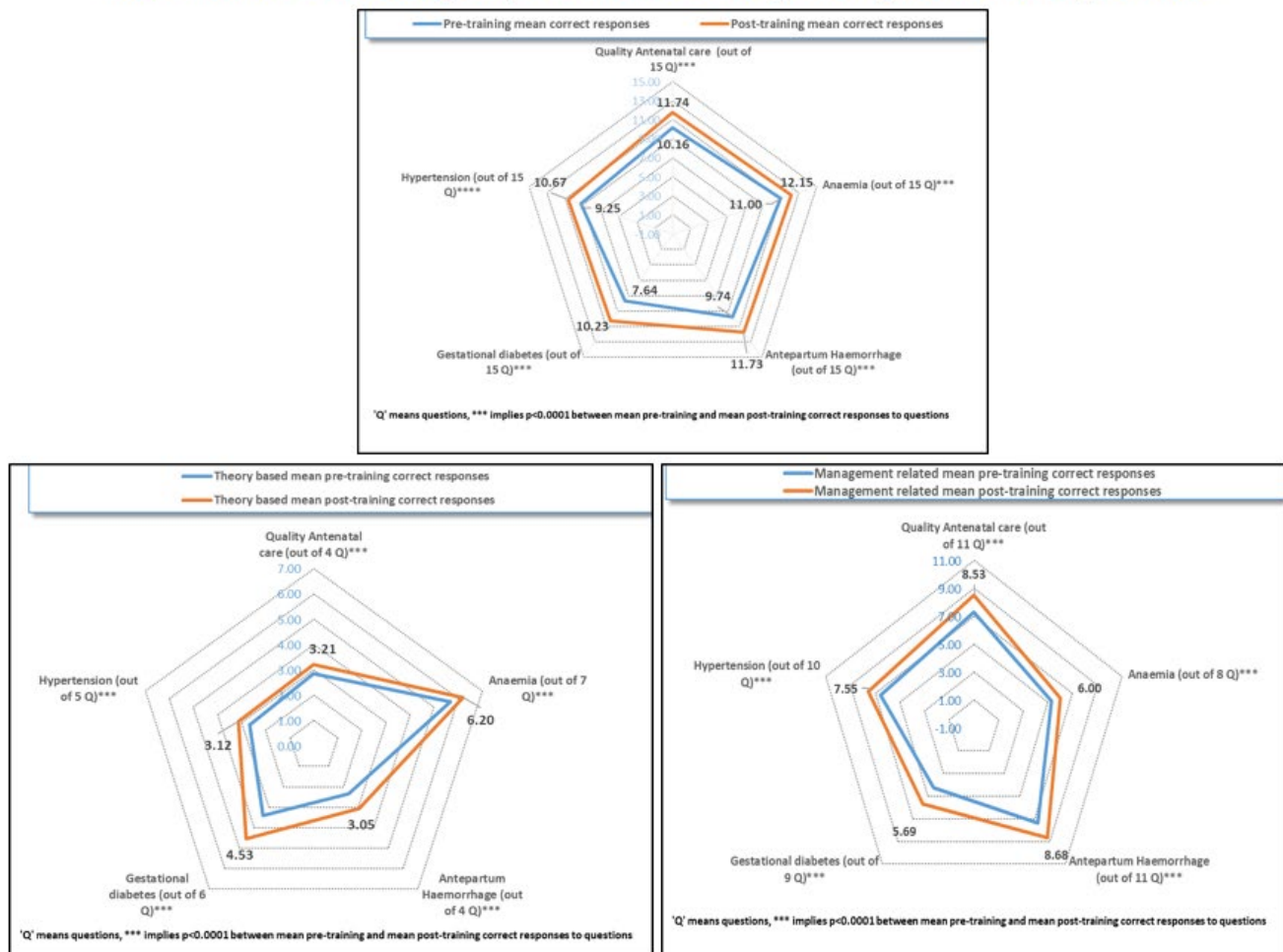


Figure 1 presents protocol-wise gain in knowledge due to classroom training, according to mean number of correct responses during pre- and post-training assessment –for all the 15-questions, only theoretical and only practical questions. Due to training, there was highly significant improvement in mean correct knowledge/skills on 15 questions, between post-and-pre-training assessments, for all the five HRPs. Mean gain in knowledge for entire HRP-condition was maximum, up to 2.6 questions for GD (from a mean of 7.6 questions correct response in pre-training assessment to 10.2 questions by post-training assessment), followed by APH 2.0 questions (9.7 to 11.7), quality ANC 1.6 questions (10.2 to 11.7), hypertension 1.4 questions (9.3 to 10.7), and anaemia 1.2

questions (11.0 to 12.2). Gain in knowledge on anaemia-HRP was less as pre-training correct knowledge was already better at 11.0 correct responses, and the scope for further improvement happens by practice! Both on theoretical and on management questions gain in knowledge due to training was highly significant for all the five HRPs. On theoretical issues, mean gain was maximum for GD (1.1 questions: 3.4 to 4.5), APH (0.7: 2.3 to 3.1), anaemia (0.5: 5.7 to 6.2), PIH (0.5: 2.7 to 3.1) and quality ANC (0.4: 2.8 to 3.2). On management/skill-based issues, mean gain was  $\geq 1.0$  questions for GD, APH, quality ANC and PIH. Only for anaemia, gain was 0.7 questions (5.3 to 6.0).

Number of correct responses (out of 15 questions)	Correct responses: QANC		Correct responses: Anaemia		Correct responses: APH		Correct responses: Hypertension		Correct responses: GD	
	% ANMs: Pre-training	% ANMs: Post-training	% ANMs: Pre-training	% ANMs: Post-training	% ANMs: Pre-training	% ANMs: Post-training	% ANMs: Pre-training	% ANMs: Post-training	% ANMs: Pre-training	% ANMs: Post-training
1	0.0	--	0.1	--	0.2	0.0	0.1	0.1	0.3	0.0
2	0.1	0.0	0.0	0.0	0.9	0.3	0.3	0.1	1.0	0.3
3	0.2	0.0	0.2	0.1	1.4	0.8	1.0	0.3	2.9	0.6
4	0.6	0.2	0.4	0.2	2.5	1.0	1.9	0.9	5.6	2.0
5	1.5	0.6	0.9	0.4	3.7	2.0	3.6	1.8	8.2	3.8
6	3.6	1.0	2.1	1.0	5.1	2.1	6.2	3.3	12.7	4.3
7	5.8	2.1	4.2	2.0	5.9	2.3	8.5	4.8	16.1	6.5
8	10.1	3.7	6.5	3.3	8.9	3.8	13.4	7.2	17.2	9.6
9	13.5	7.5	10.1	5.8	11.2	5.5	15.8	10.2	14.7	11.7
10	18.0	11.1	14.3	8.6	14.4	8.1	16.8	13.7	11.6	13.1
11	17.8	15.6	16.3	12.4	16.7	11.4	15.3	15.5	5.4	12.9
12	15.0	18.1	16.6	15.9	15.3	14.0	10.7	16.6	2.4	11.0
13	9.2	18.0	15.1	18.3	9.4	19.9	5.2	15.7	1.1	8.9
14	3.6	13.2	9.8	18.8	3.8	17.9	1.3	8.6	0.7	9.1
15	0.9	9.0	3.4	13.3	0.7	10.9	0.0	1.4	0.2	6.0
ANMs participated in pre post assessments	6,919	6,919	6,819	6,819	6,394	6,394	6,796	6,796	6,638	6,638
Mean correct responses (SD)	10.16 (2.19)	11.74 (2.16)	11.00 (2.29)	12.15 (2.20)	9.74 (2.72)	11.73 (2.69)	9.25 (2.34)	10.67 (2.43)	7.64 (2.34)	10.22 (2.89)
Sig. of diff. btw pre-and post-training means: t-statistic	42.7 (p < 0.0001)		20.9 (p < 0.0001)		41.8 (p < 0.0001)		34.7 (p < 0.0001)		56.5 (p < 0.0001)	
Gain in knowledge	1.58		1.15		1.99		1.42		2.58	
Effect size : Pearson's r	0.51		0.57		0.49		0.56		0.37	
Effect size: Cohen 'd' (RM, comb 95% CI)	0.73 (0.71 - 0.78)		0.60 (0.56 - 0.63)		0.72 (0.69 - 0.76)		0.68 (0.64 - 0.71)		0.77 (0.74 - 0.81)	

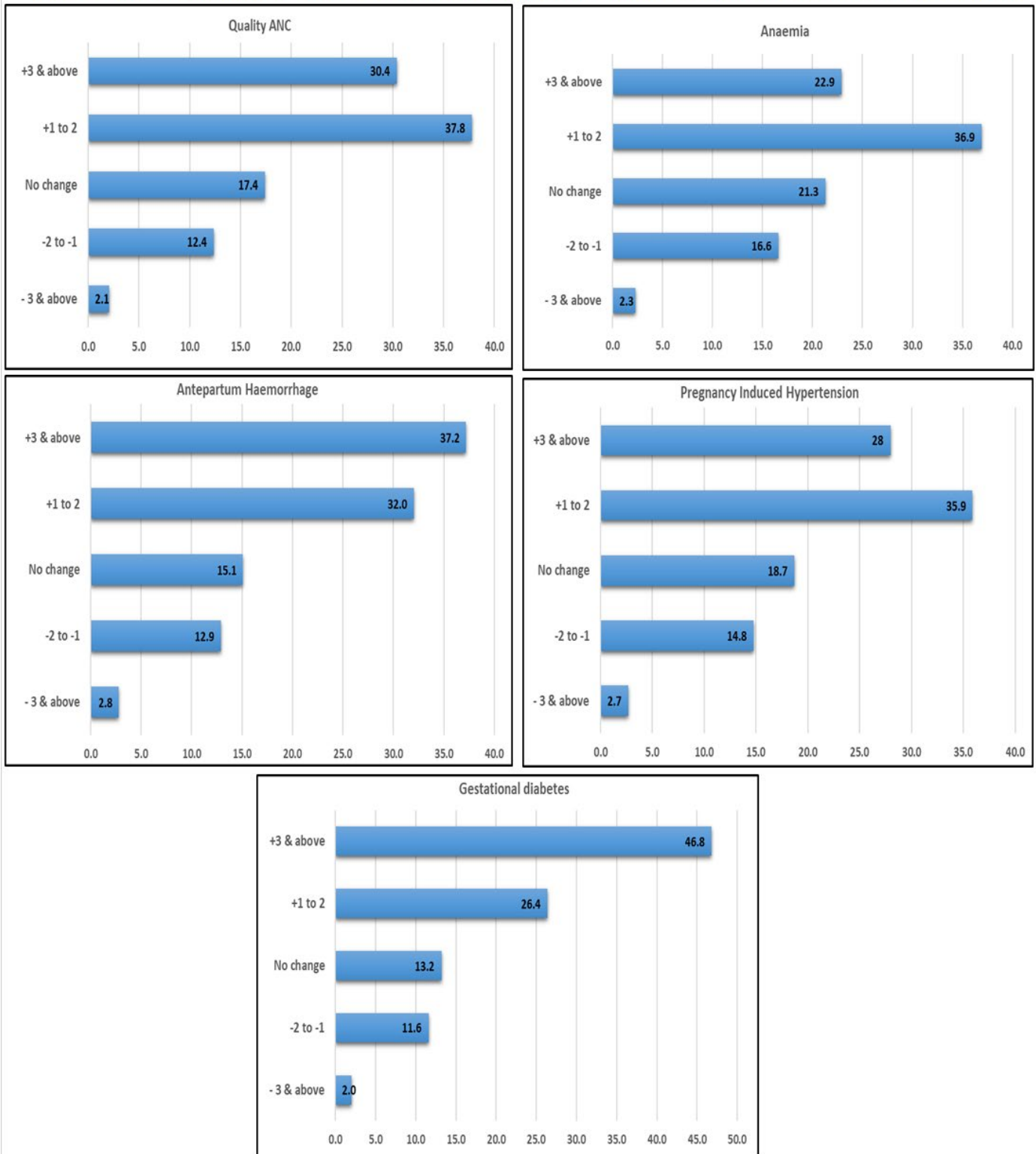
**Table 2: HRP-condition-wise percent distribution of ANMs according to number of correct responses, significance of difference between mean pre and post training assessments and effect size of training on difference in correct responses between pre and post training assessments**

Table 2 provides HRP-condition-wise percent distribution of number of correct responses, mean correct responses in pre- and post-training assessments, and gain in knowledge/skills due to class-room training. Table also provides HRP-condition-wise gain in knowledge/skills as effect sizes, using Pearson's r and Cohen's-d measures. After training, 32.1% ANMs on anaemia protocol, 28.8% on APH, 22.2% on quality ANC, 15.1% on GD and 10.0% on PIH have correctly answered 14 or 15 questions when respective pre-training percentages were 13.2%, 4.5%, 4.6%, 0.9% and 1.3%. After training there is also substantial decline in proportion of ANMs who correctly answered <10 questions, particularly for anaemia and quality ANC. For all the

five HRPs there is significant difference between pre- and post-training means, with significance of difference being highest for GD and quality ANC, and low for anaemia. Excluding GD for the remaining four protocols effect-size in terms of Pearson's r is large ( $\geq 0.5$ ) implying for quality ANC, anaemia, APH and PIH the strength of relationship between pre- and post-training responses followed the same pattern. Effect-size in terms of Cohen's d was large for quality ANC, APH, PIH and GD (d ranged between 0.7 to 0.8) and medium for anaemia (d=0.6) implying influence of class-room training on gain in knowledge/skills has either larger/medium effect [22].



**Figure 2: Percent distribution of ANMs according to gain in knowledge/skills between post and pre-training assessments, according to HRP-condition**



Percent distribution of ANMs according to improvement in knowledge/skills between pre-and post-training assessments according to HRP-condition is provided in Figure 2. Proportion of ANMs who scored less in post-training assessment as compared to pre-training was lowest for GD (13.6%) and highest for anaemia

(18.9%). However, proportion of ANMs whose post-training score as compared to pre-training score has improved by three or more questions was highest for GD (46.7%) and lowest for anaemia (23%) – implying gains due to training were better for GD as compared to anaemia.

**Figure 3: Variations in percentile cut-offs of number of correct responses during pre- and post-training assessment of ANMs, according to HRP-condition**

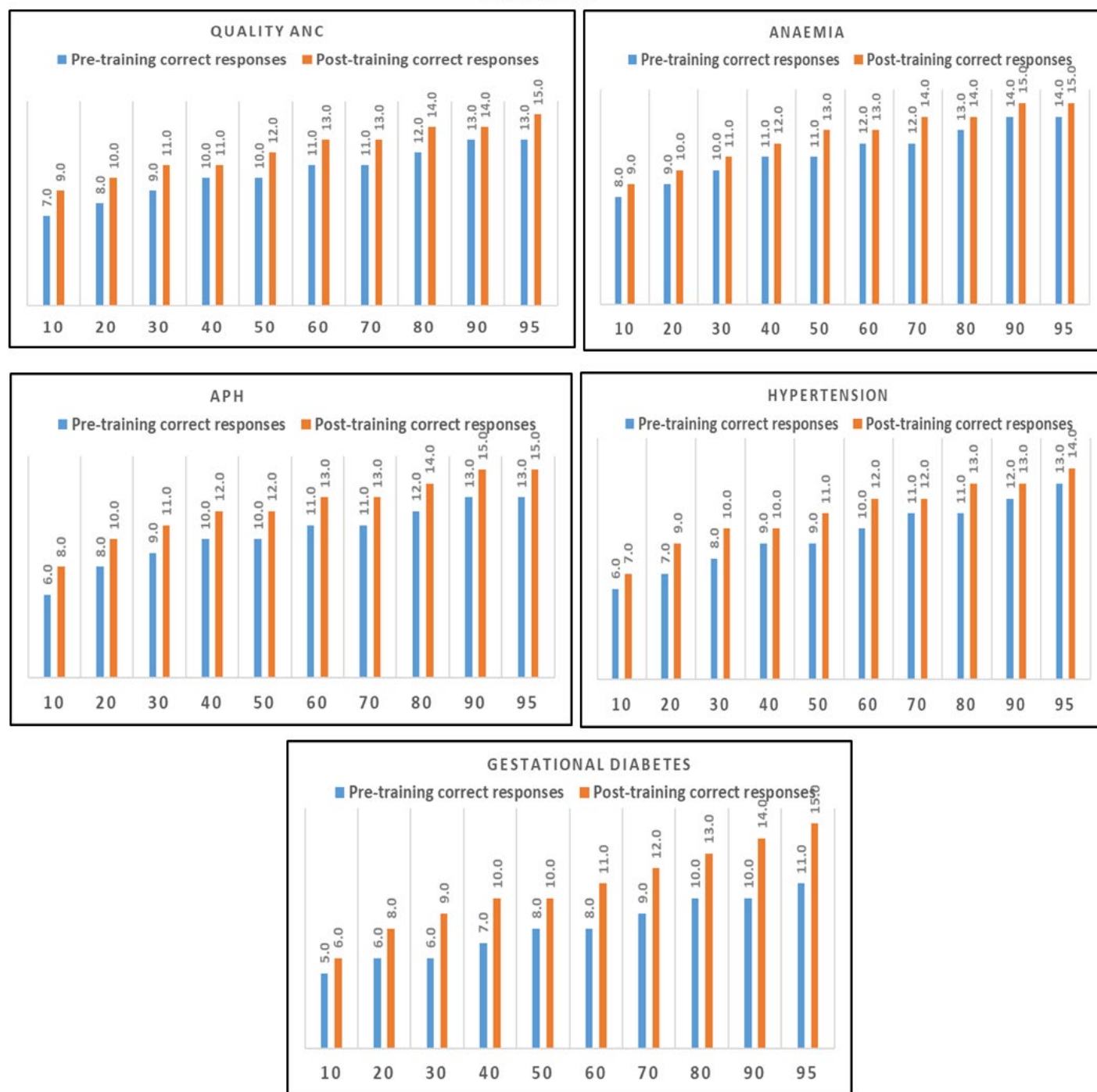


Figure 3 provides variations in 10-95<sup>th</sup> percentile cut-offs as number of correct responses (out of 15 questions) during pre-training and post-training assessments, according to HRP-condition. Variations at different percentile cut-offs of GD was different from the remaining four HRPs. For GD, from 10-20<sup>th</sup> percentile, variation between pre- and post-training correct response cut-offs was two questions, it improved to three questions during 30-80<sup>th</sup> and to four

questions during 90-95<sup>th</sup> percentile – implying ANMs who scored poorly in pre-training gained less and who scored better in pre-training gained more by post-training. For anaemia and PIH, at different percentiles, variation in cut-offs between pre- and post-training correct responses was mostly uniform by one question, while for quality-ANC and APH the difference is mostly uniform by two questions.

District	Correct responses: QAC					Correct responses: Anaemia					Mean Correct responses: APH					Mean Correct responses: Hypertension					Mean Correct responses GD				
	Pre mean	Post mean	Change	Pearson's r	Cohen's (95% CI)	Pre mean	Post mean	Change	Pearson's r	Cohen's (95% CI)	Pre mean	Post mean	Change	Pearson's r	Cohen's (95% CI)	Pre mean	Post mean	Change	Pearson's r	Cohen's (95% CI)	Pre mean	Post mean	Change	Pearson's r	Cohen's (95% CI)
Adilabad	10.6	11.9	1.3	0.66	0.8 (0.5 - 1.2)	10.5	11.4	0.9	0.72	0.6 (0.3 - 1.0)	11.0	13.1	2.1	0.58	1.2 (0.9 - 1.6)	9.5	11.2	1.6	0.49	0.8 (0.5 - 1.1)	8.6	9.0	0.4	0.8	0.3 (-0.01 - 0.6)
B Kothagudem	10.2	13.0	2.8	0.43	1.4 (1.2 - 1.5)	11.7	12.6	0.9	0.51	0.6 (0.4 - 0.7)	9.5	12.7	3.2	0.44	1.2 (1.0 - 1.3)	9.5	10.7	1.2	0.55	0.7 (0.5 - 0.8)	8.4	10.9	2.5	0.36	1.0 (0.8 - 1.1)
Hyderabad	9.8	13.2	3.4	0.31	1.1 (1.0 - 1.3)	10.6	13.5	2.8	0.41	1.1 (1.0 - 1.3)	9.3	14.0	4.7	0.25	1.3 (1.1 - 1.5)	9.7	12.3	2.5	0.45	1.2 (1.1 - 1.4)	7.3	12.3	5.0	0.34	1.7 (1.5 - 1.9)
Jagityal	10.2	11.5	1.3	0.48	0.7 (0.5 - 0.9)	12.0	12.2	0.2	0.53	0.1 (-0.1 - 0.3)	10.0	11.2	1.2	0.64	0.7 (0.5 - 0.9)	8.6	12.1	3.5	0.29	1.2 (1.0 - 1.4)	8.2	8.6	0.4	0.52	0.2 (0.03 - 0.4)
Jangaon	9.8	11.5	1.7	0.55	0.9 (0.7 - 1.1)	11.0	12.2	1.3	0.72	0.9 (0.7 - 1.1)	9.6	11.0	1.5	0.67	0.8 (0.6 - 1.0)	8.7	9.8	1.1	0.52	0.5 (0.3 - 0.7)	6.7	9.4	2.7	0.28	0.8 (0.6 - 1.1)
Jayashankar																									
Bhupalpalli	10.1	10.9	0.8	0.74	0.7 (0.4 - 0.9)	10.1	11.0	0.9	0.57	0.4 (0.2 - 0.7)	8.7	12.1	3.4	0.43	1.1 (0.7 - 1.4)	8.2	10.0	1.7	0.65	1.0 (0.7 - 1.3)	7.2	8.5	1.3	0.46	0.5 (0.2 - 0.8)
J Gadwal	10.0	13.1	3.1	0.4	1.1 (0.9 - 1.4)	11.1	13.2	2.1	0.34	0.9 (0.6 - 1.2)	10.0	13.8	3.8	0.07	1.0 (0.8 - 1.3)	9.6	12.5	3.0	0.24	0.8 (0.5 - 1.0)	7.3	11.3	4.0	0.2	1.1 (0.8 - 1.4)
Kamareddy	10.3	11.6	1.3	0.62	0.8 (0.6 - 1.0)	11.2	11.9	0.7	0.68	0.5 (0.3 - 0.7)	9.8	11.0	1.2	0.66	0.7 (0.5 - 0.9)	9.0	10.3	1.3	0.59	0.7 (0.5 - 0.9)	7.5	9.2	1.7	0.4	0.6 (0.5 - 0.8)
Karimnagar	10.8	11.6	0.8	0.66	0.6 (0.4 - 0.8)	10.9	11.3	0.4	0.72	0.3 (0.2 - 0.5)	10.5	12.0	1.4	0.67	0.9 (0.6 - 1.1)	10.1	10.6	0.5	0.75	0.4 (0.2 - 0.6)	8.6	9.4	0.7	0.69	0.6 (0.4 - 0.8)
Khammam	10.6	13.0	2.4	0.39	1.1 (0.9 - 1.2)	11.7	13.0	1.3	0.56	0.7 (0.6 - 0.9)	10.7	12.8	2.1	0.3	0.7 (0.6 - 0.9)	10.4	12.0	1.6	0.47	0.8 (0.6 - 0.9)	8.5	12.1	3.6	0.31	1.1 (0.9 - 1.3)
K Asifabad	9.8	10.2	0.5	0.47	0.2 (-0.1 - 0.5)	11.3	11.0	-0.3	0.68	0.3 (-0.7 - -0.04)	9.4	9.9	0.6	0.67	0.3 (-0.3 - 0.8)	10.6	10.3	-0.3	0.43	-0.2 (-0.6 - -0.2)	11.6	10.7	-0.9	0.71	-0.7 (-1.0 - -0.3)
Mahabubabad	10.2	11.1	0.9	0.47	0.4 (0.2 - 0.6)	10.8	11.7	0.9	0.66	0.5 (0.4 - 0.7)	9.8	11.1	1.3	0.68	0.7 (0.5 - 0.9)	8.9	9.8	0.9	0.67	0.6 (0.4 - 0.7)	7.7	9.5	1.8	0.55	0.9 (0.7 - 1.1)
Mahabubnagar	9.8	11.6	1.8	0.51	0.8 (0.6 - 1.0)	11.2	12.8	1.6	0.68	1.1 (0.9 - 1.3)	10.7	12.5	1.7	0.48	0.5 (0.3 - 0.6)	10.0	11.5	1.5	0.6	0.9 (0.7 - 1.1)	7.5	11.6	4.1	0.5	1.4 (1.2 - 1.6)
Mancheriyal	10.2	11.9	1.7	0.5	0.8 (0.6 - 1.0)	11.0	12.4	1.4	0.59	0.7 (0.6 - 0.9)	9.9	11.9	2.0	0.63	1.0 (0.8 - 1.2)	9.5	10.7	1.2	0.63	0.8 (0.6 - 1.0)	8.2	10.9	2.8	0.37	1.0 (0.8 - 1.2)
Medak	10.6	10.9	0.3	0.59	0.2 (0.0 - 0.4)	11.1	11.5	0.3	0.68	0.3 (0.1 - 0.5)	10.2	10.5	0.3	0.76	0.2 (0.03 - 0.5)	8.9	9.3	0.5	0.75	0.3 (0.1 - 0.5)	8.3	9.2	0.8	0.37	0.3 (0.1 - 0.6)
Medchal	9.8	11.2	1.4	0.54	0.7 (0.4 - 0.9)	11.0	11.6	0.6	0.61	0.3 (0.1 - 0.6)	9.8	10.8	1.0	0.61	0.5 (0.3 - 0.7)	7.9	9.6	1.6	0.43	0.7 (0.5 - 0.9)	7.2	8.9	1.6	0.51	0.7 (0.5 - 0.9)
Mulugu	9.9	10.5	0.6	0.71	0.4 (0.0 - 0.9)	10.4	10.7	0.3	0.83	0.3 (0.02 - 0.6)	8.5	9.7	1.1	0.82	0.9 (0.4 - 1.4)	8.2	8.8	0.6	0.83	0.6 (0.3 - 0.9)	6.7	7.5	0.8	0.46	0.3 (-0.2 - 0.8)
NagarKarnool	9.5	10.9	1.4	0.6	0.7 (0.5 - 0.9)	10.5	11.4	0.9	0.76	0.8 (0.6 - 0.9)	9.5	10.6	1.0	0.71	0.7 (0.5 - 0.9)	8.6	9.3	0.7	0.64	0.4 (0.2 - 0.6)	7.0	9.4	2.3	0.47	0.9 (0.7 - 1.1)
Nalgonda	10.8	12.2	1.4	0.5	0.6 (0.5 - 0.8)	11.6	12.4	0.7	0.57	0.5 (0.3 - 0.6)	9.7	12.2	2.5	0.36	0.8 (0.6 - 0.9)	9.7	11.4	1.7	0.44	0.7 (0.5 - 0.8)	7.6	10.9	3.4	0.45	1.1 (0.9 - 1.3)
Narayanpet	9.7	10.6	0.9	0.58	0.5 (0.2 - 0.8)	11.0	11.5	0.5	0.7	0.4 (0.1 - 0.7)	10.0	10.3	0.3	0.84	0.3 (-0.1 - 0.8)	9.0	9.1	0.1	0.76	0.1 (-0.2 - 0.4)	7.9	9.0	1.0	0.74	0.8 (0.6 - 1.1)
Nirmal	9.6	10.2	0.6	0.67	0.4 (0.1 - 0.6)	10.0	10.5	0.4	0.69	0.3 (0.1 - 0.6)	8.6	10.3	1.7	0.55	0.8 (0.5 - 1.0)	8.8	10.1	1.3	0.7	0.9 (0.6 - 1.1)	6.7	8.1	1.4	0.37	0.6 (0.3 - 0.8)
Nizamabad	10.0	11.2	1.2	0.59	0.7 (0.5 - 0.8)	10.6	11.6	1.0	0.57	0.6 (0.4 - 0.7)	10.0	11.0	1.0	0.6	0.5 (0.3 - 0.6)	9.1	9.9	0.7	0.7	0.6 (0.4 - 0.7)	7.5	10.1	2.7	0.46	1.0 (0.9 - 1.2)
Peddapalli	10.2	11.1	0.9	0.47	0.5 (0.2 - 0.7)	10.9	12.1	1.2	0.69	0.9 (0.7 - 1.2)	8.7	10.7	2.0	0.48	0.7 (0.5 - 1.0)	9.3	10.2	1.0	0.52	0.4 (0.2 - 0.6)	8.0	8.9	0.8	0.61	0.5 (0.3 - 0.8)
Rajanna Siricilla	10.0	11.1	1.1	0.64	0.7 (0.5 - 1.0)	10.8	11.5	0.6	0.72	0.5 (0.2 - 0.8)	8.9	10.1	1.2	0.76	0.8 (0.5 - 1.1)	8.5	9.2	0.7	0.71	0.5 (0.2 - 0.7)	6.8	8.4	1.6	0.56	0.8 (0.5 - 1.1)
Rangareddy	10.2	11.6	1.4	0.59	0.7 (0.6 - 0.9)	10.5	12.2	1.7	0.56	0.8 (0.6 - 1.0)	9.1	11.5	2.3	0.5	0.7 (0.6 - 0.9)	8.7	10.3	1.5	0.57	0.7 (0.5 - 0.8)	7.2	9.9	2.7	0.49	0.8 (0.6 - 1.0)
Sangareddy	10.0	12.2	2.2	0.48	1.0 (0.8 - 1.2)	10.5	12.8	2.3	0.42	0.9 (0.7 - 1.1)	9.3	12.9	3.6	0.39	1.1 (1.0 - 1.3)	9.0	11.1	2.2	0.43	0.8 (0.7 - 1.0)	7.1	12.5	5.5	0.26	1.5 (1.3 - 1.7)
Siddipet	10.6	12.2	1.6	0.54	0.8 (0.6 - 0.9)	10.7	13.9	3.2	0.31	1.1 (0.9 - 1.3)	9.4	13.4	4.0	0.28	1.2 (1.0 - 1.4)	9.4	12.7	3.3	0.37	1.3 (1.1 - 1.5)	7.2	13.8	6.6	0.14	1.8 (1.6 - 2.0)
Suryapet	10.4	12.3	1.9	0.33	0.9 (0.7 - 1.0)	11.3	13.1	1.8	0.33	0.7 (0.5 - 0.9)	10.3	12.5	2.3	0.34	0.8 (0.6 - 1.0)	9.7	11.1	1.5	0.4	0.6 (0.4 - 0.8)	7.7	10.3	2.6	0.07	0.7 (0.5 - 0.8)
Vikarabad	8.9	10.3	1.4	0.43	0.6 (0.4 - 0.8)	10.1	10.7	0.7	0.71	0.4 (0.2 - 0.7)	9.1	9.6	0.5	0.65	0.2 (-0.1 - 0.4)	8.2	9.2	1.0	0.55	0.5 (0.3 - 0.7)	6.5	7.6	1.1	0.58	0.5 (0.3 - 0.8)
Wanaparty	9.8	11.1	1.4	0.51	0.6 (0.4 - 0.9)	11.0	12.1	1.1	0.56	0.6 (0.3 - 0.8)	9.8	11.0	1.1	0.47	0.5 (0.3 - 0.7)	10.1	10.8	0.7	0.62	0.4 (0.2 - 0.7)	7.4	8.3	0.9	0.64	0.6 (0.3 - 0.8)
Warangal urban	10.2	11.4	1.2	0.54	0.7 (0.5 - 0.9)	10.8	11.5	0.7	0.69	0.5 (0.4 - 0.7)	9.3	9.7	0.3	0.59	0.2 (0.001 - 0.4)	9.3	9.9	0.7	0.64	0.3 (0.1 - 0.5)	7.6	9.0	1.3	0.49	0.6 (0.4 - 0.8)
Warngal rural	10.2	11.4	1.1	0.61	0.7 (0.5 - 0.9)	10.7	11.4	0.7	0.71	0.5 (0.3 - 0.7)	10.0	11.0	1.0	0.74	0.7 (0.6 - 0.9)	8.9	10.0	1.1	0.71	0.8 (0.6 - 1.0)	7.5	8.9	1.5	0.58	0.6 (0.4 - 0.8)
Yadadri	10.1	11.5	1.4	0.66	0.9 (0.7 - 1.1)	10.8	11.9	1.1	0.68	0.8 (0.6 - 1.0)	9.6	12.6	3.0	0.35	0.9 (0.6 - 1.1)	9.3	10.7	1.4	0.49	0.6 (0.4 - 0.8)	7.5	10.9	3.4	0.28	0.9 (0.7 - 1.1)
Age of ANM (years)																									
<= 30	9.9	11.6	1.7	0.5	0.8 (0.6 - 0.9)	10.6	12.1	1.5	0.54	0.7 (0.6 - 0.8)	9.4	11.6	2.3	0.49	0.7 (0.6 - 0.8)	8.9	10.4	1.5	0.59	0.7 (0.6 - 0.8)	7.4	10.2	2.8	0.42	0.9 (0.8 - 1.0)
31-35	10.1	11.7	1.6	0.51	0.7 (0.6 - 0.8)	10.9	12.2	1.3	0.57	0.7 (0.6 - 0.8)	9.6	11.7	2.1	0.47	0.7 (0.6 - 0.8)	9.1	10.6	1.5	0.6	0.8 (0.7 - 0.8)	7.5	10.2	2.8	0.36	0.8 (0.7 - 0.9)
36-40	10.2	11.7	1.5	0.53	0.7 (0.7 - 0.8)	10.9	12.1	1.2	0.6	0.7 (0.6 - 0.7)	9.7	11.8	2.1	0.48	0.7 (0.7 - 0.8)	9.2	10.7	1.5	0.56	0.7 (0.6 - 0.8)	7.6	10.2	2.6	0.35	0.8 (0.7 - 0.8)
41-45	10.2	11.8	1.6	0.48	0.7 (0.6 - 0.8)	11.1	12.2	1.1	0.55	0.6 (0.5 - 0.6)	9.8	11.7	1.9	0.54	0.8 (0.7 - 0.8)	9.4	10.7	1.3	0.55	0.6 (0.5 - 0.7)	7.6	10.1	2.5	0.39	0.8 (0.7 - 0.9)
46-61	10.3	11.8	1.6	0.51	0.7 (0.6 - 0.8)	11.1	12.2	1.0	0.59	0.6 (0.5 - 0.7)	10.0	11.8	1.8	0.5	0.7 (0.6 - 0.8)	9.5	10.8	1.3	0.53	0.6 (0.5 - 0.7)	7.8	10.3	2.4	0.36	0.8 (0.7 - 0.8)
Years of work experience																									
1-10	9.9	11.7	1.8	0.51	0.8 (0.7 - 0.9)	10.7	12.1	1.4	0.53	0.6 (0.6 - 0.7)	9.5	11.7	2.3	0.48	0.7 (0.7 - 0.8)	9.0	10.6	1.6	0.59	0.8 (0.7 - 0.9)	7.5	10.3	2.8	0.4	0.9 (0.8 - 0.9)
11-13	10.1	11.7	1.6	0.52	0.8 (0.7 - 0.9)	11.1	12.2	1.1	0.6	0.6 (0.5 - 0.7)	9.7	11.5	1.8	0.53	0.7 (0.6 - 0.8)	9.1	10.5	1.4	0.58	0.7 (0.6 - 0.8)	7.6	9.9	2.4	0.48	0.8 (0.7 - 0.8)
14-17	10.1	11.6	1.5	0.52	0.7 (0.7 - 0.8)	10.9	12.1	1.1	0.59	0.7 (0.6 - 0.7)	9.7	11.7	1.9	0.5	0.7 (0.7 - 0.8)	9.2	10.7	1.4	0.56	0.7 (0.7 - 0.8)	7.6	10.1	2.5	0.35	0.7 (0.7 - 0.8)
18-31	10.4	11.9	1.5	0.48	0.7 (0.6 - 0.8)	11.2	12.3	1.1	0.56	0.6 (0.5 - 0.7)	10.0	12.0	1.9	0.46	0.7 (0.7 - 0.8)	9.5	10.8	1.3	0.53	0.6 (0.5 - 0.7)	7.8	10.4	2.6	0.33	0.8 (0.7 - 0.8)
Timing (month) of training																									
September 2022	10.1	11.7	1.6	0.49	0.7 (0.7 - 0.8)	10.8	12.3	1.5	0.54	0.7 (0.6 - 0.7)	9.7	11.9	2.2	0.46	0.8 (0.7 - 0.8)	9.2	10.7	1.5	0.55	0.7 (0.6 - 0.7)	7.5	10.3			

Characteristic	% ANMs
<b>Quality of training</b>	
Presentations 'very clear'	98.0
Training session 'very engaging and interactive'	95.7
Language/technical terms used in slides 'clear'	99.5
Referral guidelines in the modules 'very clear'	95.1
Counselling guidelines 'relevant and clear'	95.8
Content of modules makes 'roles & responsibilities clear'	97.5
All aspects of managing high-risk conditions fully covered	96.7
ANM's 'extremely confident to practice protocols'	96.6
'Overall satisfied' with attending training	94.8
<b>Supplementary resources sought (multiple responses)</b>	
Multimedia live videos	48.7
Poster on high-risk conditions for display in HSCs	47.0
Hands on training on certain aspects	37.8
Handout/e-booklet of the guidelines	33.9
WhatsApp support groups	27.7
<b>Benefits of training</b>	
Got clarity on managing, counselling and referring high-risk conditions	65.7
Gained new technical information on high-risk pregnancies	60.0
Got an opportunity to clarify doubts on high-risk pregnancy protocols management	51.8
Its an opportunity to refresh high-risk protocols with peers once again	38.1
Did not gain as much as expected through training	6.7
<b>ANMs who provided feedback</b>	6,884

**Table 4: Feedback of ANM's on the quality of phase-I training, among those who attended the training.**

Towards the end of training session of a batch, a feedback checklist on quality of training was obtained from all the ANMs who participated in the training. and the results are presented in Table 4. Around 95% or more ANMs said presentations, language/terms used in presentation, referral guidelines, roles & responsibilities specified in the guidelines were clear. Around 95-97% ANMs were confident to practice knowledge/skills gained through training and are satisfied with the training. By attended the training more than half of the ANMs said 'they got clarity on manging, counselling and referring HRP's' or 'got opportunity to clarify doubts on HRP's management' or 'got opportunity to refresh their knowledge/skills on five HRP's'.

Qualitative insights were also obtained from 51ANMs, using in-depth interviews. The following are important findings from the qualitative survey:

*'Ideal batch size is 50 and prefer to spread training for two days with 3 protocols per day is good for detailed discussion – ANM-35, Rangareddy'*

#### **On Advantages Due to Training:**

*'Pre- and post-training assessments have been very useful as this gave affirmations of their past and present knowledge on important topics – ANM-7 Hyderabad.*

*'We have become more confident after assessments and we have improved on our mistakes from pre-training assessment – ANM-8 Hyderabad'*.

#### **On the Contents of Training:**

*'Anaemia and PIH protocols are very useful and relatable' while some ANMs felt, 'APH and GD are unfamiliar topics. Almost all the ANMs agreed 'language used to train was colloquial and use of English terms for medical terms was a good decision' and 'trainers were efficient to make sessions engaging'.*

#### **On Value Addition of this Training:**

*"We always thought - what an ANM can do to save a life when a Specialist Gynecologist cannot. But after attending this training session, I realized our timely referral and early identification can save many lives. I feel empowered today" - ANM 44, Wanaparthi.*

“Today I have learnt that at subcenter level I can stabilize a mother and then refer. Previously we used to just refer a mother and take an update later.” - ANM 50, Yadadri Bhuvanagiri.

” I am going to carry the booklet every day to my workplace now and I am 100% confident that I will be able to manage and track

HRPs better now.” - ANM 45, Wanaparthy.

“I have personally learned many things today. Generally, at the PHC, most of the work is handled by the staff nurse, but today I understood how and when to check the BP, foetal heart rate and palpate fundal grips.” - ANM 49, Yadadri Bhuvanagiri.

Type of protocol	Mean correct responses	SD	Change as in mean correct responses as compared to pre-training level	Pearson's r	Effect Size as Cohen d (95% CI), as compared to pre-training level
<b>Quality ANC</b>					
Pre class-room training	10.52	1.95	--	--	--
Post class-room training	12.36	1.80	1.84	0.47	0.78 (0.68 - 0.88)
Assessment 6-9 months after class-room training	11.43	1.93	0.91	0.13	0.20 (0.10 - 0.29)
<b>Anaemia</b>					
Pre class-room training	10.97	2.20	--	--	--
Post class-room training	12.52	2.09	1.55	0.47	0.68 (0.59 - 0.78)
Assessment 6-9 months after class-room training	12.18	2.00	1.21	0.20	0.36 (0.27 - 0.45)
<b>APH</b>					
Pre class-room training	10.08	2.66	--	--	--
Post class-room training	12.37	2.28	2.29	0.45	0.84 (0.73 - 0.94)
Assessment 6-9 months after class-room training	10.62	2.25	0.54	0.06	0.12 (0.02 - 0.22)
<b>PIH</b>					
Pre class-room training	9.53	2.20	--	--	--
Post class-room training	10.79	2.34	1.26	0.60	0.68 (0.58 - 0.78)
Assessment 6-9 months after class-room training	10.17	2.34	0.64	0.16	0.17 (0.07 - 0.26)
<b>Gestational diabetes</b>					
Pre class-room training	8.03	2.23	--	--	--
Post class-room training	10.77	2.72	2.74	0.21	0.70 (0.59 - 0.80)
Assessment 6-9 months after class-room training	8.56	2.19	0.53	0.09	0.13 (0.03 - 0.23)
<b>ANMs covered</b>	<b>529</b>	--	--	--	--

**Table 5: Variations in mean correct responses in pre and post-training assessments and at six-nine months after class-room training of ANMs and effect size of training immediately after training and six-nine months after training - according to HRP-condition**



Table 5 provides HRP-condition-wise changes in mean number of correct responses during pre-training, post-training and six-nine months after class-room training, and the effect-sizes. Mean pre- and post-training knowledge/skills due to class-room training among sampled ANMs on five protocols are at similar levels of all the 7,553 ANMs of the state (table 2) - implying our random selection of ANMs for follow-up survey is representative of the state. As expected, six-nine months after class-room training, knowledge/skills retention in terms of Cohen's-d was small  $\leq 0.2$  for quality-ANC, APH, PIH and GD, while the same due to class-room training for these four protocols was large/medium, as it ranged between 0.68-0.84. For anaemia, although there was drop in knowledge/skills retention six-nine months after initial training in terms of Cohen's-d, it has medium effect both during immediately after class-room training (0.68) and six-nine months after first training (0.36).

#### 4. Discussion

Since creation of ANM cadre in 1950s, their scope of work kept on expanding, and currently, they are the key providers of maternal, newborn and child health services, on ground. With just 18 months pre-service training, major concerns about their role are knowledge gaps and lack of continued training/supportive infrastructure/mentoring/supervision [23]. IHRPTM program tries to fill this gap by capacitating and mentoring them on improved screening, management, referral, and follow-up on 20 HRPs, during next one-two years.

Due to class-room training, there was 8-17% improvement in immediate gain on knowledge/skills of ANMs, maximum (17%) for GD, followed by APH (13%), Quality-ANC (11%), PIH (9%) and anaemia (8%) (additional files 1-5). Due to class-room training, we noticed gain, both on theoretical/knowledge and management/skills of ANMs on five HRPs. Immediate gain in terms of mean number of correct responses was significantly different between pre-and-post-training assessments for all five HRPs: 2.6 questions for GD (7.6-10.2); 2.0 for APH (9.7-11.7); 1.6 for quality-ANC (10.2-11.7); 1.4 for PIH (9.3-10.7); and 1.2 for anaemia (11.0-12.3) - implying class-room training of ANM on five HRPs was effective! Influence of class-room training on immediate gain in knowledge/skills in terms of Cohen's-d was large for GD, APH, quality-ANC and PIH and medium for anaemia (Table 2)- indicated effectiveness of training was large for four HRPs and medium for anaemia. However, six-nine months after training influence of training on knowledge/skills became small for GD, APH, quality-ANC and PIH and remained medium for anaemia (Table 5). Both pre-and post-training knowledge was generally better for straight forward questions and poor/very poor for indirect/vignette-based questions, irrespective of HRP. On value addition of training, ANMs said '*now they can stabilize women with anaemia, APH, PIH and GD at sub-centre level and then refer*'.

**Comparability with other Studies:** There are limited studies on gain in knowledge/management skills of ANMs to manage HRPs, using pre-post training assessments, at macro level. In our knowledge, perhaps, ours is the first comprehensive assessment

of gain in knowledge/skills of all the public-sector ANMs of a state on four HRPs (anaemia, APH, PIH and GD) and on quality-ANC topic! A pre- and post-training assessment on identification of HRPs by ANMs in a private hospital in Andhra Pradesh found, majority had inadequate knowledge on pre-test (mean: 15.5 out of maximum 34) and after a structured training their post-test knowledge was adequate (mean 27.7), a significant improvement. In our study, mean pre-training knowledge on different protocols was slightly better as compared to this study. In concurrence to our finding, this study also, did not find any association between post-test knowledge scores with age and work experience of ANM [24]. In a similar pre-post-assessment with 40 ANMs from a community health centre in Lucknow there was significant difference between the mean pre-test (20.4) and post-test (29.1) knowledge scores [25].

A KAP study of MOs, staff nurses (SN) and ANMs in two states found that, higher proportion of ANMs at HSCs enumerated HRPs compared to MOs/SNs at PHCs and CHCs, but management by ANMs was poor. A similar result was also found in Karnataka [26]. Knowledge of diagnosis/management of pre-eclampsia was good among SNs and ANMs, but most staff did not administer MgSO<sub>4</sub> or antihypertensive to women with pre-eclampsia, while in our post-assessment of ANMs, we also found only around half of the ANMs correctly answered a management question: '*29 years, gravida 2, with normal BP but history of hypertension during previous pregnancy*', and a question: '*warning symptom of hypertension in pregnancy*'. As found in KAP study, we also found ANMs opted referral as a strategy, for early complications without providing any treatment, during in-depth interviews. The KAP study concluded that a large proportion of antenatal referrals were likely to be very early, unnecessary, or for investigations, and a smaller proportion were delayed referrals, coupled with poor pre-referral management. In our study we additionally identified specific-areas of a HRP-condition, that require more focused training/re-orientation to improve knowledge/skills, on issues like: abnormal abdominal symptoms; right steps to be followed while doing urine pregnancy test (UPT); correct signs of APH; different things to be documented in referral slip while referring an APH case; right timing for oral glucose tolerance test (OGTT); right time for first screening of GD; and how to manage a woman with only a OGTT report of 145mg/dl (additional files 1-5)

**Strengths and limitations:** Due to inability of ANMs to provide basic HRP-conditions screening and management services, 25-52% women with HRPs are referred to higher facilities, mainly to tertiary facilities. Through five-year IHRPTM program, we are not only training the ANMs on screening & management of 20 types of HRPs (in the next one-two years), but also developing strategies to continuously handhold them using learning app, providing supportive supervision, tracking app etc., initiatives, so that they are capable, not only to screen/manage HRPs but are also capable of providing quality ANC services. Major strength of IHRPTM's five-year program is role-based training/handholding to all the public sector ANMs, MOs and specialists to screen and manage 20 types of HRPs, although in this paper we have elaborated gain

in knowledge/skills of ANMs to diagnose and manage five HRP, due to class-room training. For five HRP, we have provided gains in knowledge/skills six-nine months after first training to alert policy makers that, without continuous handholding it is difficult to retain knowledge/skills, particularly by the ANMs. Results of this study are also useful for identifying and focusing geographies and specific groups of ANMs who need reorientation (Table 3) Qualitative findings provided ANM's views on specific nuances of effectiveness of class-room training on five HRP [27].

Our study has few limitations. We assessed knowledge/skills on a HRP through a set of 15 questions per HRP-condition, rather than through direct observation, particularly on the skills, as they may have over-stated or under-stated actual practices in pre-post-assessments. However, given IHRPTM's mandate is to train all the ANMs in the state, direct observation is not practical. Through this analysis we found, ANMs have generally fared better on straight forward questions as compared to indirect/case-study based questions!

## 5. Conclusions and significance

As envisaged by the IHRPTM program, during next five years, if all the ANMs of a state, who are at the bottom of the public health pyramid have necessary & sufficient knowledge to screen women with 20 types of HRP, and the skills to stabilize emergency cases till they reach higher facility- we assume, majority of pregnancy related maternal morbidities that lead to death can be averted. At the end of five years of IHRPTM program and once all the ANMs are trained and handhold on 20 HRP, we will be testing this hypothesis of 'influence of IHRPTM program on maternal morbidity/mortality reduction in the state'! Through this assessment, we have identified HRP-condition-wise specific areas that need focused attention and/or refresher training. By capacitating ANMs on screening/management on 20 types of HRP, we also envisage, proportion of timely referrals to higher facilities can be enhanced and unnecessary referrals can be reduced. We conclude that through implementation of IHRPTM program for five-years in Telangana, on 20 types of HRP by all the ANMs, MOs and specialists - the provision of obstetric care, particularly the HRP care in the state can be standardized at system level, leading to further reductions maternal morbidities/mortality.

## Declaration

**Ethics Approval and Consent to Participate:** On 1<sup>st</sup> May 2021, Royal Pune Independent Ethics Committee (DCGI Reg No: ECR/45/Indt/MH/2013/RR-19), provided ethical approval for the larger study titled 'Integrated high risk pregnancy management and tracking in Telangana: Monitoring and Evaluation, Implementation Research framework', including consent to interview ANMs, MOs and Specialists from the state. Government of Telangana through Memorandum of understanding (SI No: 189, dated 17<sup>th</sup> April 2021) gave approval to collect pre-post-training assessment data from all the ANMs who participate in training. Prior to ANM's participation in pre-post-training assessment, informed consent was obtained from each ANM.

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**Data Availability:** Not applicable in this case.

**Competing Interests:** The authors declare that they have no competing interests.

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Question	% Pre correct responses	% Post correct responses	Change / gain
<b>Theory-based questions</b>			
When do we do a urine pregnancy test?	64.2	75.1	10.9
To calculate the expected date of delivery, following is the right method:	97.4	98.8	1.4
Ideal weight gain in pregnancy should be	81.7	94.3	12.6
Which of the following abdominal finding in a pregnant woman would you consider to be abnormal	41.0	52.6	11.6
<b>Mean of above 4 knowledge questions</b>	<b>71.1</b>	<b>80.3</b>	<b>9.2</b>
<b>Management/skill based questions</b>			
Prerequisites of a good history taking are	34.1	48.8	14.7
Mark the correct statement about History taking in antenatal period:	78.1	85.7	7.6
In obstetric history of a pregnant woman which of the following should be asked:	86.5	90.7	4.2
Which of the following positive history would make the pregnancy high risk	79.3	88.0	8.7
While doing a UPT, what are the right steps:	51.1	63.4	12.3
Following is true for antenatal examination	63.9	69.3	5.4
What are the various parts that you need to examine to detect pallor	73.7	84.0	10.3
Which of the following may be normal in pregnancy	48.8	62.6	13.8
Is it important to examine chest and cardiovascular system also in a pregnant woman	83.5	92.4	8.9
Abdominal examination for uterine size and foetal well-being should be done	56.5	82.3	25.8
First pelvic grip helps in	76.3	85.5	9.2
<b>Mean of above 11 management questions</b>	<b>66.6</b>	<b>77.8</b>	<b>11.2</b>
<b>Mean of all 15 questions</b>	<b>67.7</b>	<b>78.2</b>	<b>10.5</b>

**Additional file 1: Question-wise percent correct responses in pre- and post-training assessments and gain in knowledge due to class-room training of ANMs: Quality-ANC (N=6919)**

Question	% Pre correct responses	% Post correct responses	Change / gain
<b>Theory-based questions</b>			
What is anaemia?	83.3	92.8	9.5
Anaemia in pregnancy is defined as	81.9	89.2	7.3
Current method of haemoglobin estimation in the field is using	77.9	88.5	10.6
Can anaemia in pregnant woman affect the baby?	89.1	93.7	4.6
What are the common symptoms with which a patient of anaemia may present?	97.9	98.9	1.0
Out of the given options, choose the correct nutritional advice for a pregnant woman with anaemia	95.2	96.6	1.4
What pre cautions will you ask the pregnant woman to take while taking iron tablets:	41.8	59.8	18.0
<b>Mean of above 7 questions</b>	<b>81.0</b>	<b>88.5</b>	<b>7.5</b>
<b>Management/skill based questions</b>			
Correct classification of anaemia in pregnancy is:	78.0	90.2	12.2
What are the ways of preventing anaemia in pregnancy?	70.7	82.0	11.3

What is the recommended dose of iron and folic acid tablets in pregnant women with mild anaemia?	71.1	78.5	7.4
What are the signs of anaemia on clinical examination?	85.6	91.1	5.5
Estimation of haemoglobin levels in pregnancy should be done:	68.2	75.1	6.9
26 yr., primigravida at 22 weeks POG was tested to have a Hb of 10g/dl, mark the correct statement about her management plan:	53.2	57.8	4.6
26 yr., primigravida received recommended dose of iron and folic acid tablets for mild anaemia for one month. On repeat testing a month later, no improvement was seen in her Hb levels. What will you do next?	42.2	54.3	12.1
Which of the following cases should be referred to higher centre:	61.7	66.5	4.8
<b>Mean of above 8 management questions</b>	<b>66.3</b>	<b>74.4</b>	<b>8.1</b>
<b>Mean of all 15 questions</b>	<b>73.2</b>	<b>81.0</b>	<b>7.8</b>

**Additional file 2: Question-wise percent correct responses in pre- and post-training assessments and gain in knowledge due to class-room training of ANMs: Anaemia (N=6814)**

Question	% Pre correct responses	% Post correct responses	Change / gain
<b>Theory-based questions</b>			
Antepartum haemorrhage (APH) is defined as	42.8	72.9	30.1
Causes of APH are	58.7	75.0	16.3
How will you counsel a pregnant woman with placenta previa on USG?	73.8	83.0	9.2
Patients with h/o last delivery by LSCS are at increased risk of	59.2	73.9	14.7
<b>Mean of above 4 knowledge questions</b>	<b>58.6</b>	<b>76.2</b>	<b>17.6</b>
<b>Management/skill based questions</b>			
Which of the following is true for APH?	20.2	33.2	13.0
APH is a high-risk condition as	83.4	90.7	7.3
A pregnant woman with low lying placenta	90.5	95.5	5.0
A 24 yr. old primigravida at 32 weeks POG presents to you with c/o painless spotting P/V. On examination her pulse and BP are normal, fundal height corresponds to 32 weeks with normal foetal heart sounds. Her pad is minimally soaked. What will you do next?	78.2	87.0	8.8
A 28yr old G3P2L2 with 36 wks POG is brought to you in a semi-conscious state with pulse rate > 100/ min, BP 90/60 mmHg with bleeding P/V for 30 mins. Her clothes are soaked with blood. How will you manage?	49.3	74.8	25.5
While transferring a patient of APH to a tertiary care hospital, following should be kept in mind:	75.2	84.7	9.5
Following facilities should be available at any centre to ensure safe delivery of a woman with APH:	80.1	86.4	6.3
While referring a patient to a higher centre in view of APH what all points should she and her family be counselled about	84.7	90.7	6.0
Which of the following is true?	51.7	64.0	12.3
Which of the following patients is high risk for APH?	69.7	83.0	13.3
A primi woman at 28 weeks POG comes with h/o BPV (bleeding per vagina) for 30 mins. Which of the following will you ask her?	56.7	78.3	21.6
<b>Mean of above 11 management questions</b>	<b>67.2</b>	<b>78.9</b>	<b>11.7</b>
<b>Mean of all 15 questions</b>	<b>64.9</b>	<b>78.2</b>	<b>13.3</b>

**Additional file 3: Question-wise percent correct responses in pre- and post-training assessments and gain in knowledge due to class-room training of ANMs: Antepartum Haemorrhage (N=6393)**



Question	% Pre correct responses	% Post correct responses	Change / gain
<b>Theory-based questions</b>			
What is hypertension?	35.5	42.0	6.5
Hypertension in pregnancy is defined as?	91.8	95.1	3.3
Risk factors for preeclampsia are:	52.0	68.8	16.8
Can hypertension in pregnant woman affect the baby?	82.0	91.7	9.7
Out of the given options, choose the correct nutritional advice that should be given to a woman with gestational hypertension	4.3	14.7	10.4
<b>Mean of above 5 knowledge questions</b>	<b>53.1</b>	<b>62.5</b>	<b>9.4</b>
<b>Management/skill based questions</b>			
Which of the following is a warning symptom of hypertension in pregnancy?	52.6	50.1	-2.5
What are the signs of hypertension on clinical examination during ANC visit?	72.4	84.0	11.6
What is the next step after a pregnant woman is detected with hypertension during ANC visit?	83.6	82.1	-1.5
What are the medications given to treat hypertension in pregnancy?	44.0	71.2	27.2
What are the warning symptoms a patient of preeclampsia may present with?	43.8	68.8	25.0
Blood pressure levels in pregnancy should be checked	85.4	86.7	1.3
26 yr., prim gravida at 22 weeks has BP reading 166/112 mm Hg, mark the correct statement about her management plan	78.5	88.8	10.3
What would be your plan for 29 yrs, gravida 2, with normal BP but history of hypertension during previous pregnancy?	37.9	53.3	15.4
Do you think there is any advantage of early detection and diagnosis of hypertension in pregnancy?	87.5	92.2	4.7
Which of the following cases should be referred to higher centre	73.8	77.5	3.7
<b>Mean of above 10 management questions</b>	<b>66.0</b>	<b>75.5</b>	<b>9.5</b>
<b>Mean of all 15 questions</b>	<b>61.7</b>	<b>71.1</b>	<b>9.4</b>

**Additional file 4: Question-wise percent correct responses in pre- and post-training assessments and gain in knowledge due to class-room training of ANMs: Pregnancy induced hypertension (N=6796)**

Question	% Pre correct responses	% Post correct responses	Change / gain
<b>Theory-based questions</b>			
Gestational diabetes is defined as:	52.3	71.4	19.1
Following conditions increase the risk of developing gestational diabetes in pregnancy	59.1	76.9	17.8
OGTT can only be done	17.3	50.7	33.4
GDM is a high risk condition as it can cause maternal and foetal adverse effects	84.7	94.4	9.7
Foetal risks with GDM include	48.5	69.2	20.7
What exercises will you recommend to patients of GDM?	77.9	90.2	12.3
<b>Mean of above 6 knowledge questions</b>	<b>56.6</b>	<b>75.5</b>	<b>18.9</b>
<b>Management/skill based questions</b>			
Screening test used for gestational diabetes is:	18.9	63.9	45.0
Screening for GDM should be done at:	36.1	54.2	18.1
In OGTT with 75 gm glucose the diagnosis of GDM is made if:	42.5	56.0	13.5
Following parameters are s/o overt diabetes mellitus	50.8	63.2	12.4
Management of GDM includes	83.9	87.3	3.4
If a pregnant woman with no other risk factor comes to you with a OGTT report of 145mg/dl, how will you manage?	24.3	56.4	32.1
A Primigravida with GDM on medical nutrition therapy for 2 weeks comes for a follow up visit. What tests will you do?	65.9	60.7	-5.2
Counselling of a woman with GDM should include	85.0	88.4	3.4
26 yr. Primigravida at 14 weeks comes for her OGTT. A level of 220mg/dl is detected. What will you do?	16.9	38.8	21.9
<b>Mean of above 9 management questions</b>	<b>47.1</b>	<b>63.2</b>	<b>16.1</b>
<b>Mean of all 15 questions</b>	<b>50.9</b>	<b>68.1</b>	<b>17.2</b>

**Additional file 5: Question-wise percent correct responses in pre- and post-training assessments and gain in knowledge due to class-room training of ANMs: Gestational diabetes (N=6638)**

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