
WEB APPENDIX

**Neonatal Clinical Examination for Gestational Age Determination:
*A systematic literature review***

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Web Appendix 1. PRISMA Statement

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2009

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4-5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5-6; Web Appendices 2.1 & 2.2
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6; Web Appendix 2
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6-7; Web Appendix 2.3
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6; Web Appendix 2.3
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Web Appendix 3
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6-7; Figures 1&3; Web Appendix 2.3
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Web Appendices 2.4 & 4
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7-8; Web Appendix 2.5
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8-9; Web Appendix 2.6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	8-9; Web Appendix 2.6

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Web Appendix 2.7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	8-9
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	9,17; Figures 1 & 3
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	33-41; 43 (i.e. Tables 1-4,6); Web Appendices 5, 10, & 11
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	10,17
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	33-41, 43 (i.e. Tables 1-4,6); Figure 2; Web Appendices 7a-b & 8-12
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	42 (i.e. Table 5); Figure 2; Web Appendices 7a-b & 8
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	10,17; Web Appendices 6 & 12
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	42 (i.e. Table 5); Web Appendix 8
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	19-23
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	19-23
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	23-24; Figure 4
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	1

Web Appendix 2. Systematic Review Protocol

Diagnostic Accuracy of Methods of Gestational Age Determination Systematic Review Protocol

1. Background

Preterm birth is the leading cause of under-5 child mortality. However, ascertainment of gestational age is limited and challenging in low resource settings. The accurate determination of gestational age in pregnancy and after birth is required in order to identify prematurity and fetal growth restriction, and effectively deliver interventions. The aim of this review is to identify a range of methods currently used to determine gestational age before and after birth, assess the validity of these methods, and identify potential new methods for application in low- and middle-income countries (LMIC).

2. Research questions

- 1) What range of methods are currently available to determine gestational age both before and after birth?
- 2) What are the accuracy, reliability, precision (i.e. validity) of these methods to assess gestational age?
- 3) What methods are available which are currently feasible for LMIC settings?
- 4) What new methods may be applicable to LMIC in the future?

3. Search Strategy

We will conduct automated and manual searches including multiple search engines and databases (Table 1). The databases will include: pubmed, embase, web of science, popline, cochrane library, global health library, WHO regional database, www.clinicaltrials.gov and targeted google searches. There will be no restrictions on language or publication period. The detailed search terms are listed in the Appendix formatted for PubMed.

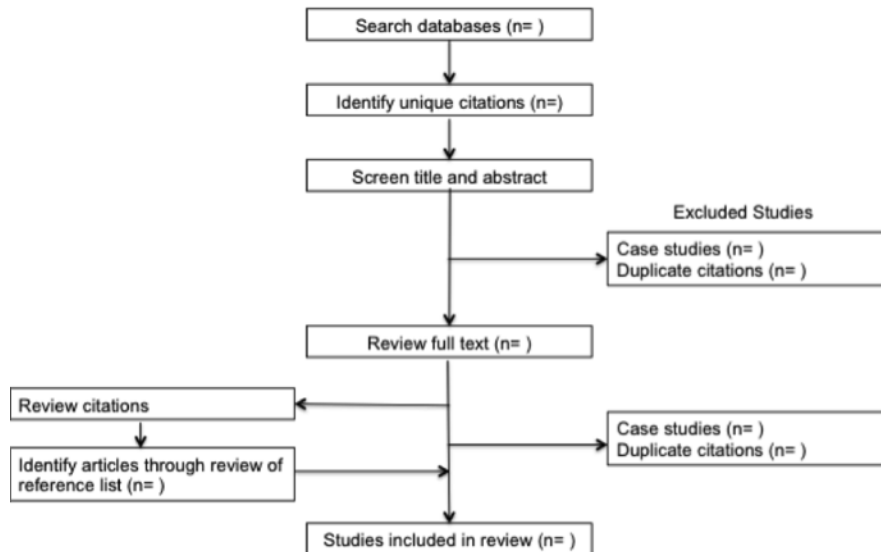
Table 1: Databases and Search engines

Database	Website
PubMed/Medline	http://www.ncbi.nlm.nih.gov/pubmed
Embase	http://www.embase.com/
Web of Science	
Popline	
The Cochrane Library	http://www.cochrane.org/
Global Health Library	http://www.globalhealth.org/
World Health Organization Regional Databases: LILACs, IMEMR, AIM, IMSEAR, WPRIM	www.who.int
Clinical trials	www.clinicaltrials.gov
Targeted Google searches	

Selection Criteria

- a. Inclusion Criteria:
 - i. For Broader Landscape Review:
 1. All Inclusive
 2. Any Birth: Live births OR stillbirths
 - ii. For Inclusion for diagnostic accuracy
 1. Comparison of at least 2 GA estimation methods
 2. Report on at least one statistic assessing accuracy of GA determination method
- b. Exclusion Criteria:
 - i. No language exclusions
 - ii. Individual case reports
 - iii. Duplicate studies
 - iv. Editorials or reviews without original data
 - v. No data on accuracy of testing or insufficient data to calculate

Figure 1: Sample Flowchart for Literature Searches



4. Data Abstraction

Data will be extracted into a standard Excel file by two independent reviewers. A sample of the variables to be extracted is shown in Table 2 (full list available in Web Appendix 4). As data are available, a two-by-two table will be constructed for each study to determine the true positives, false positives, true negatives, and false negatives, comparing the test method to the reference standard definition.

Table 2. Sample of Variables in Data Abstraction Table

Study Characteristics	Reference Standard GA Determination Method	Test GA Estimation Method(s)
<ul style="list-style-type: none"> • Authors • Journal • Publication year • Country • Study design • Study setting • Population characteristics • Sample selection method • Total sample size 	<ul style="list-style-type: none"> • Type/description of method/ test • Type/level of training of health worker performing assessment • Mean GA [SD] of cohort with reference standard method • Total number of preterm <37 weeks; preterm <34 weeks; LBW; SGA • % preterm <37 weeks; preterm <34 weeks; LBW; SGA 	<ul style="list-style-type: none"> • Type/description of reference standard and test methods • Type/level of health worker performing assessments • Mean GA (+ standard deviation) of cohort with reference standard and test methods • Mean difference (+ standard deviation) between reference standard vs test method • Total number or % of preterm <37 weeks; preterm <34 weeks; LBW; SGA • Correlation coefficient with reference standard gestational age • Area under the receiver operating curve • Cutoff values (if applicable) with corresponding <ul style="list-style-type: none"> ○ Sensitivity [95%CI] for preterm <37 weeks; preterm <34 weeks; LBW, SGA ○ Specificity [95%CI] for preterm <37 weeks; preterm <34 weeks; LBW, SGA ○ PPV for preterm <37 weeks; preterm <34 weeks; LBW, SGA ○ NPV for preterm <37 weeks; preterm <34 weeks, LBW, SGA

CI= confidence interval, GA= gestational age, LBW= low birth weight, NPV= negative predictive value, PPV= positive predictive value, SD= standard deviation, SGA= small for gestational age

5. Study Quality Assessment

For studies reporting diagnostic accuracy, methodological quality will be assessed per the Cochrane Diagnostic Test Accuracy Working group recommendations using the QUADAS-2 (Quality Assessment of Diagnostic-Accuracy Studies-2).

All studies will be scored for quality by two independent researchers. If the data reviewers disagree, they will discuss their position in detail, using evidence from the study in question until they reach a compromise. If they do not reach a compromise, the question at hand will be discussed with the research team during a team meeting to arrive at a compromise that the team as a whole agrees with.

Methodological quality will be assessed per the Cochrane Diagnostic Test Accuracy Working Group's recommendations using the QUADAS-2 (Quality Assessment of Diagnostic Accuracy Studies-2). Individual studies will be evaluated for limitations and biases in the following domains: patient selection, reference standard method, test method, and flow and timing of the study. For each of these domains, a score will be assigned (0=low risk, 1=high risk). A total quality assessment score will be given to each study. Study design will be scored according to whether the sample size was sufficient ($n \geq 50$ vs. $n < 50$), whether methodology and data were adequately reported, whether subjects were enrolled randomly vs. purposively, whether inappropriate exclusion criteria were avoided, whether the reference standard vs. test method were used independently and users were blinded, whether multiple measurements were taken to assess inter- and or/ intra-rater reliability, whether any quality control measures were undertaken, whether users were trained in the GA assessment method(s), whether thresholds were pre-specified (if applicable), whether the reference standard method was ultrasound (adequate) vs. other (inadequate) method, whether any enrolled subjects were excluded from assessment by either the reference standard method or the test method, whether all enrolled subjects received the same reference standard, and whether any enrolled subjects were excluded from the analysis.

In addition to summarizing study quality, we will also summarize the consistency of definitions of each gestational age method, and the overall generalizability of study results to our target population (newborns in LMICs).

6. Data Analysis

All data will be summarized in study data tables by each major group of methods of gestational age determination. If there is sufficient and adequate quality data to perform pooled analysis, we will conduct meta-analysis with hierarchical bivariate models using the Stata “metandi” command, as per the recommendations of the Cochrane Working Group on Systematic Reviews of Diagnostic Test Accuracy.¹ Hierarchical summary receiver operating characteristic curves will be generated with the “metanplot” command. Coupled forest plots will be generated with Review Manager 5.1. Sub-group analysis and meta-regression may be performed, if required, to explore sources of heterogeneity

7. Study Limitations

The potential limitations we foresee are the paucity of published studies. We therefore will attempt to target numerous search engines and sources in the grey and unpublished literature, as well as targeted Google searches. The study may potentially be limited if the studies found in our search are not representative of global regions.

8. Reporting

We plan to report these findings to public health experts in child and maternal health first by submitting interim and final reports to The Bill & Melinda Gates Foundation, and finally through publication in a peer-reviewed journal. Depending on the findings of the review, this may result in a publication supplement of 2-3 papers.

9. Protocol Registration

The protocol was registered in the PROSPERO International prospective register of systematic reviews, University of York Centre for Reviews and Dissemination (<http://www.crd.york.ac.uk/PROSPERO>). PROSPERO Registration number: CRD42015020499

Web Appendix 3. Search Terms

Date of Original Search	Search Topics	Detailed Search Strings/MeSH Terms	Database (report by each database searched)	# of hits per database	Total Hits Before De-duplication	Total Hits After De-duplication	Total de-duplicated hits for updated searches from June 2016
3/23/2015	Neonatal Assessment Neonatal Clinical Exam Postnatal Exam	("gestational age"[MeSH Terms] OR "gestational age"[Text Word] OR "premature birth"[MeSH Terms] OR "premature birth"[Text Word] OR preterm[Text Word] OR ptb[Text Word] OR "fetal growth retardation"[MeSH Terms] OR "fetal growth restriction"[Text Word] OR "fetal growth retardation"[Text Word] OR "infant, low birth weight"[MeSH Terms] OR "low birth weight"[All Fields] OR "IUGR"[Text Word] OR "lbw"[Text Word] OR "birth weight"[MeSH Terms] OR "infant, low birth weight"[MeSH Terms]) AND ("neonatal assessment"[All Fields] OR "Infant, Newborn/growth and development"[Mesh] OR "Infant, Newborn/statistics and numerical data"[Mesh] OR "clinical assessment"[All Fields] OR "postnatal exam"[All Fields] OR "postnatal examination"[All Fields] OR "neonatal exam"[All Fields])	Pubmed	2781	3656	3625 (for all neonatal exam searches combined)	237 (for all neonatal exam searches combined)
3/23/2015	Neonatal Assessment Neonatal Clinical Exam Postnatal Exam	gestational age/exp OR 'gestational age' OR 'premature'/exp OR 'premature' OR 'prematurity'/exp OR 'prematurity' OR 'preterm birth'/exp OR 'preterm birth' OR 'preterm' OR 'ptb' OR 'intrauterine growth retardation'/exp OR 'intrauterine growth retardation' OR 'intrauterine growth restriction' OR 'fetal growth retardation'/exp OR 'fetal growth retardation' OR 'low birth weight'/exp OR 'low birth weight' OR 'iugr' OR 'lbw' AND ('newborn assessment'/exp OR 'newborn assessment' OR 'neonatal assessment' OR 'neonatal examination' OR 'neonatal exam' OR 'postnatal examination' OR 'postnatal exam')	EMBASE	522			
3/23/2015	Neonatal Assessment Neonatal Clinical Exam Postnatal Exam	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND ("neonatal assessment" OR "infant growth" OR "infant development" OR "newborn clinical assessment" OR "clinical assessment" OR "postnatal examination" OR "newborn examination" OR "postnatal exam" OR "postnatal examination")	Cochrane	168			
3/23/2015	Neonatal Assessment Neonatal Clinical Exam Postnatal Exam	("gestational age" OR "premature birth" OR preterm OR ptb OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR iugr OR lbw OR "birth weight") AND ("neonatal assessment" OR "neonatal clinical examination" OR "newborn assessment" OR "newborn clinical examination" OR "postnatal assessment" OR "postnatal examination" OR "postnatal exam" OR "postnatal clinical assessment" OR "postnatal clinical examination" OR "postnatal clinical exam")	Web of Science	63			
3/23/2015	Neonatal Assessment Neonatal Clinical Exam Postnatal Exam	("gestational age" OR "premature birth" OR preterm OR ptb OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR iugr OR lbw OR "birth weight") AND ("neonatal assessment" OR "neonatal clinical examination" OR "newborn assessment" OR "newborn clinical examination" OR "postnatal assessment" OR "postnatal examination" OR "postnatal exam" OR "postnatal clinical assessment" OR "postnatal clinical examination" OR "postnatal clinical exam")	Popline	12			
3/23/2015	Neonatal Assessment Neonatal Clinical Exam Postnatal Exam	(tw:(("gestational age" OR "premature birth" OR preterm OR ptb OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR iugr OR lbw OR "birth weight") AND ("neonatal assessment" OR "neonatal clinical examination" OR "newborn assessment" OR "newborn clinical examination" OR "postnatal assessment" OR "postnatal examination" OR "postnatal exam" OR "postnatal clinical assessment" OR "postnatal clinical examination" OR "postnatal clinical exam")))	LILACs/V HL	89			
3/23/2015	Neonatal Assessment Neonatal Clinical Exam Postnatal Exam	("gestational age" OR "premature birth" OR preterm OR ptb OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR iugr OR lbw OR "birth weight") AND ("neonatal assessment" OR "neonatal clinical examination" OR "newborn assessment" OR "newborn clinical examination" OR "postnatal assessment" OR "postnatal examination" OR "postnatal exam" OR "postnatal clinical assessment" OR "postnatal clinical examination" OR "postnatal clinical exam")	WPRIM	4			
3/23/2015	Neonatal Assessment Neonatal Clinical Exam Postnatal Exam	neonatal assessment OR neonatal clinical examination OR newborn assessment OR newborn clinical examination OR postnatal assessment OR postnatal examination OR postnatal exam OR postnatal clinical assessment OR postnatal clinical examination OR postnatal clinical exam	Global Health Library	17			
3/23/2015	Neonatal Assessment Neonatal Clinical Exam Postnatal Exam		LILACs/V HL				
3/23/2015	Ballard Score/Exam	("ballard score"[All Fields] OR "ballard examination"[All Fields] OR "ballard exam"[All Fields])	Pubmed	33			
3/23/2015	Ballard Score/Exam	'ballard score' OR 'ballard examination' OR 'ballard exam'	EMBASE	52			
3/23/2015	Ballard Score/Exam	"ballard score" OR "ballard examination" OR "ballard exam"	Cochrane	3			
3/23/2015	Ballard Score/Exam	"ballard score" OR "ballard examination" OR "ballard exam"	Web of Science	30			
3/23/2015	Ballard Score/Exam	"ballard score" OR "ballard examination" OR "ballard exam" OR "ballard"	Popline	0			

3/23/2015	Ballard Score/Exam	ballard score OR ballard examination OR ballard exam	Global Health Library	0	
3/23/2015	Dubowitz Score/Exam	"dubowitz score"[All Fields] OR "dubowitz examination"[All Fields] OR ("dubowitz"[tw] AND (neurolog[tw] OR neurologia[tw] OR neurologifti[tw] OR neurologa[tw] OR neurologaicly[tw] OR neurologien[tw] OR neurologenic[tw] OR neurologeneering[tw] OR neurologeneering[tw] OR neurologer[tw] OR neurologgers[tw] OR neurologi[tw] OR neurologia[tw] OR neurologia[tw] OR neurologial[tw] OR neurologi[tw] OR neurologi[tw] OR neurologica[tw] OR neurological[tw] OR neurological[tw] OR neurologicalal[tw] OR neurologicalcondition[tw] OR neurologicaldeficit[tw] OR neurologicaldeterioration[tw] OR neurologicaldiseases[tw] OR neurologicalfindings[tw] OR neurologically[tw] OR neurologically[tw] OR neurologicalneuroradiological[tw] OR neurologicalresponses[tw] OR neurologicals[tw] OR neurologicalsyhndromes[tw] OR neurologically[tw] OR neurologicas[tw] OR neurologicaspol[tw] OR neurologiche[tw] OR neurologie[tw] OR neurologie[tw] OR neurologics[tw] OR neurologicos[tw] OR neurologics[tw] OR neurologisequelaef[tw] OR neurologiczna[tw] OR neurologidal[tw] OR neurologie[tw] OR neurologie[tw] OR neurologies[tw] OR neurologi[tw] OR neurologinen[tw] OR neurologins[tw] OR neurological[tw] OR neurologique[tw] OR neurologiques[tw] OR neurologis[tw] OR neurologische[tw] OR neurologischen[tw] OR neurologisen[tw] OR neurologisk[tw] OR neurologiskit[tw] OR neurologism[tw] OR neurologisms[tw] OR neurologist[tw] OR neurologist's[tw] OR neurologists[tw] OR neurologists'[tw] OR neurologists's[tw] OR neurologistsand[tw] OR neurologits[tw] OR neurologix[tw] OR neurologization[tw] OR neurologize[tw] OR neurologial[tw] OR neurologof[tw] OR neurologopedics[tw] OR neurologos[tw] OR neurologost's[tw] OR neurologu[tw] OR neurologues[tw] OR neurology[tw] OR neurology[tw] OR neurology's[tw] OR neurology38[tw] OR neurologycal[tw] OR neurologycal[tw] OR neurologymobility[tw] OR neurologypatients[tw]) AND (score[All Fields] OR ("physical examination"[MeSH Terms] OR ("physical"[All Fields] AND "examination"[All Fields]) OR "physical examination"[All Fields] OR "examination"[All Fields]))	Pubmed	54	170
3/23/2015	Dubowitz Score/Exam	'dubowitz score/exp OR 'dubowitz score' OR 'dubowitz examination' OR 'dubowitz exam'	EMBASE	66	
3/23/2015	Dubowitz Score/Exam	"dubowitz score" OR "dubowitz examination" OR "dubowitz method"	Cochrane	5	
3/23/2015	Dubowitz Score/Exam	"dubowitz score" OR "dubowitz examination" OR "dubowitz method"	Web of Science	25	
3/23/2015	Dubowitz Score/Exam	"dubowitz score" OR "dubowitz examination" OR "dubowitz method"	Popline	12	
3/23/2015	Dubowitz Score/Exam	dubowitz score OR dubowitz examination OR dubowitz method	Global Health Library	8	
3/23/2015	Capurro Method/Score/Exam	("capurro method"[All Fields] OR "capurro score"[All Fields] OR "capurro exam"[All Fields] OR "capurro examination"[All Fields] OR "capurro"[tw])	Pubmed	27	239
3/23/2015	Capurro Method/Score/Exam	'capurro method' OR 'capurro score' OR 'capurro examination' OR 'capurro exam'	EMBASE	16	
3/23/2015	Capurro Method/Score/Exam	"capurro method" OR "capurro score" OR "capurro exam" OR "capurro examination" OR "capurro"	Cochrane	11	
3/23/2015	Capurro Method/Score/Exam	"capurro method" OR "capurro score" OR "capurro exam" OR "capurro examination" OR "capurro"	Popline	6	
3/23/2015	Capurro Method/Score/Exam	"capurro method" OR "capurro score" OR "capurro exam" OR "capurro examination" OR "capurro"	Web of Science	33	
3/23/2015	Capurro Method/Score/Exam	capurro method OR capurro score OR capurro exam OR capurro examination OR capurro	Global Health Library	146	
3/23/2015	Parkin	("gestational age"[MeSH Terms] OR "gestational age"[Text Word] OR "premature birth"[MeSH Terms] OR "premature birth"[Text Word] OR preterm[Text Word] OR ptb[Text Word] OR "fetal growth retardation"[MeSH Terms] OR "fetal growth restriction"[Text Word] OR "fetal growth retardation"[Text Word] OR "infant, low birth weight"[MeSH Terms] OR "low birth weight"[All Fields] OR "IUGR"[Text Word] OR "lbw"[Text Word] OR "birth weight"[MeSH Terms] OR "infant, low birth weight"[MeSH Terms]) AND "parkin j"[All Fields]	Pubmed	13	24
3/23/2015	Parkin	'gestational age/exp OR 'gestational age' OR 'premature/exp OR 'premature' OR 'prematurity/exp OR 'prematurity' OR 'preterm birth/exp OR 'preterm birth' OR 'preterm' OR 'ptb' OR 'intrauterine growth retardation/exp OR 'intrauterine growth retardation' OR 'intrauterine growth restriction' OR 'fetal growth retardation/exp OR 'fetal growth retardation' OR 'low birth weight'/exp OR 'low birth weight' OR 'iugr' OR 'lbw' AND 'parkin j'	EMBASE	10	
3/23/2015	Parkin	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND "parkin j"	Cochrane	0	
3/23/2015	Parkin	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND "parkin j"	Popline	1	
3/23/2015	Parkin	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND "parkin j"	Web of Science	0	

3/23/2015	Parkin	(gestational age OR premature birth OR preterm OR ptb OR fetal growth retardation OR fetal growth restriction OR intrauterine growth retardation OR intrauterine growth restriction OR low birth weight OR IUGR OR lbw OR birth weight) AND parkin j	Global Health Library	0			
3/23/2015	Eregie	("gestational age"[MeSH Terms] OR "gestational age"[Text Word] OR "premature birth"[MeSH Terms] OR "premature birth"[Text Word] OR preterm[Text Word] OR ptb[Text Word] OR "fetal growth retardation"[MeSH Terms] OR "fetal growth restriction"[Text Word] OR "fetal growth retardation"[Text Word] OR "infant, low birth weight"[MeSH Terms] OR "low birth weight"[All Fields] OR "IUGR"[Text Word] OR "lbw"[Text Word] OR "birth weight"[MeSH Terms] OR "infant, low birth weight"[MeSH Terms]) AND "eregie"[All Fields]	Pubmed	18	42		
3/23/2015	Eregie	('gestational age'/exp OR 'gestational age' OR 'premature'/exp OR 'premature' OR 'prematurity'/exp OR 'prematurity' OR 'preterm birth'/exp OR 'preterm birth' OR 'preterm' OR 'ptb' OR 'intrauterine growth retardation'/exp OR 'intrauterine growth retardation' OR 'intrauterine growth restriction' OR 'fetal growth retardation'/exp OR 'fetal growth retardation' OR 'low birth weight'/exp OR 'low birth weight' OR 'iugr' OR 'lbw') AND 'eregie'	EMBASE	16			
3/23/2015	Eregie	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND "eregie"	Cochrane	0			
3/23/2015	Eregie	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND "eregie"	Web of Science	2			
3/23/2015	Eregie	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND "eregie"	Global Health Library	0			
3/23/2015	Eregie	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND "eregie"	Popline	6			
3/23/2015	Anterior Vascularity of Lens	("gestational age"[MeSH Terms] OR "gestational age"[Text Word] OR "premature birth"[MeSH Terms] OR "premature birth"[Text Word] OR preterm[Text Word] OR ptb[Text Word] OR "fetal growth retardation"[MeSH Terms] OR "fetal growth restriction"[Text Word] OR "fetal growth retardation"[Text Word] OR "infant, low birth weight"[MeSH Terms] OR "low birth weight"[All Fields] OR "IUGR"[Text Word] OR "lbw"[Text Word] OR "birth weight"[MeSH Terms] OR "infant, low birth weight"[MeSH Terms]) AND (((anterior[All Fields] AND vascularity[All Fields]) OR "lens vessels"[All Fields]) OR "Lens Capsule, Crystalline"[Mesh]) OR "Lens, Crystalline"[Mesh])	Pubmed	173	400		
3/23/2015	Anterior Vascularity of Lens	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND (("anterior" AND "vascularity") OR "lens capsule" OR "crystalline lens capsule" OR "anterior vascularity" OR "lens vessels" OR "lens vessels" OR "lens")	Cochrane	8			
3/23/2015	Anterior Vascularity of Lens	'gestational age'/exp OR 'gestational age' OR 'premature'/exp OR 'premature' OR 'prematurity'/exp OR 'prematurity' OR 'preterm birth'/exp OR 'preterm birth' OR 'preterm' OR 'ptb' OR 'intrauterine growth retardation'/exp OR 'intrauterine growth retardation' OR 'intrauterine growth restriction' OR 'fetal growth retardation'/exp OR 'fetal growth retardation' OR 'low birth weight'/exp OR 'low birth weight' OR 'iugr' OR 'lbw' AND ('lens capsule'/exp OR 'lens capsule' OR ('anterior' AND 'vascularity') OR 'lens vessels' OR 'lens capsule, crystalline'/exp OR 'lens capsule, crystalline')	EMBASE	47			
3/23/2015	Anterior Vascularity of Lens	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND (("anterior" AND "vascularity") OR "lens capsule" OR "crystalline lens capsule" OR "anterior vascularity" OR "lens vessels" OR "lens vessels" OR "lens")	Web of Science	154			
3/24/2015	Anterior Vascularity of Lens	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND (("anterior" AND "vascularity") OR "lens capsule" OR "crystalline lens capsule" OR "anterior vascularity" OR "lens vessels" OR "lens vessels" OR "lens")	Global Health Libraries	15			
3/23/2015	Anterior Vascularity of Lens	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND (("anterior" AND "vascularity") OR "lens capsule" OR "crystalline lens capsule" OR "anterior vascularity" OR "lens vessels" OR "lens vessels" OR "lens")	Popline	3			
3/23/15	Intermamillary Distance	("gestational age"[MeSH Terms] OR "gestational age"[Text Word] OR "premature birth"[MeSH Terms] OR "premature birth"[Text Word] OR preterm[Text Word] OR ptb[Text Word] OR "fetal growth retardation"[MeSH Terms] OR "fetal growth restriction"[Text Word] OR "fetal growth retardation"[Text Word] OR "infant, low birth weight"[MeSH Terms] OR "low birth weight"[All Fields] OR "IUGR"[Text Word] OR "lbw"[Text Word] OR "birth weight"[MeSH Terms] OR "infant, low birth weight"[MeSH Terms]) AND (((intermamillary distance"[All Fields] OR ("Breast/anatomy and histology"[Mesh]) OR "Breast/growth and development"[Mesh]) OR ("Nipples/anatomy and histology"[Mesh]) OR "Nipples/growth and development"[Mesh])) AND "humans"[MeSH Terms])	Pubmed	72	358	320	
3/23/15	Intermamillary Distance	'gestational age'/exp OR 'gestational age' OR 'premature'/exp OR 'premature' OR 'prematurity'/exp OR 'prematurity' OR 'preterm birth'/exp OR 'preterm birth' OR 'preterm' OR 'ptb' OR 'intrauterine growth retardation'/exp OR 'intrauterine growth retardation' OR 'intrauterine growth restriction' OR 'fetal growth retardation'/exp OR 'fetal growth retardation' OR 'low birth weight'/exp OR 'low birth weight' OR 'iugr' OR 'lbw' AND ('intermamillary distance' OR 'breast areola'/exp OR 'nipple'/exp)	EMBASE	121			
3/23/15	Intermamillary Distance	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND ("intermamillary" OR "intermamillary distance" OR "breast anatomy" OR "nipple" OR "breast areola")	Cochrane	32			

3/23/15	Intermamillary Distance	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND ("intermamillary" OR "intermamillary distance" OR "breast anatomy" OR "nipple" OR "breast areola")	Web of Science	105			
3/23/15	Intermamillary Distance	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND ("intermamillary" OR "intermamillary distance" OR "breast anatomy" OR "nipple" OR "breast areola")	Global Health Libraries	7			
3/23/15	Intermamillary Distance	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND ("intermamillary" OR "intermamillary distance" OR "breast anatomy" OR "nipple" OR "breast areola")	Popline	21			
3/23/15	Skin Impedance	((("gestational age"[MeSH Terms] OR "gestational age"[Text Word] OR "premature birth"[MeSH Terms] OR "premature birth"[Text Word] OR preterm[Text Word] OR ptb[Text Word] OR "fetal growth retardation"[MeSH Terms] OR "fetal growth restriction"[Text Word] OR "fetal growth retardation"[Text Word] OR "infant, low birth weight"[MeSH Terms] OR "low birth weight"[All Fields] OR "IUGR"[Text Word] OR "lbw"[Text Word] OR "birth weight"[MeSH Terms] OR "infant, low birth weight"[MeSH Terms])) AND ((("skin"[MeSH Terms] OR "skin"[All Fields]) AND ("electric impedance"[MeSH Terms] OR "electric"[All Fields] AND "impedance"[All Fields]) OR "electric impedance"[All Fields] OR "impedance"[All Fields] OR "Galvanic Skin Response"[Mesh]))))	Pubmed	34	160	109	
3/23/15	Skin Impedance	'gestational age'/exp OR 'gestational age' OR 'premature/exp OR 'premature' OR 'prematurity/exp OR 'prematurity' OR 'preterm birth'/exp OR 'preterm birth' OR 'preterm' OR 'ptb' OR 'intrauterine growth retardation'/exp OR 'intrauterine growth retardation' OR 'intrauterine growth restriction' OR 'fetal growth retardation'/exp OR 'fetal growth retardation' OR 'low birth weight'/exp OR 'low birth weight' OR 'iugr' OR 'lbw' AND ('skin conductance'/exp OR 'skin' AND 'impedance'/exp) OR 'electrodermal response'/exp OR 'galvanic skin response' OR 'skin impedance')	EMBASE	82			
3/23/15	Skin Impedance	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND ("skin conductance" OR "skin impedance" OR "electrodermal response" OR "galvanic skin response" OR ("skin" AND "impedance"))	Cochrane	6			
3/23/15	Skin Impedance	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND ("skin conductance" OR "skin impedance" OR "electrodermal response" OR "galvanic skin response" OR ("skin" AND "impedance"))	Web of Science	36			
3/23/15	Skin Impedance	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND ("skin conductance" OR "skin impedance" OR "electrodermal response" OR "galvanic skin response" OR ("skin" AND "impedance"))	Global Health Libraries	1			
3/23/15	Skin Impedance	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND ("skin conductance" OR "skin impedance" OR "electrodermal response" OR "galvanic skin response" OR ("skin" AND "impedance"))	Popline	1			
3/23/15	Palmar Crease	("gestational age"[MeSH Terms] OR "gestational age"[Text Word] OR "premature birth"[MeSH Terms] OR "premature birth"[Text Word] OR preterm[Text Word] OR ptb[Text Word] OR "fetal growth retardation"[MeSH Terms] OR "fetal growth restriction"[Text Word] OR "fetal growth retardation"[Text Word] OR "infant, low birth weight"[MeSH Terms] OR "low birth weight"[All Fields] OR "IUGR"[Text Word] OR "lbw"[Text Word] OR "birth weight"[MeSH Terms] OR "infant, low birth weight"[MeSH Terms]) AND ("palmar crease"[All Fields] OR (("Hand/analysis"[Mesh] OR "Hand/anatomy and histology"[Mesh]) OR "Hand Deformities, Congenital"[Mesh]))	Pubmed	297	327	320	
3/23/15	Palmar Crease	'gestational age'/exp OR 'gestational age' OR 'premature/exp OR 'premature' OR 'prematurity/exp OR 'prematurity' OR 'preterm birth'/exp OR 'preterm birth' OR 'preterm' OR 'ptb' OR 'intrauterine growth retardation'/exp OR 'intrauterine growth retardation' OR 'intrauterine growth restriction' OR 'fetal growth retardation'/exp OR 'fetal growth retardation' OR 'low birth weight'/exp OR 'low birth weight' OR 'iugr' OR 'lbw' AND ('palmar crease'/exp OR 'palmar crease' OR 'hand anatomy and histology' OR 'hand deformities' OR 'hand analysis')	EMBASE	27			
3/23/15	Palmar Crease	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND (("palmar" AND "crease") OR "palmar crease" OR "hand anatomy and histology" OR "hand deformities" OR "hand analysis")	Cochrane	0			
3/23/15	Palmar Crease	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND (("palmar" AND "crease") OR "palmar crease" OR "hand anatomy and histology" OR "hand deformities" OR "hand analysis")	Web of Science	2			
3/23/15	Palmar Crease	("gestational age" OR "premature birth" OR "preterm" OR "ptb" OR "fetal growth retardation" OR "fetal growth restriction" OR "intrauterine growth retardation" OR "intrauterine growth restriction" OR "low birth weight" OR "IUGR" OR "lbw" OR "birth weight") AND (("palmar" AND "crease") OR "palmar crease" OR "hand anatomy and histology" OR "hand deformities" OR "hand analysis")	Popline	1			

Web Appendix 4. Variables in Neonatal Assessment Data Extraction Sheet

Study Characteristics	
<ul style="list-style-type: none"> Lead Author Journal Publication Year Region (1= Africa; 2=Southeast Asia, 3=Other) Country City & District Study Design (cross-sectional vs. longitudinal; prospective vs. retrospective) Study Setting (1 = Tertiary Hospital / ICU; 2 = Primary health center/peripheral facility/clinic; 3 = Community based recruitment/rural health post/home visit) 	<ul style="list-style-type: none"> Population characteristics (rural/urban, maternal age, etc.) Sample Selection/Recruitment Method (Consecutive, Random, Non-Random, etc.) Inclusion Criteria Exclusion Criteria Stillborn Included (Y/N) Study Period (from MMY - to MMY) Total Sample Size for GA Method Comparison Characteristics
Reference Standard GA Method	
<ul style="list-style-type: none"> Reference Standard GA Method (Detailed description) Reference Standard Type If Reference=ultrasound, timing of ultrasound (e.g., 14-19 weeks) Type of health worker performing assessment (community health worker, physician, nurse, sonographer, radiologist, other non-medical staff, other) 	<ul style="list-style-type: none"> Mean GA SD and/or 95%CI Definition of preterm used (if not <37 weeks) % Preterm % Preterm <34 wks
Reference Standard Birthweight	
<ul style="list-style-type: none"> Method of reference standard birth weight measurement (open description) Type of scale (hanging vs. digital) Scale precision Mean birthweight 	<ul style="list-style-type: none"> SD and/or 95% CI for birth weight % <2500 g % SGA % LGA
Neonatal Clinical Assessment: Measurement	
<ul style="list-style-type: none"> Method Name Was the person performing the assessment blinded to reference standard result? (Yes/No) Type of health worker performing assessment (community health worker, physician, nurse, other non-medical staff, other) Timing of measurement from birth (e.g., within 24 hours of birth) 	<ul style="list-style-type: none"> Repeat measures done? (Yes/No) INTER-Rater Reliability (e.g., Kappa, Bland-Altman bias w/ LOA) INTRA-Rater Reliability Mean neonatal exam score SD and/or 95%CI Mean GA by test method, if applicable SD and/or 95%CI
Agreement (Gestational Age by Neonatal Assessment vs. Reference Standard (Continuous Data))	
<ul style="list-style-type: none"> Correlation coefficient (R) with true gestational age Lin's concordance correlation coefficient Intraclass correlation coefficient 	<ul style="list-style-type: none"> Bland Altman mean difference Bland Altman 95% limits of agreement What is the trend? Descriptive. Any tests performed? Over/Under-estimates?
Validity (Neonatal Assessment to Identify Preterm Births)	
<ul style="list-style-type: none"> Total number of preterm <37 wk by test method % preterm <37 wk by test method ROC-AUC 	<ul style="list-style-type: none"> Kappa (preterm by clinical exam vs. reference standard) Sensitivity, Specificity, PPV, NPV
Validity (Neonatal Assessment to Identify Very Preterm Births (<34 weeks))	
<ul style="list-style-type: none"> Cutoff of parameter (e.g., foot length) for predicting preterm <34 wk, if applicable Total number of preterm <34 weeks 	<ul style="list-style-type: none"> % preterm <34 weeks by test method ROC-AUC Sensitivity, Specificity, PPV, NPV
Validity (Small for Gestational Age)	
<ul style="list-style-type: none"> Name of reference curve used to define SGA Number of SGA % SGA 	<ul style="list-style-type: none"> ROC-AUC Sensitivity, Specificity, PPV, NPV

Web Appendix 5. Overall Study Table

Author ^a	Year	Place (district/city, country)	Study Setting (NICU,hospital/tertiary care center, primary clinic, community)	GA of cohort included	Sample Size	Reference Standard	Assessment Conducted (i.e. Test Method)
Neonatal Clinical Assessment							
Ahn	2008	South Korea (Incheon)	Tertiary Health Center/NICU	All gestational ages, 773-4870g	213	LMP	Ballard
Alexander	1990	USA (South Carolina)	Hospital	20-45 weeks	10794	LMP	Ballard
Alexander ^b	1992	USA (Charleston, South Carolina)	Hospital	28-42 weeks	2091, 3480	LMP	Ballard
Alexander ^c	1992	USA (Charleston, South Carolina)	Hospital	28-44 weeks by Ballard	4193	US, LMP	Ballard
Allan	2009	Australia	Tertiary care hospital/NICU	29-42 weeks	98, 56	US (CRL), LMP	Dubowitz
Amato	1991	Switzerland	NICU, hospital	All Preterm	38	"Obstetrical dates"	Ballard (Physical)
Amiel Tison	1999	France (Paris)	Tertiary Health Center/NICU	37-41 weeks	397	BOE	Amiel-Tison
Aslan	2000	Turkey (Trabzon)	Hospital	All	387	LMP	Eregie
Awoust	1982	Belgium (Brussels)	Tertiary care hospital/NICU	NS	130	US (CRL/BPD)	Dubowitz
Ballard	1979	USA	NICU/nursery, Hospital	NS	224	LMP + Clinical Exam (81: Inaccurate)	Dubowitz, Ballard
Ballard	1991	USA (Cincinnati)	Tertiary Health Center/NICU	20-44 weeks; All GA	578	BOE, LMP	Ballard
Baumann	1993	Switzerland	Tertiary Health Center/NICU	Preterm; 27-35 wks AGA & 28-36 wks SGA	60 (AGA), 29 (SGA)	LMP	Ballard
Bindusha	2014	India (Kerela)	Tertiary Health Center/NICU	Preterm; 28-37 weeks	1000	LMP	Ballard, Bhagwat (Physical)
Capurro	1978	Uruguay (Montevideo)	Tertiary Health Center/NICU	All gestational ages	115	LMP	Capurro, Dubowitz
Cevit	1998	Turkey (Sivas)	NS	LBW; 28-38 weeks; <2500g	91	LMP	Dubowitz, Ballard, Tuncer
Constantine	1987	USA (AK, NY, MA, FL, PA, TX, WA, CN)	Tertiary Health Center/NICU	All GA; <35 wk (53.9%), 36-37wk (20.8%), >38wk (25.3%)	1246	LMP	Ballard
Dawodu	1977	Nigeria	Tertiary care hospital/NICU	29-43 weeks	100	LMP	Dubowitz
Dombrowski	1992	USA (Detroit, Michigan)	Tertiary Health Center/NICU	24-46 weeks	38818	BOE, LMP	Ballard
Donovan	1995	USA (Maryland)	NICU, hospital	Preterm; All 24-27 weeks	242	BOE	Ballard
Dubowitz	1970	England	Tertiary care hospital/NICU	All gestational ages	167	LMP	Dubowitz
Eregie	1991	Nigeria (Benin City)	Tertiary Health Center/NICU	All gestational ages	262	Dubowitz	Eregie
Eregie	2000	Nigeria (Benin City)	Tertiary Health Center/NICU	All gestational ages	508	LMP	Eregie
Farr	1968	Scotland (Aberden)	Tertiary Health Center/NICU	34-43.5 weeks	82	LMP	Precht and Beintema (1964)
Feresu	2002	Zimbabwe (Harare)	Tertiary care hospital/NICU	24-45 weeks	364	LMP	Dubowitz, Ballard
Finnstrom	1972	Sweden (Umea)	Tertiary Health Center/NICU	All gestational ages	174	LMP	Finnstrom
Gagliardi	1992	Italy (Milano)	Tertiary Health Center/NICU	Preterm; <37 weeks; <2500g	227	BOE	Ballard
Hertz	1978	USA	Tertiary care hospital/NICU	All GA	126	LMP (reliable)	Dubowitz
Jaroszewicz	1973	South Africa	Tertiary care hospital/NICU	NS	100	LMP	Dubowitz
Karl	2015	Papua New Guinea (Madang, North Coast)	Primary Health Center	25.5-43.7 weeks; 900g-4250g	623	US	Ballard
Karunasekera	2002	Sri Lanka (Ragama)	Tertiary care hospital/NICU	35-42 weeks	200	US	Dubowitz, Parkin
Klimek	2000	Poland (Cracow)	Tertiary Health Center/NICU	30-43 weeks	800	LMP	Klimek
Kollee	1985	The Netherlands (Nijmegen)	Tertiary Health Center/NICU	NS	229	LMP	Kollee

Author ^a	Year	Place (district/city, country)	Study Setting	GA of cohort included	Sample Size	Reference Standard	Assessments conducted (i.e. Method)
Latis	1981	Italy	Tertiary care hospital/NICU	27-42 weeks	92	LMP	Dubowitz
Laveriano	2015	Peru (Lima)	Tertiary care hospital/NICU	34-42 weeks	167	US	Capurro
Lee	2014	Bangladesh (Sylhet District)	Tertiary care hospital	All GA	192	Ballard	Ballard (inter-rater reliability)
Lee	2016	Bangladesh (Sylhet District)	Community-based	All gestational ages	710	US	Ballard, Eregie, Capurro, Parkin, Bhagwat
Mackanje	1996	Canada (Ontario)	NICU, hospital	Preterm 23-33 weeks; <1500g	47	LMP	Ballard
Mitchell	1979	England	Tertiary care hospital/NICU	NS	20	LMP	Dubowitz
Moore	2015	Thai Myanmar Border	Tertiary care hospital/NICU	All GA	250	US (CRL)	Dubowitz
Moraes	2000	Brazil (Rio de Janeiro)	Tertiary Health Center/NICU	NS	146	US, BOE, LMP	Ballard
Narayanan	1982	India (New Delhi)	Tertiary Health Center/NICU	All gestational ages	356	LMP	Narayanan, including AVCL
Neufeld	2006	Guatemala (Eastern)	Community based recruitment	All GA; 34.6-43.7 weeks	171	US	Capurro Method A
Nicolopoulos	1976	Greece	Tertiary care hospital/NICU	28-44 weeks	710	LMP	Dubowitz
Oliveira	1999	Brazil (Sao Paulo)	Community center + maternity	NS	50	US, LMP	Capurro
Parkin	1976	England	Tertiary Health Center/NICU	25.2-45.2 weeks	392	LMP	Parkin
Pereira	2013	Brazil (Rio de Janeiro)	Tertiary Health Center/NICU	All gestational ages	961	US	Capurro
Raghu MB	1981	Lusaka, Zambia	Premature Unit, hospital	NS	160	LMP	Dubowitz
Roberts	1979	Wales (Cardiff)	Tertiary care hospital/NICU	NS	118	US (BPD), LMP (Rounded)	Dubowitz
Robillard	1992	France (Guadeloupe, French West Indies)	NICU and NICU referrals, hospital	LBW; <2500g neonates	384	BOE	Dubowitz
Rosenberg	2009	Bangladesh (Dhaka)	Special Care Nursery, hospital	Preterm; <33 weeks	355	US	Dubowitz, Ballard
Sanders	1991	USA (Baltimore)	NICU, hospital	LBW; <1500gm, >20 wk; <1500g, <37 weeks	110	BOE, LMP	Dubowitz, Ballard
Sasidharan	2009	India (Northern India)	NICU, medical institute	Preterm; 29-35 weeks	129	LMP	Ballard
Scher	1987	USA (Pittsburg, PA)	Tertiary Health Center/NICU	Preterm; 23-30 weeks by LMP, all died after clinical exam	24	US, LMP	Ballard
Serfontein	1978	South Africa	NS	29-40 weeks, BW <2800g	73	Dubowitz	Robinson
Shukla	1987	USA	Hospitals	Preterm; <38 weeks; AGA	25	BOE	Dubowitz
Smith	1999	USA (Houston, Texas)	Tertiary Health Center/NICU	LBW; <2500g	82	BOE	Ballard
Sreekumar	2013	India (Bangalore)	Tertiary Health Center/NICU	24-41.2 weeks	284	BOE	Ballard, Parkin
Sunjoh	2004	Cameroon	Tertiary care hospital/NICU	25-44 weeks	358	LMP	Dubowitz, Ballard, Eregie
Taylor	2010	Gambia	Community Based	All GA	80	US	Ballard (External)
Thi	2015	Vietnam (Hoa Binh)	Tertiary Health Center/NICU	30.0 - 42.0 weeks by LMP	391	US, LMP	Ballard
Tuncer	1981	Turkey (Ankara)	Tertiary care hospital/NICU	27-41 weeks	120	LMP	Dubowitz, Tuncer
Verhoeff	1997	Malawi (Chikwawa & Montfor, Southern Region)	Primary Health Center	All GA	76	LMP	Ballard (External)
Vik	1997	Norway (Bergen)	Tertiary care hospital/NICU	All GA; 20.5% SGA, 4.3% preterm, 6.8% postterm	970	US (BPD), LMP	Dubowitz
Vogt	1981	Norway	Tertiary care hospital/NICU	All GA; 25 SGA infants, 14 LGA infants	380	LMP	Dubowitz, Parkin
Wariyar	1997	UK (Newcastle)	Tertiary Health Center/NICU	All (Range not stated)	347	BOE	Ballard, Dubowitz, Parkin, Robinson
Wylie	2013	Malawi	Tertiary Health Center/NICU	All gestational ages	177	BOE	Ballard

Author ^a	Year	Place (district/city, country)	Study Setting	GA of cohort included	Sample Size	Reference Standard	Assessments conducted (i.e. Method)
Anterior Vascular Capsule of the Lens (AVCL)							
Finnstrom	1972	Sweden (Umea)	Tertiary Health Center/NICU	All gestational ages	174	LMP	AVCL
Hittner	1977	USA (Houston)	Jefferson Davis Hospital (Tertiary Care)	27-34 weeks	100	Dubowitz & LMP	AVCL
Guillory	1980	USA (Houston)	Tertiary care hospital/NICU	Preterm	43	Dubowitz & LMP	AVCL
Hittner	1981	USA (Houston)	Tertiary care hospital/NICU	Preterm & SGA	33	Dubowitz	AVCL
Narayanan	1982	India (New Delhi)	Tertiary Health Center/NICU	All gestational ages	356	LMP	AVCL
Krishnamohan	1982	USA (Connecticut)	NICU, University of Connecticut Hospital & Hartford Hospital	28-32 weeks	30	Ballard & LMP	AVCL
Sasivimokul	1986	Thailand (Bangkok)	Ramithibodi Hospital	LBW infants, all GA included	80	Ballard & LMP	AVCL
Skapinker	1987	South Africa (Johannesburg)	Johannesburg Hospital	<35 weeks	58	Ballard	AVCL
Sanders	1991	USA (Baltimore)	NICU, Johns Hopkins Hospital	<1500gm, >20 wk; <1500g, <37 weeks	89	BOE	AVCL
Baumann	1993	Switzerland (Bern)	University Clinic- Bern	27-35 weeks	89 (60 AGA; 29 SGA)	US	AVCL
Inter-mamillary Distance							
Amato	1991	Switzerland (Bern)	Neonatal Unit, University Clinic Berne	Preterm	38	LMP	Inter-mamillary distance
Thawani	2013	India (Dehli)	Neonatology division, University College of Medical Sciences and GTB Hospital	25-42 weeks	1000	New Ballard Score	Inter-mamillary distance

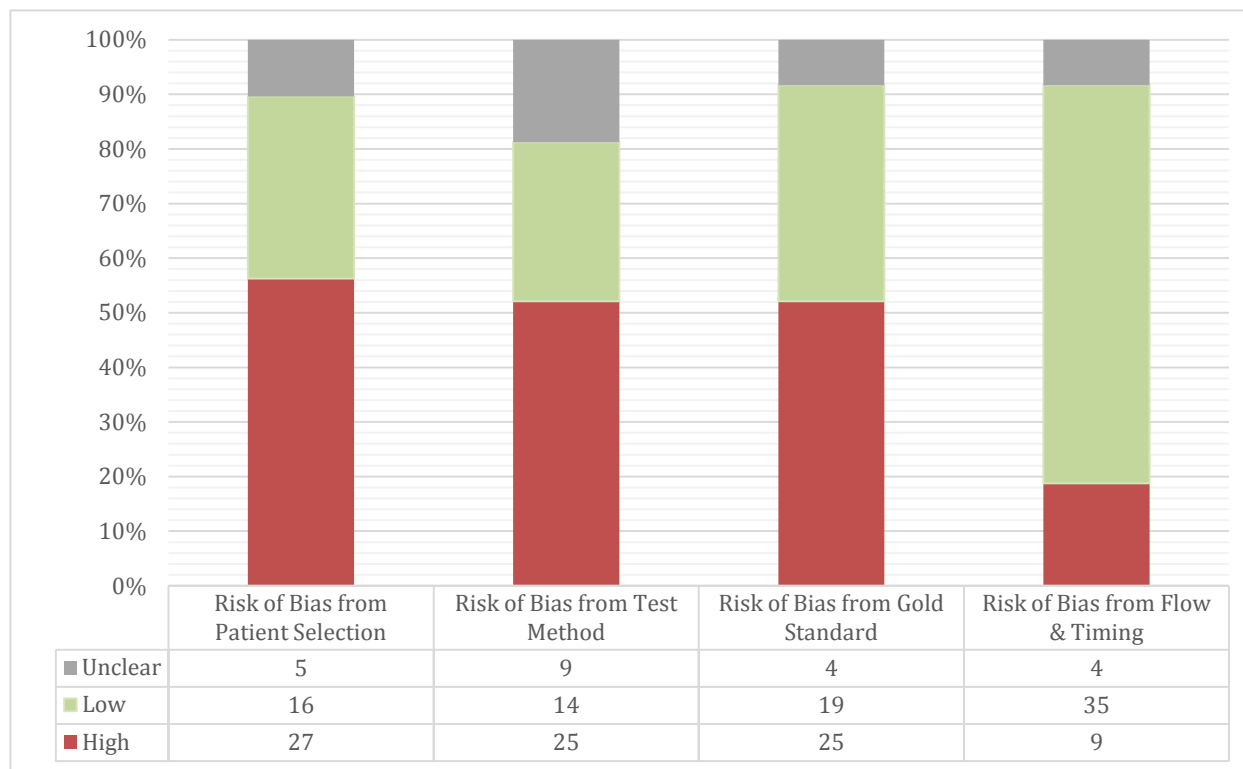
^a Papers may be listed in Table more than once if they contain both neonatal clinical assessment data *and* AVCL or inter-mamillary distance data.

² Alexander 1992, "Ethnic variation in postnatal assessments of gestational age: a reappraisal."

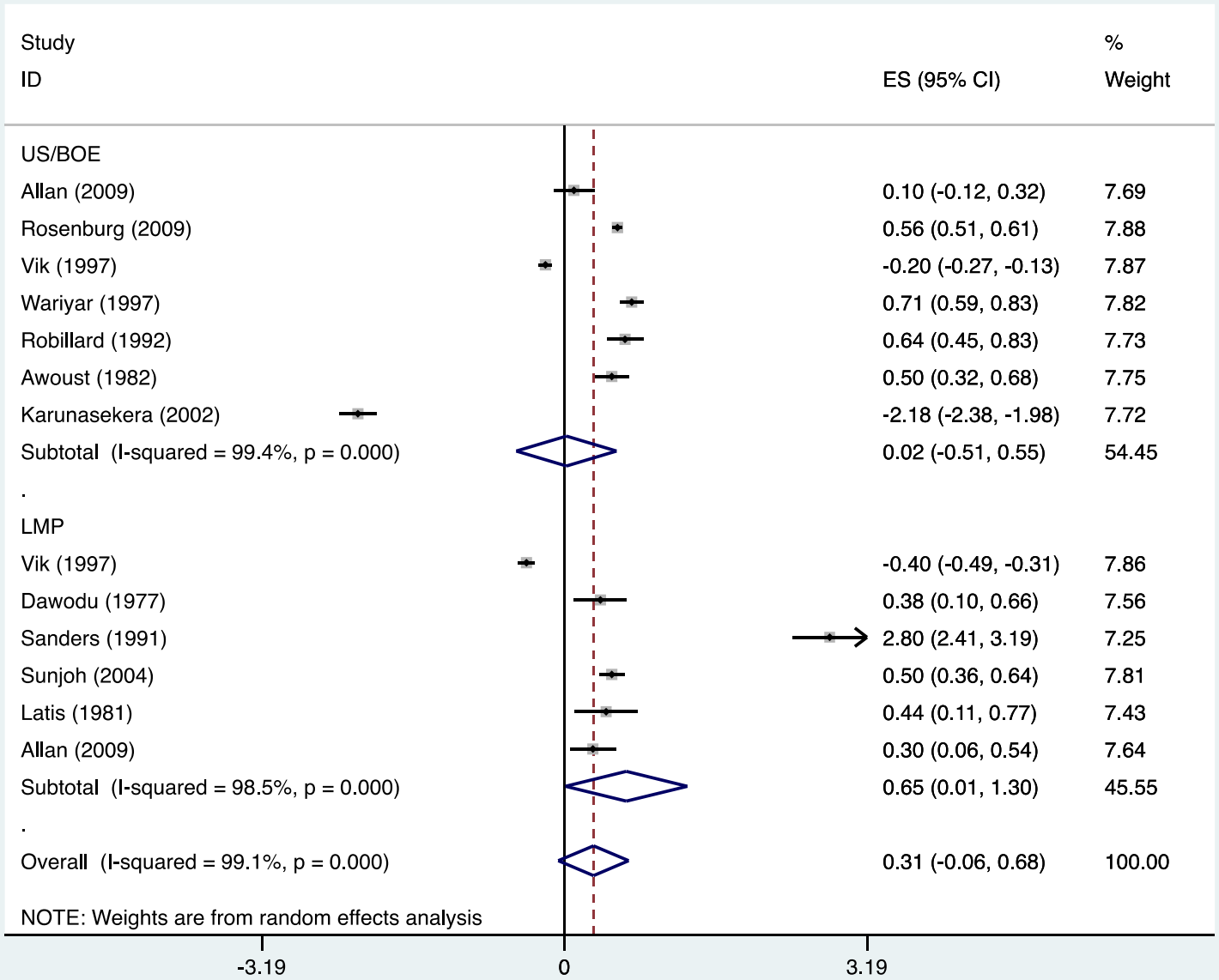
³ Alexander 1992, "Validity of postnatal assessments of gestational age: a comparison of the method of Ballard et al and early ultrasonography"

Web Appendix 6. Neonatal Clinical Assessment QUADAS-2 Summary.

Overall study quality scores on the 4 domains measured by QUADAS-2 (Quality Assessment of Diagnostic Accuracy Studies-2, Whiting et al. 2011) for all neonatal clinical assessment studies (n=48).

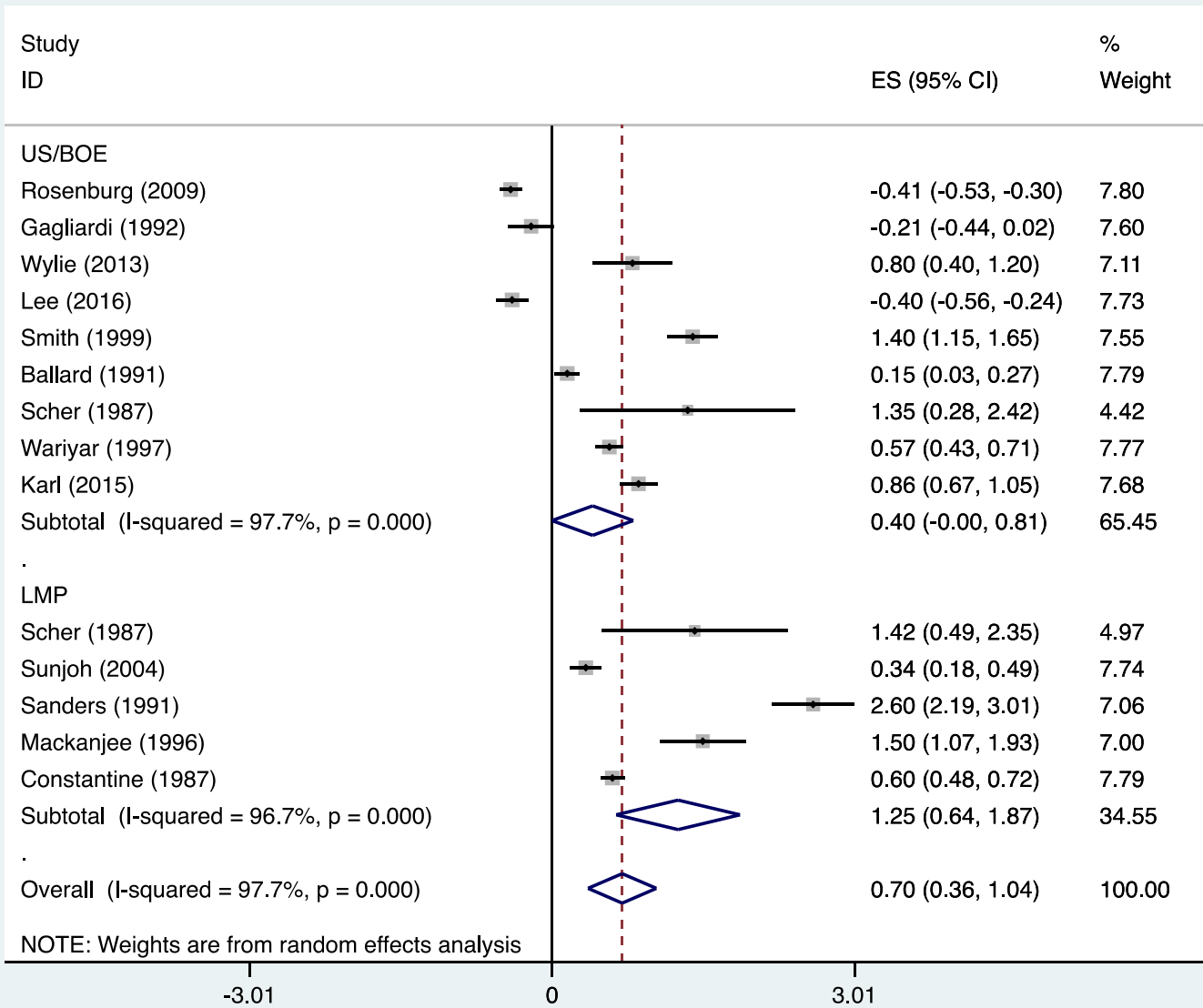


Web Appendix 7a. Forrest Plots of Mean Difference Between Dubowitz Score and Reference Standard Gestational Age



Abbreviations: US= ultrasound, BOE= best obstetric estimate, LMP= last menstrual period, ES= effect size

Web Appendix 7b. Forrest Plots of Mean Difference Between Ballard Score and Reference Standard Gestational Age



Abbreviations: US= ultrasound, BOE= best obstetric estimate, LMP= last menstrual period, ES= effect size

Web Appendix 8. Pooled Data for Agreement and Validity of Neonatal Clinical Assessments, Stratified by Country Income Status

			AGREEMENT								VALIDITY			
			Mean Difference			% within 1 week		% within 2 weeks			Sensitivity		Specificity	
Assessment Type	# of studies identified	Reference Standard	Country Income Level	N	Pooled Difference	Pooled Std. Dev.	N	Pooled %	N	Pooled %	N	Pooled Sensitivity (%) (95% CIs)	Pooled Specificity (%) (95% CIs)	
Dubowitz	9	US/BOE	HIC	5	0.349	1.33	3	48.1	3	74.5	0	61	99	
			LMIC	2	-0.808	0.95	0	0	1					
	20	LMP	HIC	4	0.773	1.50	2	44.7	3	70.5	0	81.5	98.6	
			LMIC	2	0.477	1.33	2	67.5	3	94.4	1			
Ballard	14	US/BOE	HIC	5	0.570	1.49	2	37.2	2	73.9	1	72.2	97.1	
			LMIC	4	0.199	2.12	1	1	3	25.0 (18.0, 33.0)	90.0 (88.0, 91.0)			
	18	LMP	HIC	4	1.525	2.17	2	34.7	2	72.6	1	85	81	
			LMIC	1	1	2	95.0	1	68.0	92.0				
Capurro	4	US/BOE	HIC	0			0		0		0	42.7 (35.6, 50.0)	96.7 (95.7, 97.5)	
			LMIC	2	0.11	1.96	2	40.1	3	79.2	3			

Abbreviations: US/BOE= ultrasound or best obstetric estimate; LMP= last menstrual period; HIC= High-income countries (by World Bank definition); LMIC= low-and-middle-income countries; CI= confidence interval

Web Appendix 9. Bias of Neonatal Assessment for Estimating Gestational Age in Small Babies

Author	Year	Study Setting (district/city, country)	Clinical Assessment	Reference Standard	Bias in Small Babies	
					Preterm Babies	SGA Babies
Moore	2015	Refugee/migrant antenatal clinics, Thai-Myanmar border	Dubowitz	US	Dubowitz overestimated gestational age of preterms. For a preterm infant of 34 weeks (z-score=0), GA was overestimated by 2.57 weeks (95% LOA: 0.49, 4.65). Mean bias decreased as GA increased (bias changed by -0.35 wks for each 1wk increase in GA).	
Robillard	1992	Neonatology Dept, Guadalupe, French W. Indies	Dubowitz	BOE	In a sample of infants <2500g, the Dubowitz overestimated GA in preterm infants, with the highest bias in the lowest GAs (28-32wks).	
Shukla	1987	New York University-affiliated hospitals; New York, USA	Dubowitz	BOE	In a population of AGA preterm infants (n=25), the Dubowitz tended to overestimate GA, and overestimated by >2wks in 50% of infants. Overestimation tended to be greater in lower gestational ages.	
Sunjoh	2004	Neonatology services, Mother and Child Centre, National Social Insurance & Central Hospitals; Yaounde, Cameroon	Dubowitz	LMP	Dubowitz tended to systematically over estimate GA in preterm infants, with greater overestimation in extremely preterm (<28wk, n=11) infants compared to later preterms (28-31wks, n=34; and 32-36wks, n=71). Mean differences for the groups were 1.44wks, 0.59 wks, and 0.61wks respectively.	
Vogt	1981	Tertiary Care Center, Norway	Dubowitz	LMP	The Dubowitz tended to overestimate GA in infants <34wks. Bias increased as GA decreased, with highest overestimation in extremely preterm infants.	
Sanders	1991	NICU, Johns Hopkins Hospital; Baltimore, Maryland, USA	Ballard, Dubowitz	BOE	In infants <34wks and <1500g, both the Ballard and Dubowitz assessments overestimated GA by an average of 2.7 and 3.0 wks, respectively. As GA increased, the degree of overestimation by postnatal assessment decreased.	
Wariyar	1997	Newcastle, UK	Ballard, New Ballard, Dubowitz	US	Among early preterm babies (<30wks GA; n=105), the original Ballard, New Ballard, and Dubowitz assessments all systematically overestimated GA by averages of 3.4, 1.6, and 2.9 wks, respectively.	
Alexander	1992*	Medical University Hospital; Charleston, South Carolina, USA	Ballard	US	The Ballard overestimated GA in infants <37wks, with the proportion of infants in which GA was overestimated by 2 or more weeks increasing as GA decreased, and in the lowest GA range of 28-29wks, the Ballard overestimated GA by 2 or more weeks in ~50% of those infants.	The Ballard tended to underestimate the GA of SGA infants compared to non-SGA infants.
Karl	2015	8 health facilities, Madang municipality, Papua New Guinea	Ballard	US	The Ballard systematically underestimated GA, increasing in lower GAs.	
Lee	2016	Community setting, Sylhet district, Bangladesh	Ballard	US		Ballard tended to systematically underestimate GA in SGA infants (n=230), particularly in the lower GA ranges, equating to a 2.5-wk underestimate in a 36-wk SGA infant).
Constantine	1987	8 states (AK, NY, MA, FL, PA, TX, WA, CN), USA	Ballard	LMP	In a cohort of infants <2500g, the Ballard tended to overestimate GA in infants <37wks, with increased bias towards overestimation in infants <35wks (>1wk).	For SGA babies, bias of the Ballard for GA dating was 1-1.5 weeks lower than for non-SGA infants.
Verhoeff	1997	Chikwawa District Hospital & Montfort Hospital, Southern Region, Malawi	Ballard (External)	LMP	The external Ballard assessment tended to overestimate GA in preterm infants.	
Baumann	1993	University Clinic-Bern, Bern, Switzerland	Ballard	LMP		The correlation of Ballard score with GA was lower among SGA infants (0.66; n=29) compared to AGA infants (0.91; n=60).

*Alexander GR, et al. 1992, Validity of postnatal assessments of gestational age: a comparison of the method of Ballard et al. and early ultrasonography. *Am J Obstet Gynecol*; **166**(3): 891-5.

Abbreviations: SGA= small-for gestational-age; AGA= appropriate-size-for-gestational age; GA= gestational age; US= ultrasound; BOE= best obstetric estimate; LMP= last menstrual period

Web Appendix 10. Other Clinical Assessments

Author	Year	Study Setting (NICU/hospital/clinic, city/district, country)	Sample Size	GA of cohort	AGREEMENT						VALIDITY				
					Comparison Method	Correlation coefficient (R) with true gestational age	Mean difference (wks)	SD of mean diff.	Bland Altman 95% LOA [± 1.96 SD] (LL, UL) [wks]	% within 1 wk	% within 2 wks	Sensitivity <37wk, % (95%CI)	Specificity <37wk, % (95% CI)	<37 wk PPV	<37 wk NPV
ULTRASOUND															
High Income Countries															
Wariyar	1997	Newcastle, UK	347	32-42wks	Parkin		0.29	1.24	(-3.3, 4.1)						
			105	<30wks	Robinson		0.43	1.31	(-2.1, 3.0)						
Low/Middle Income Countries (LMIC)															
Pereira	2013	Primary and tertiary antenatal clinics, Rio de Janeiro State, Brazil	961	All GA	Capurro							61.0	97.0	74.0	95.0
Neufeld	2006	Community-based recruitment, rural villages, Eastern Guatemala	171	All GA	Capurro		-0.48	1.43		44.0	82.0	28.6	97.6	33.3	97.0
Oliveira	1999	Community center & maternity, San Paulo, Brazil	50	NS	Capurro						88.0				
Laveriano (translated)	2014	Instituto Nacional Materno Perinatal, Lima, Peru	167	34-42 weeks	Capurro		0.41		(-2.1, 2.9)						
Lee	2016	Community setting, Sylhet district, Bangladesh	710	All GA	Parkin		-0.70	2.12	(-4.8, 3.5)			10.0	93.0	12.0	92.0
					Bhagwat		-0.90	2.09	(-5.0, 3.2)			18.0	87.0	11.0	92.0
					Eregie		-2.00	1.76	(-5.4, 1.5)			75.0	58.0	14.0	96.0
					Capurro		0.40	2.07	(-3.6, 4.5)	38.0	68.0	5.0	96.0	10.0	92.0
Karunasekera	2002	North Colombo Teaching Hospital, Ragama, Sri Lanka	200	35-42 weeks	Parkin		-0.34	1.29							
Sreekumar	2013	NICU & postnatal wards, St. John's Hospital, Bangalore, India	284	24-41.2 weeks	Parkin		1.50								
LMP															
High Income Countries															
Capurro	1978	Tertiary Care Hospital, Montevideo, Uruguay	115	All GA	Capurro	0.9	SE: 1.14								
Vogt	1981	Neonatal unit, hospital, Oslo, Norway	380	All GA	Parkin				± 6						
Finnstrom	1972	University Hospital, Umea, Sweden	174	All GA	Finnstrom					78.6	100.0				
Low/Middle Income Countries (LMIC)															
Eregie	2000	Tertiary Care Hospital, Benin City, Nigeria	508, 262 ^a	All GA	Eregie	0.921					94.3				
Sunjoh	2004	Neonatology services, Mother and Child Centre, National Social Insurance & Central Hospitals; Yaounde, Cameroon	358	All GA	Eregie	0.933	0.26	1.38			92.4				
Oliveira	1999	Community center & maternity, San Paulo, Brazil	40	All GA	Capurro						72.5				
Cevit	1998	Tertiary Care Center, Sivas, Turkey	91	Preterm LBW	Tuncer		0.80			57.1	93.4				
Tuncer	1981	NICU, Ankara, Turkey	100	27-41wks	Tuncer	0.945									
Bindusha	2014	Tertiary Care Hospital, Kerala, India	1000	28-37 weeks	Bhagwat (Physical)	0.91	-0.58					<36 wk: 97.7%	<36 wk: 68.5%	<36wk: 94.6%	<36wk: 84.2%
Narayanan	1982	Kalawati Saran Children's Hospital, New Dehli, India	356	All GA	Narayanan				± 1.57						
Dubowitz Assessment (as Reference Standard)															
Serfontein	1978	South Africa	73	29-40wks; <2800g	Robinson	0.85									

^aN=508 for correlation; N=262 for % agreement.

An empty cell indicates that the data was not available in that paper. **Abbreviations:** GA= gestational age, SD= standard deviation, LOA= limits of agreement, LL=lower limit, UL=upper limit, CI= confidence interval, PPV= positive predictive value, NPV=negative predictive value, SE= standard error, NS= not stated

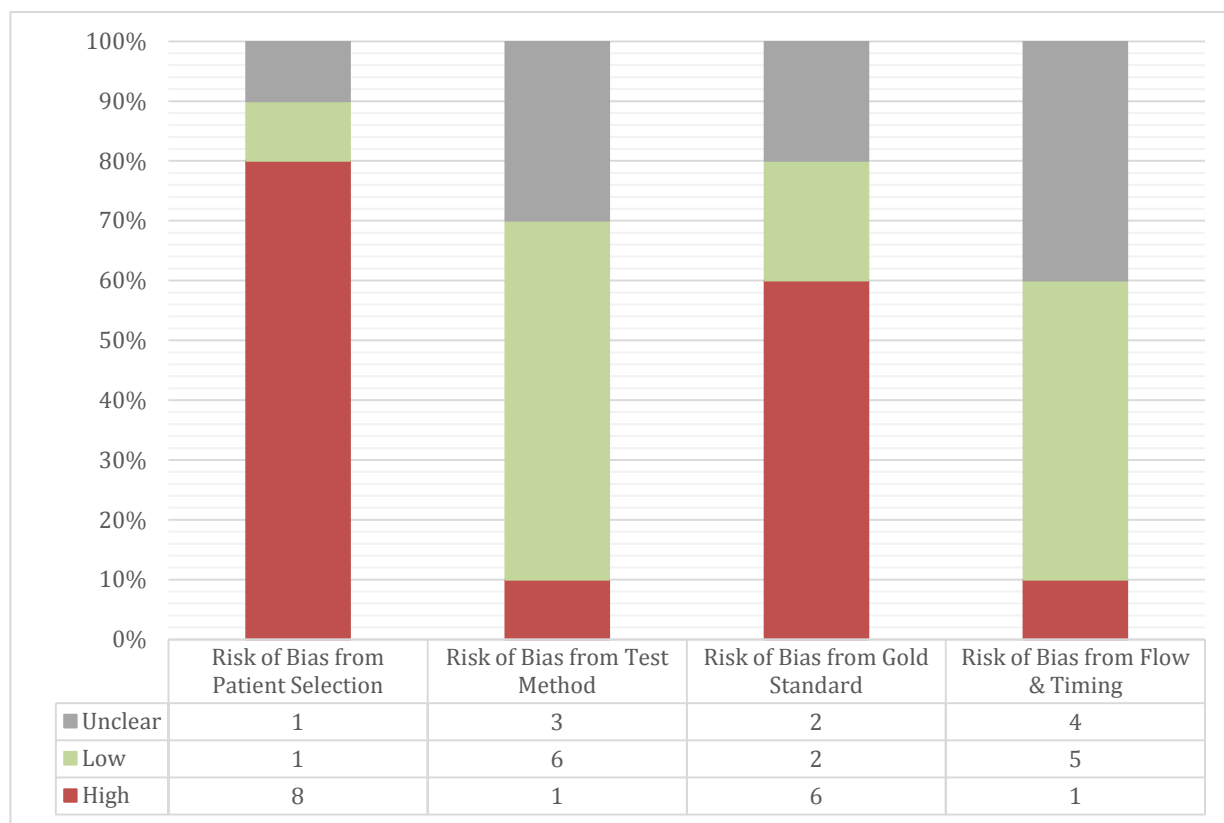
Web Appendix 11. Inter-Rater Reliability

Author	Year	Study Setting (district/city, country)	Sample Size for Inter-Rater	Reference Standard	Neonatal Clinical Assessment	Inter-rater reliability		
						Kappa	Correlation Coefficient	Agreement/Other
Aslan	2000	Tertiary care center, Turkey	387	LMP	Eregie		R= 0.710 (p=0.043)	
Smith	1999	Tertiary care center, USA	10	BOE	Ballard			Spearman rank correlation test of Ballard scores assigned by the 2 examiners found no significant difference between raters (R=0.85)
Ballard	1991	Tertiary care center, USA	67	LMP	New Ballard	0.93 (+/- 1 point)	R=0.95	Agreement (+/- 1 score point): 86%
Moraes (translated)	2000	Tertiary care center, Brazil	52	US	New Ballard	0.74 (CI: 0.49-0.99)		Intra-class correlation (ICC)=0.88 (CIs: 0.78, 0.93)
Lee	2013	Tertiary care hospital, Bangladesh	192	Ballard	Ballard	0.7342		
Sasidharan	2009	Tertiary care center, India	129	LMP	New Ballard			Agreement (on day 7 of life): Mean difference between raters= -0.9 wks (95% LOA: -1.12, 0.93)
Parkin	1976	Tertiary care center, England	101	LMP	Dubowitz			Inter-observer score consistency and score bias was reported for 11 external and 10 neurologic characteristics
Shukla	1987	Tertiary care center, USA	8	BOE	Dubowitz			No statistically significant differences in GA predicted by the 2 examiners (paired t testing = 0.16, P>0.05)
Gagliardi	1992	Tertiary care center, Italy	227	US/LMP	Ballard			Agreement: Mean difference between raters= -0.21 wks (95% LOA: -3.8, 3.1)
Taylor	2010	Community medical station, The Gambia	10	US/LMP	External Ballard		R ² = 0.7	

Abbreviations: LMP= last menstrual period, BOE= best obstetric estimate, US= ultrasound; CI= confidence interval, LOA= limits of agreement, GA= gestational age

Web Appendix 12. Anterior Vascular Capsule of the Lens (AVCL) QUADAS-2 Summary.

Overall study quality scores on the 4 domains measured by QUADAS-2 (Quality Assessment of Diagnostic Accuracy Studies-2, Whiting *et al.* 2011) for all studies assessing AVCL gestational age determination (n=10).



References

1. Macaskill P, Gatsonis C, Deeks J, Harbord R, Takwoingi Y. Chapter 10: Analysing and Presenting Results. In: Deeks JJ, Bossuyt PM, Gatsonis C, eds. *Cochrane Handbook for Systematic Reviews of Diagnostic Test Accuracy* Version 10: The Cochrane Collaboration; 2010.