WEBAPPENDIX: WHO AMANHI Gestational Age Study

Machine Learning Models to Assess Newborn Gestational Age in Low-Middle

Income Countries: Findings from a multi-country, prospective cohort study

Table of Contents

Web Table 1: Detailed description of the Study Sites and Procedures

	Bangladesh	Ghana	Pakistan (Karachi)	Tanzania (Pemba)	Zambia
Site Location/ Description	Rural areas of Sylhet district	Rural areas in central Ghana	1 peri-urban community of Bin Qasim town and 1 peri-urban community of Korangi town, Karachi	Pemba Island in the Zanzibar archipelago	6 rural districts in Southern Province
Pregnancy surveillance	2-monthly by trained community health workers (CHWs)	Monthly fieldworkers (FW)	3-monthly by FWs	6-weekly by CHWs	Facility ANC enrollment
Population area[1]	88,000	147,000	97000	72,000	25,000
Ultrasonography	Fujifilm Sonosite M-Turbo® ultrasound system (Bothel, WA, US). Scans performed by trained MD sonographers.	Portable SonoSite[TM] S180 machines (SonoSite[TM], Inc, Bothel, WA, US). Scan performed by hospital midwives.	Mindray 7 Ultrasound System. Scan done by trained sonologist.	Sonoscape s6. Scans performed by trained sonographer in district hospitals.	Philips Sono Diagnost 260; Scans performed by trained sonographers.
% Facility Delivery[1]	43.7	79.9	64.3	99 (?)	97.1
% with newborn visit completed <72 hours	71.1%	99.2%	80.0%	92.7%	82.6%
Infant Weighing Scale	TANITA BD-585 Pediatric Scale Digital weighing scale. Precision 10 gm.	Salter suspension scale (non-digital) with sling. Precision 100 gm.	LAICA Electronic/digital infant scale. Precision 5 gm.	Seca 374 (capacity 44lb Digital infant weighing scale Precision 10 gm	GPC Gps092 Medical hanging scale (Delhi, India). Precision 100 grams.
Health worker type performing newborn assessment	Locally recruited women (non-clinical) with at least 10 grade education received 6 weeks training on maternal and newborn health; additional 7 days training on newborn assessment	Locally recruited non-clinical field supervisors with secondary school education. Trained for 7 days on newborn assessment.	Locally recruited women with at least 12 grade education received 6 month training on maternal and newborn care; additional 7 days training on newborn assessment	Trained health worker (health assistant) with 2 years formal health training. Initial 7 days training for newborn assessment.	Locally recruited women (non-clinical) with 12 years of schooling; Trained for 3 days on newborn assessment.
% SGA[1]	41.8	33.4	35.5	9.6	17.8
% LBW[1]	25.6	11.8	22.5	4.6	6.5
NMR[1]	37.8 (35.5-40.2)	29.1 (26.9-31.2)	50.1 (46.9-53.4)	16.0 (14.3-17.8)	14·5 (13·0–16·0)

[1]Population-based rates, timing, and causes of maternal deaths, stillbirths, and neonatal deaths in south Asia and sub-Saharan Africa: a multi-country prospective cohort study. Lancet Glob Health 2018; 6(12): e1297-e308.

2

Web Table 2. Diagnostic accuracy of Ballard, LMP, and AMANHI models for identification of <37 week and <34 week infants
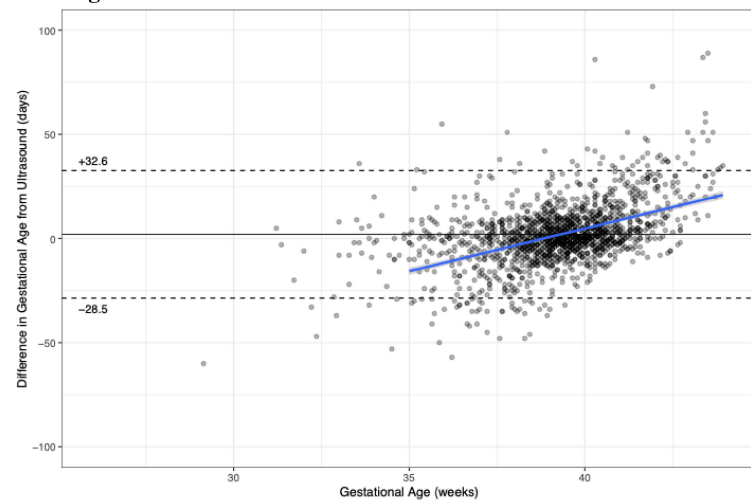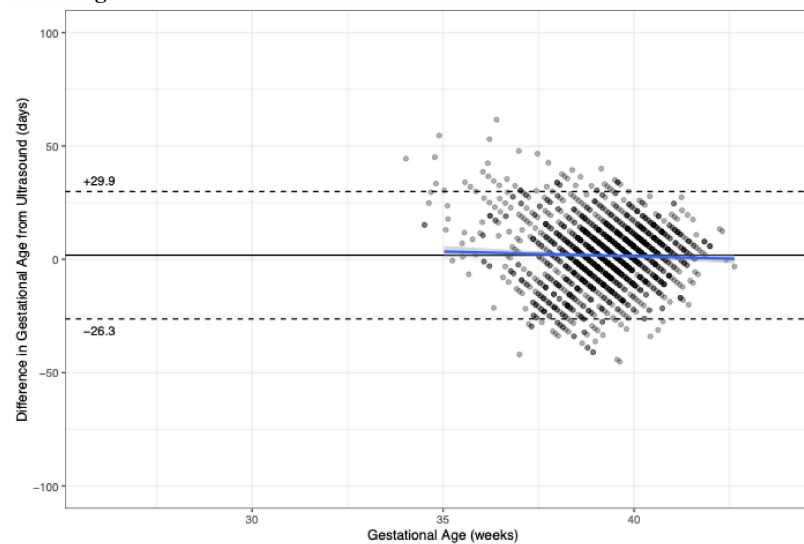
Gold standard dated by early pregnancy ultrasound, additional clinical thresholds maximizing sensitivity for identification of preterm births.
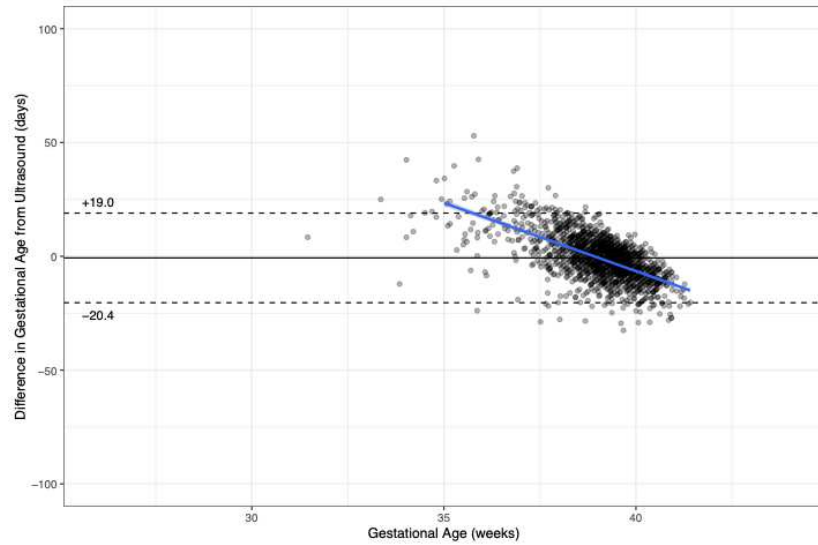
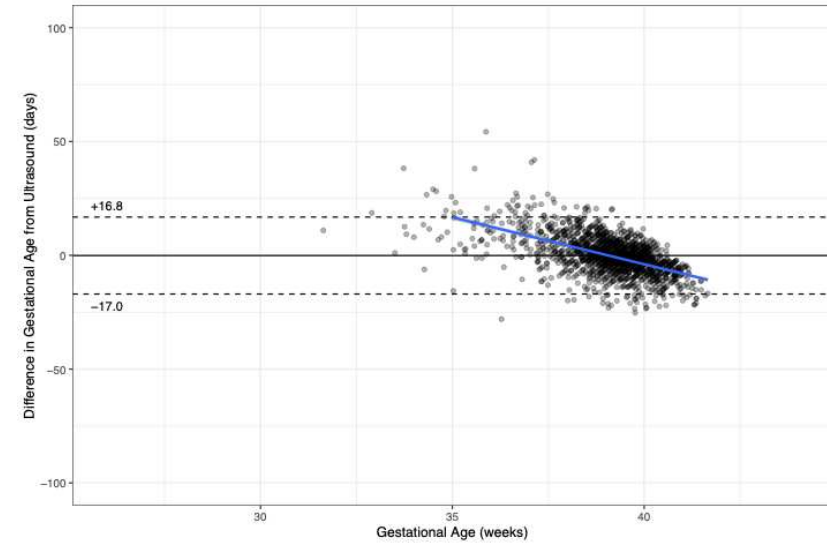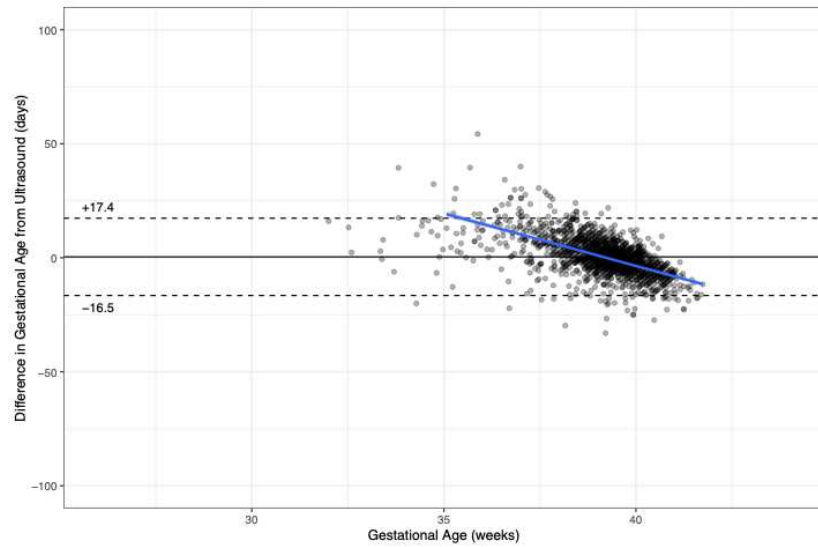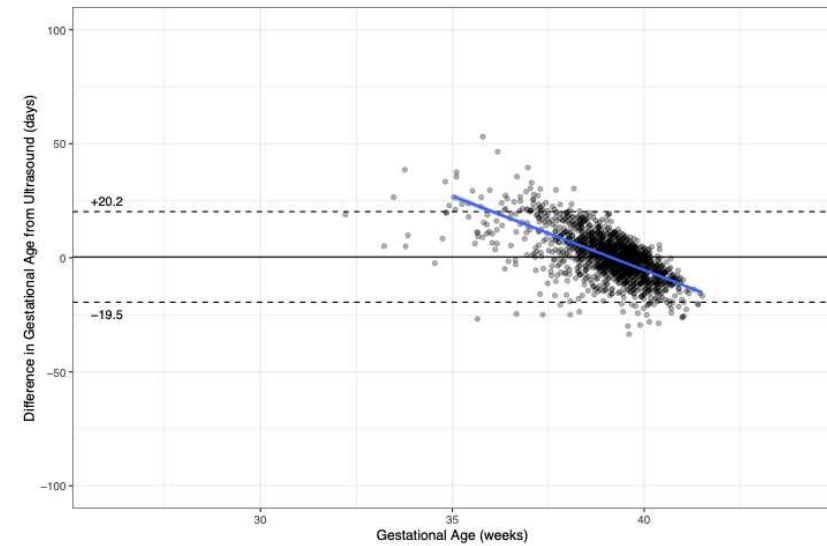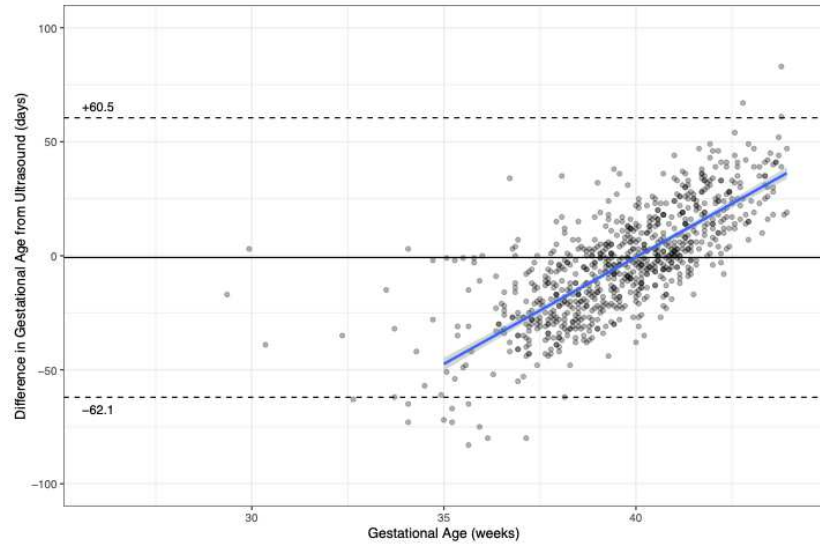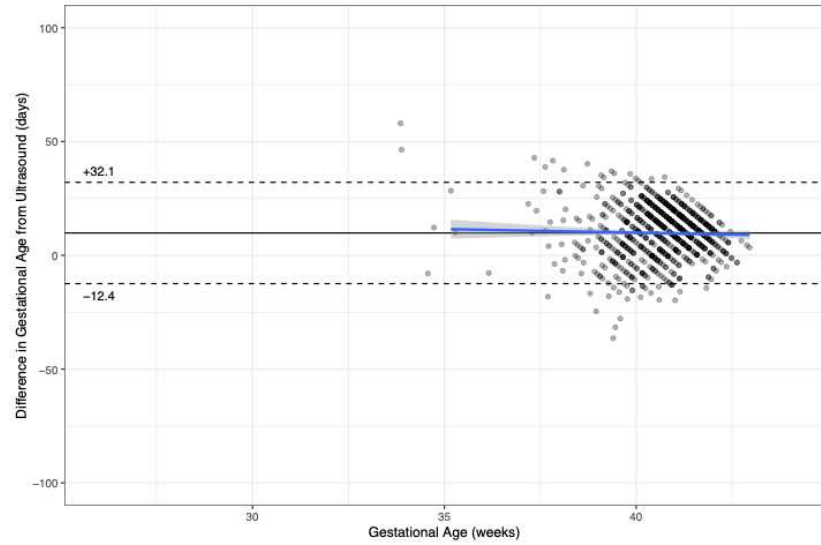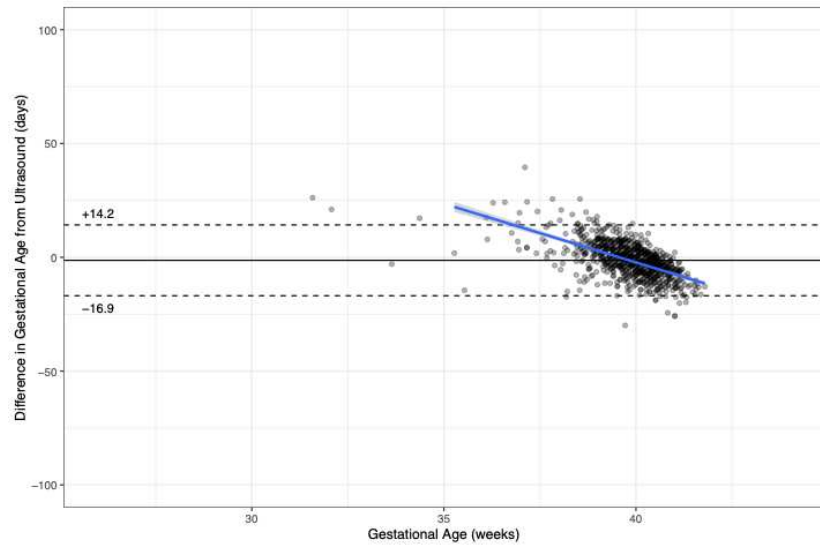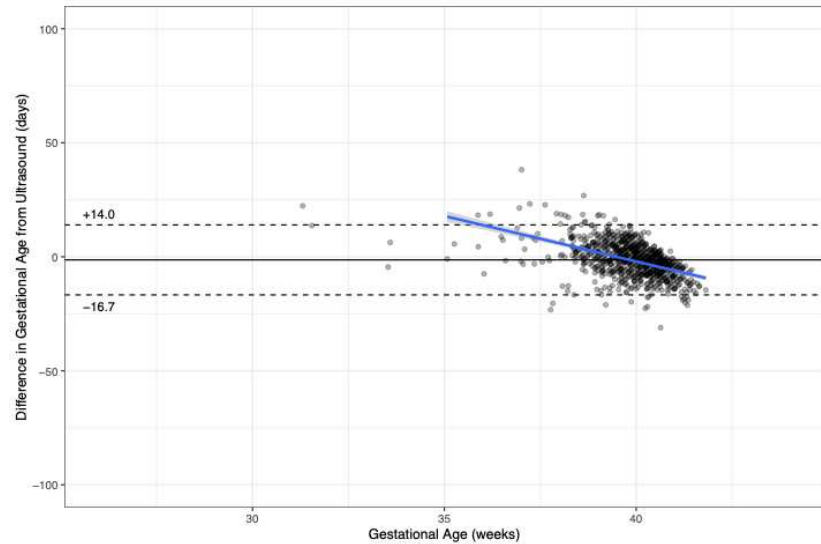| Model	AUC	Threshold selection	Se	Sp	PPV	NPV	LRP	LRN
Classify <37 weeks								
LMP	0.81	Youden Index	0.76	0.76	0.20	0.96	2.38	0.51
LMP	0.81	95% sensitivity	0.95	0.23	0.09	0.98	1.23	0.22
LMP	0.81	90% sensitivity	0.90	0.36	0.11	0.98	1.66	0.22
LMP	0.81	85% sensitivity	0.85	0.61	0.14	0.98	2.17	0.25
Ballard exam	0.74	Youden Index	0.63	0.71	0.15	0.96	2.20	0.52
Ballard	0.74	95% sensitivity	0.95	0.25	0.09	0.98	1.26	0.20
Ballard	0.74	90% sensitivity	0.90	0.37	0.10	0.98	1.42	0.27
Ballard	0.74	85% sensitivity	0.85	0.45	0.11	0.97	1.55	0.33
Model A (10-characteristics)	0.88	Youden Index	0.78	0.82	0.25	0.98	4.35	0.27
Model A	0.88	95% sensitivity	0.95	0.45	0.12	0.99	1.74	0.11
Model A	0.88	90% sensitivity	0.90	0.64	0.16	0.99	2.48	0.16
Model A	0.88	85% sensitivity	0.85	0.73	0.20	0.98	3.15	0.21
Model B (10-characteristics+LMP)	0.91	Youden Index	0.82	0.85	0.30	0.98	5.40	0.21
Model B	0.91	95% sensitivity	0.95	0.52	0.13	0.99	1.96	0.10
Model B	0.91	90% sensitivity	0.90	0.71	0.19	0.99	3.07	0.14
Model B	0.91	85% sensitivity	0.85	0.81	0.26	0.99	4.49	0.19
Model C (BW+LMP)	0.88	Youden Index	0.76	0.84	0.27	0.98	4.83	0.29
Model C	0.88	95% sensitivity	0.95	0.42	0.11	0.99	1.65	0.12
Model C	0.88	90% sensitivity	0.90	0.60	0.15	0.99	2.27	0.17
Model C	0.88	85% sensitivity	0.85	0.72	0.19	0.98	3.03	0.21
Model D (BW+HC)	0.84	Youden Index	0.74	0.79	0.22	0.97	3.53	0.33
Model D	0.84	95% sensitivity	0.95	0.38	0.11	0.99	1.54	0.13
Model D	0.84	90% sensitivity	0.90	0.54	0.13	0.99	1.97	0.18
Model D	0.84	85% sensitivity	0.85	0.65	0.16	0.98	2.40	0.23
Classify <34 weeks								
LMP	0.94	Youden Index	0.88	0.84	0.05	1.00	5.58	0.14
LMP	0.94	95% sensitivity	0.95	0.74	0.03	1.00	3.65	0.07
LMP	0.94	90% sensitivity	0.90	0.82	0.04	1.00	5.13	0.12
LMP	0.94	85% sensitivity	0.85	0.87	0.06	1.00	6.57	0.17
Ballard	0.89	Youden Index	0.81	0.80	0.03	1.00	4.04	0.24
Ballard	0.89	95% sensitivity	0.95	0.53	0.02	1.00	2.02	0.09
Ballard	0.89	90% sensitivity	0.90	0.67	0.02	1.00	2.70	0.15
Ballard	0.89	85% sensitivity	0.85	0.75	0.03	1.00	3.39	0.20
Model A (10-characteristics)	0.94	Youden Index	0.84	0.93	0.10	1.00	12.28	0.17
Model A	0.94	95% sensitivity	0.95	0.62	0.02	1.00	2.47	0.08
Model A	0.94	90% sensitivity	0.90	0.83	0.05	1.00	5.39	0.12
Model A	0.94	85% sensitivity	0.85	0.92	0.09	1.00	10.93	0.16
Model B (10-characteristics+LMP)	0.96	Youden Index	0.87	0.95	0.12	1.00	15.91	0.14
Model B	0.96	95% sensitivity	0.95	0.72	0.03	1.00	3.38	0.07
Model B	0.96	90% sensitivity	0.90	0.90	0.08	1.00	9.11	0.11
Model B	0.96	85% sensitivity	0.85	0.96	0.16	1.00	22.01	0.16
Model C (BW+LMP)	0.96	Youden Index	0.88	0.93	0.10	1.00	12.88	0.13
Model C	0.96	95% sensitivity	0.95	0.78	0.04	1.00	4.25	0.06
Model C	0.96	90% sensitivity	0.90	0.91	0.08	1.00	9.56	0.11
Model C	0.96	85% sensitivity	0.85	0.95	0.14	1.00	18.71	0.16
Model D (BW+HC)	0.93	Youden Index	0.82	0.92	0.08	1.00	9.72	0.19
Model D	0.93	95% sensitivity	0.95	0.56	0.02	1.00	2.18	0.09

3

| Model D | 0.93 | 90% sensitivity | 0.90 | 0.78 | 0.04 | 1.00 | 4.10 | 0.13 |
| Model D | 0.93 | 85% sensitivity | 0.85 | 0.88 | 0.06 | 1.00 | 7.19 | 0.17 |

Supplemental material

BMJ Publishing Group Limited (BMJ) disclaims all liability and responsibility arising from any reliance placed on this supplemental material which has been supplied by the author(s)

BMJ Global Health

Web Table 3. Stratified analysis by SGA vs AGA Status

Model	SGA			AGA		
	Mean Difference	Bland Altman Limits of Agreement	BA LOA	Mean Difference	Bland Altman Limits of Agreement	BA LOA
LMP	-0.64 (-1.52, -0.25)	(-40.6, 39.3)	40.0	-1.42 (-2.54, -1.98)	(-41.2, 37.3)	39.2
Ballard	4.85 (4.31, 5.39)	(-19.7, 29.4)	24.6	10.53 (10.19, 10.86)	(-13.0, 34.1)	23.5
Model A (10 characteristics)	-5.05 (-5.38, -4.71)	(-20.1, 10.0)	15.0	1.66 (1.43, 1.88)	(-14.4, 17.7)	16.0
Model B (10 characteristics+LMP)	-4.03 (-4.35, -3.72)	(-18.2, 10.1)	14.2	1.31 (1.10, 1.52)	(-13.3, 15.9)	14.6
Model C (BW+LMP)	-4.49 (-4.83, -4.15)	(-19.8, 10.9)	15.4	1.50 (1.29, 1.72)	(-13.8, 16.8)	15.3
Model D (BW+HC)	-5.61 (-5.95, -5.27)	(-20.9, 9.7)	15.3	1.93 (1.68, 2.17)	(-15.1, 19.0)	17.0

Web Figure 2a-f. Bangladesh Bland Altman Curves

2a. Bangladesh LMP vs Ultrasound

2b. Bangladesh Ballard vs Ultrasound

5

2c. Bangladesh Model A vs Ultrasound

2d. Bangladesh Model B vs Ultrasound

2e. Bangladesh Model C vs Ultrasound

2f. Bangladesh Model D vs Ultrasound

6

Web Figure 3a-f. Ghana Bland Altman Curves

3a. Ghana LMP vs Ultrasound
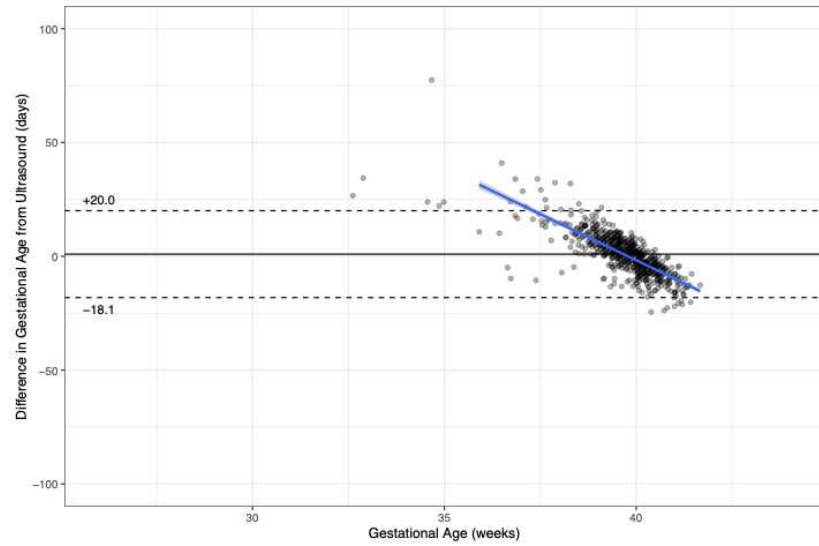

3b. Ghana Ballard vs Ultrasound

3c. Ghana Model A vs Ultrasound

3d. Ghana Model B vs Ultrasound

Supplemental material

BMJ Publishing Group Limited (BMJ) disclaims all liability and responsibility arising from any reliance placed on this supplemental material which has been supplied by the author(s)

BMJ Global Health

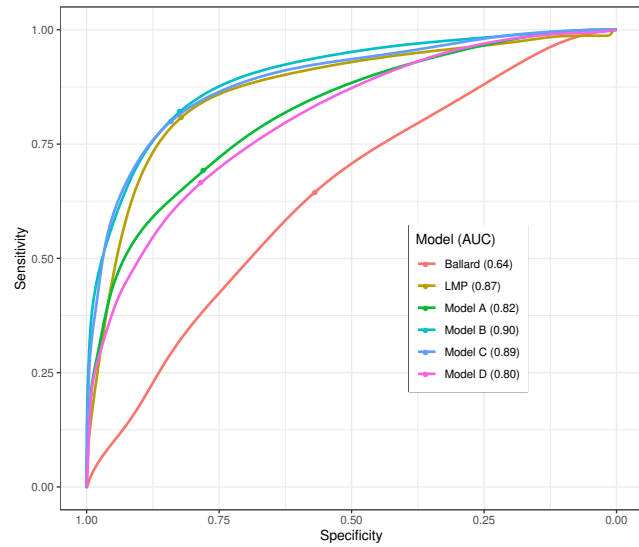**3e. Ghana Model C vs Ultrasound**

3f. Ghana Model D vs Ultrasound

Web Figure 4a-f. Pakistan (Karachi) Bland Altman Curves

4a. Karachi LMP vs Ultrasound

4b. Karachi Ballard vs Ultrasound

8

4c. Karachi Model A vs Ultrasound

4d. Karachi Model B vs Ultrasound

4e. Karachi Model C vs Ultrasound

4f. Karachi Model D vs Ultrasound

9

Web Figure 5a-f. Tanzania (Pemba) Bland Altman Curves

5a. Pemba LMP vs Ultrasound

5b. Pemba Ballard vs Ultrasound

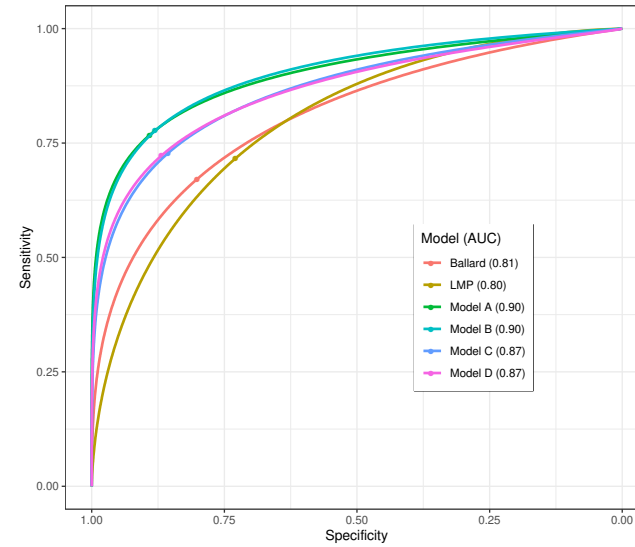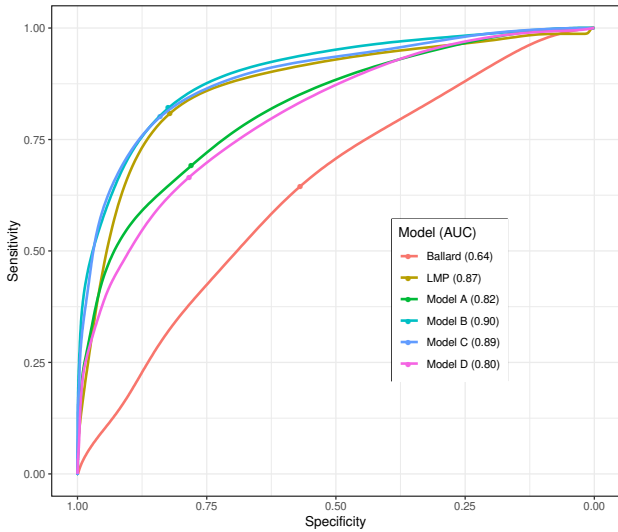**5c. Pemba Model A vs Ultrasound**

5d. Pemba Model B vs Ultrasound

10

5e. Pemba Model C vs Ultrasound

5f. Pemba Model D vs Ultrasound

Web Figure 6a-f. Zambia Bland Altman Curves

6a. Zambia LMP vs Ultrasound

6b. Zambia Ballard vs Ultrasound

11

6c. Zambia Model A vs Ultrasound

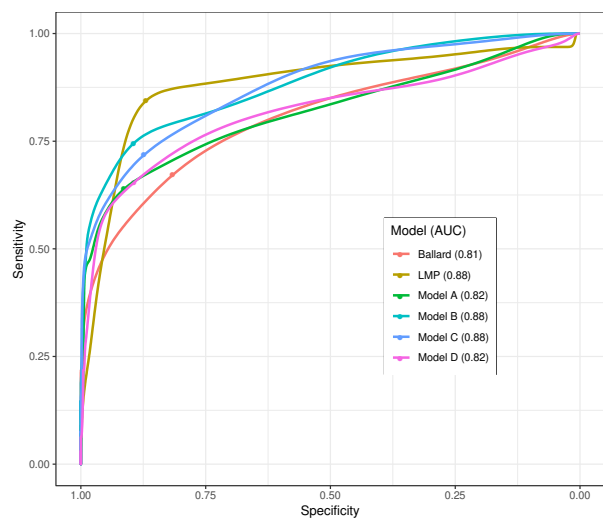**6d. Zambia Model B vs Ultrasound**

6e. Zambia Model C vs Ultrasound

6f. Zambia Model D vs Ultrasound

12

Web Figure 7a-e. Receiver Operating Curves for the Identification of Preterm Births (<37 weeks)

WHO AMANHI Cohorts - Site Specific Data

7a. Bangladesh

7b. Ghana

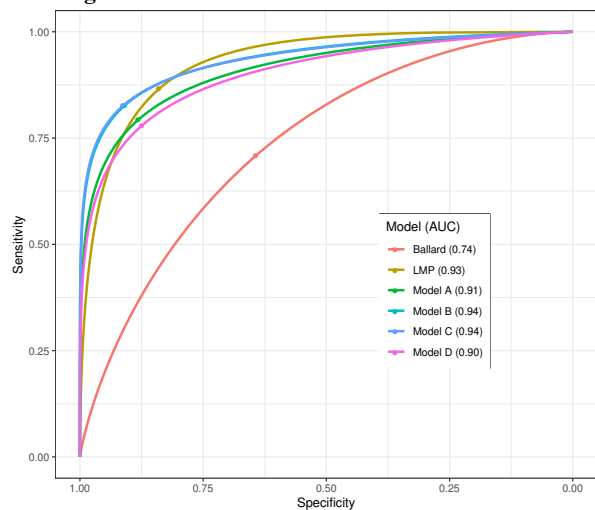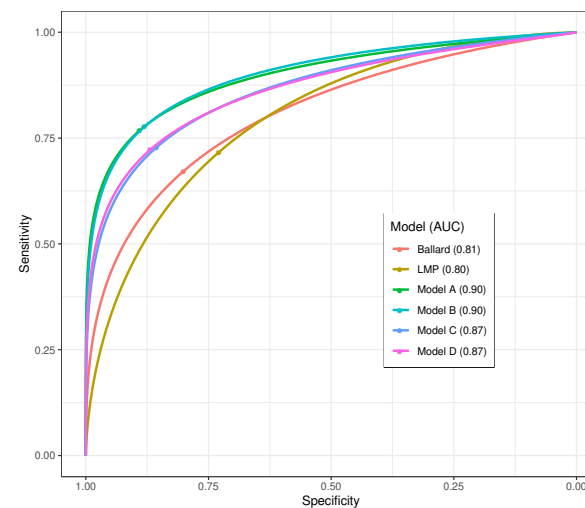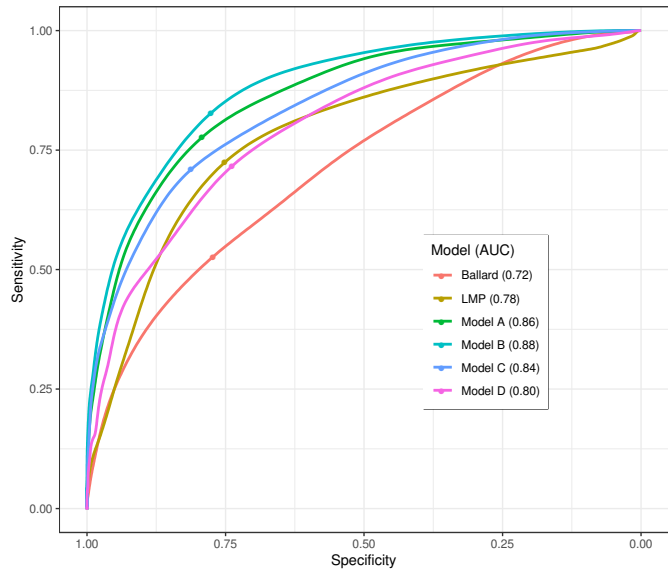**7c. Pakistan (Karachi)**

7d. Tanzania (Pemba)

13

7e. Zambia

Web Figure 8.a-e Receiver Operating Curves for the Identification of Preterm Births (<34 weeks)

WHO AMANHI Cohorts - Site Specific Data

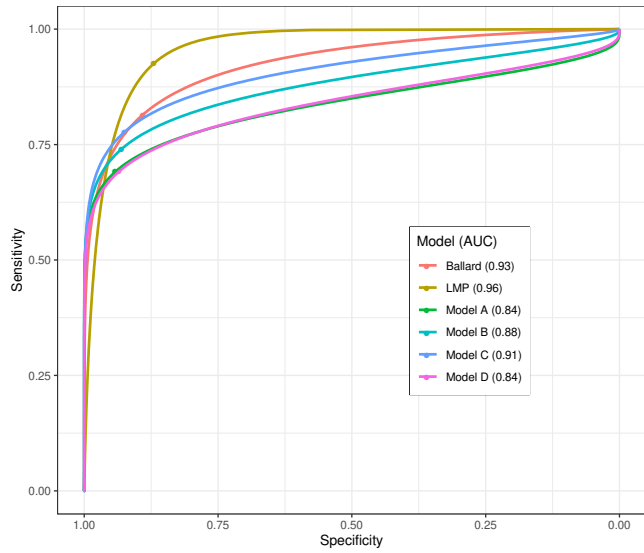**8a. Bangladesh**

8b. Ghana

14

8c. Pakistan (Karachi)

8d. Tanzania (Pemba)

8e. Zambia

15

Web Figure 9a-d. ROC Curves by AGA and SGA status for classification of infants <37 weeks and <34 weeks
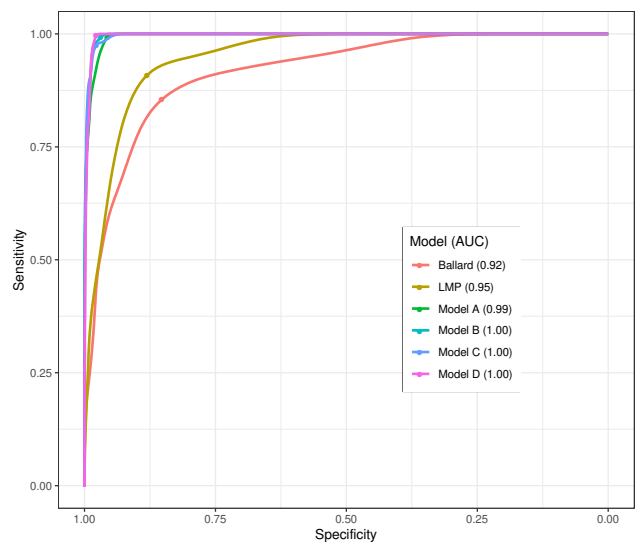
9a. Preterm (<37 weeks) classification among AGA infants

9b. Preterm (<37 weeks) classification among SGA infants

9c. Early preterm (<34 wk) classification among AGA infants

9d. Early preterm (<34 wk) classification among SGA infants