SUPPLEMENTARY MATERIALS

Supplement 1: Childhood immunization schedule, World Health Organization (WHO), Updated September 2020

Schedule	Vaccine	Route of administration	Site
Birth	BCG (Bacillus Calmette–Guérin)	Intradermal	Left upper arm
	OPV (Oral Polio Vaccine)	Oral drops	Mouth
	Hep B_0	Intramuscular	Antero-lateral aspect of right thigh
6 weeks,	Pentavalent 1 (DPT, Hep B and Hib)	Intramuscular	Antero-lateral aspect of left thigh
	PCV 1 (Pneumococcal Conjugate Vaccine)	Intramuscular	Antero-lateral aspect of right thigh
	OPV 1	Oral drops	Mouth
	Rotavirus vaccine 1	Oral drops	Mouth
10 weeks	Pentavalent 2 (DPT, Hep B and Hib)	Intramuscular	Antero-lateral aspect of left thigh
	PCV 2 (Pneumococcal Conjugate Vaccine)	Intramuscular	Antero-lateral aspect of right thigh
	OPV 2	Oral drops	Mouth
	Rotavirus vaccine 2	Oral drops	Mouth
14 weeks	Pentavalent 3 (DPT, Hep B and Hib)	Intramuscular	Antero-lateral aspect of left thigh
	PCV 3 (Pneumococcal Conjugate Vaccine)	Intramuscular	Antero-lateral aspect of left thigh
	OPV 3	Oral drops	Mouth
	Rotavirus vaccine 3	Oral drops	Mouth
6 months	Vitamin A (1st dose)	Oral drops	Mouth
9 months	Measles vaccine (MCV1)	Subcutaneous	Left upper arm
	Yellow fever	Subcutaneous	Left upper arm
12 months	Vitamin A (2nd dose)	Oral drops	Mouth
	Meningitis	Intramuscular	Antero-lateral aspect of left thigh
18 months	Measles vaccine (MCV2)	Subcutaneous	Left upper arm

Culled from Table 2: Summary of WHO Position Papers - Recommended Routine Immunizations for Children, World Health Organization (WHO), updated September 2020: https://www.who.int/immunization/policy/Immunization_routine_table2.pdf

Supplement 2: Inclusion and exclusion criteria for studies evaluating effectiveness of mobile-phone reminders on routine immunization in LMICs.

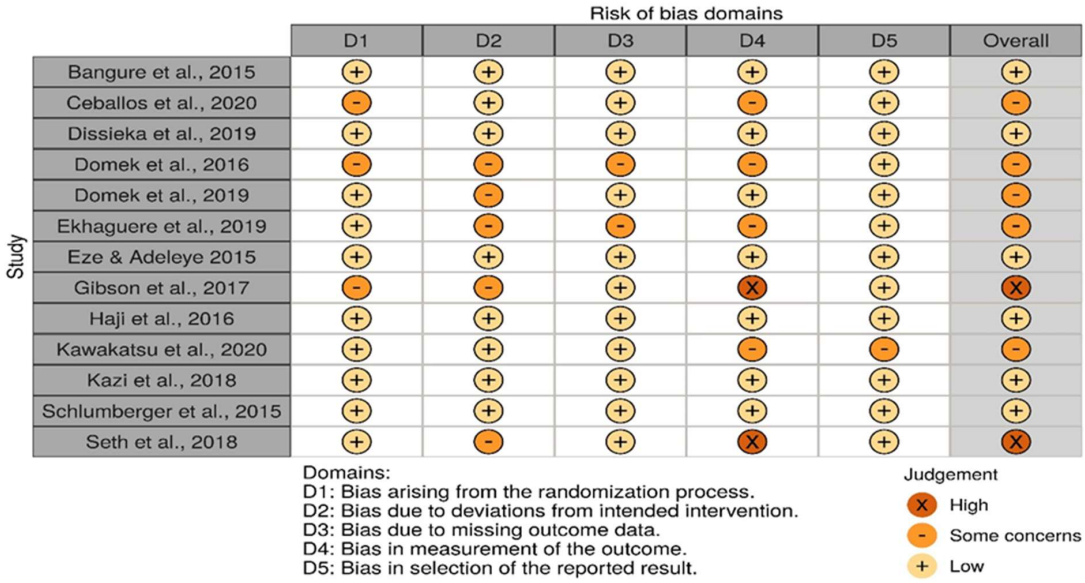
	Inclusion criteria	Exclusion criteria
Population	Infants less than 24 months of age	Children > 24 months of age
	Low- and middle-income countries	High-income countries
	Children for routine immunization of DPT-1 or Penta-1, DPT-2 or Penta-2, DPT-3 or Penta-3 and Measles vaccine	Children for immunization for BCG, Rabies, Vitamin A supplementation, PCV, and Rotavirus,
Intervention	Mobile-phone reminders: Short message service (SMS) or text message reminders	Phone call, E-mails, or Multi-media service (MMS) reminders
		Letters and paper correspondence
		Smartphone-based apps
Comparison	Traditional reminder practices including informing the mother of the next vaccination appointment, or writing on the immunization card	Absence of comparator arm or the comparator arm not traditional reminder practice
Outcome	Coverage for DPT-3, Penta-3, or overall immunization	
Study	Randomized controlled trials, Cluster randomized trials, and Quasi-experimental studies	Observational studies (Cross-sectional, Case-control, Retrospective studies), Reviews, Study protocols
	Published and unpublished (Grey) literature	
	Full study available	Conference abstracts, Retracted studies

Supplement 3: Search strategy and terms

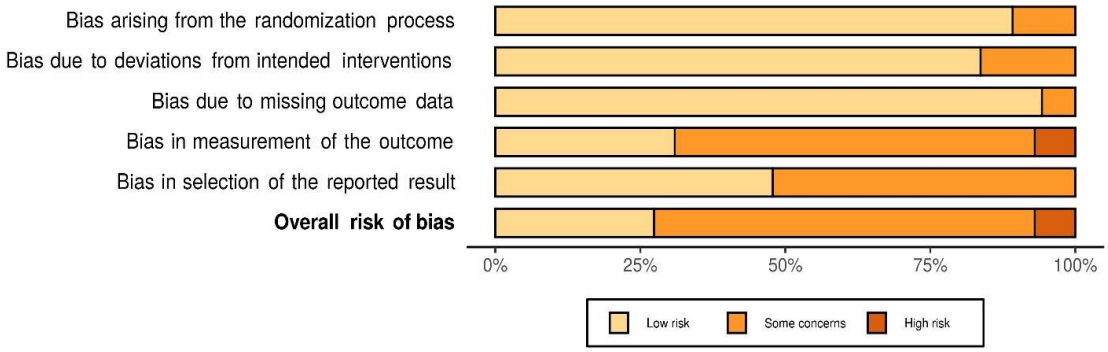
PubMed / MEDLINE	**Results****
Search: ("text messag*"[MeSH Terms] OR "text messag*"[All Fields] OR "telemedicine"[MeSH Terms] OR ("health"[MeSH Terms] OR "health"[All Fields] OR "health s"[All Fields] OR "healthful"[All Fields] OR "healthfulness"[All Fields] OR "healths"[All Fields]) OR "reminder systems"[MeSH Terms] OR ("reminder systems"[MeSH Terms] OR ("reminder"[All Fields] AND "systems"[All Fields]) OR "reminder systems"[All Fields]) OR "messag*"[All Fields]) AND ("routine"[All Fields] OR "routinely"[All Fields] OR "routines"[All Fields] OR "routinization"[All Fields] OR "routinize"[All Fields] OR "routinized"[All Fields] OR "routinizing"[All Fields]) AND ("immune"[All Fields] OR "immuned"[All Fields] OR "immunes"[All Fields] OR "immunisation"[All Fields] OR "vaccination"[MeSH Terms] OR "vaccination"[All Fields] OR "immunization"[All Fields] OR "immunization"[MeSH Terms] OR "immunisations"[All Fields] OR "immunizations"[All Fields] OR "immunise"[All Fields] OR "immunised"[All Fields] OR "immuniser"[All Fields] OR "immunisers"[All Fields] OR "immunising"[All Fields] OR "immunities"[All Fields] OR "immunity"[MeSH Terms] OR "immunity"[All Fields] OR "immunization s"[All Fields] OR "immunize"[All Fields] OR "immunized"[All Fields] OR "immunizer"[All Fields] OR "immunizers"[All Fields] OR "immunizes"[All Fields] OR "immunizing"[All Fields]) AND ("Afghanistan" OR "Albania" OR "Algeria" OR "American Samoa" OR "Angola" OR "Argentina" OR "Armenia" OR "Azerbaijan" OR "Bangladesh" OR "Belarus" OR "Belize" OR "Benin" OR "Bhutan" OR "Bolivia" OR "Bosnia and Herzegovina" OR "Botswana" OR "Brazil" OR "Bulgaria" OR "Burkina Faso" OR "Burundi" OR "Cabo Verde" OR "Cambodia" OR "Cameroon" OR "Central African Republic" OR "Chad" OR "China" OR "Colombia" OR "Comoros" OR "Congo Democratic Republic" OR "Congo Republic" OR "Costa Rica" OR "Côte d'Ivoire" OR "Cuba" OR "Djibouti" OR "Dominica" OR "Dominican Republic" OR "Ecuador" OR "Egypt" OR "El Salvador" OR "Equatorial Guinea" OR "Eritrea" OR "Eswatini" OR "Ethiopia" OR "Fiji" OR "Gabon" OR "The Gambia" OR "Georgia" OR "Ghana" OR "Grenada" OR "Guatemala" OR "Guinea" OR "Guinea-Bissau" OR "Guyana" OR "Haiti" OR "Honduras" OR "India" OR "Indonesia" OR "Iran, Islamic Republic" OR "Iraq" OR "Jamaica" OR "Jordan" OR "Kazakhstan" OR "Kenya" OR "Kiribati" OR "Korea, Democratic People's Republic" OR "Kosovo" OR "Kyrgyz Republic" OR "Lao PDR" OR "Lebanon" OR "Lesotho" OR "Liberia" OR "Libya" OR "Madagascar" OR "Malawi" OR "Malaysia" OR "Maldives" OR "Mali" OR "Marshall Islands" OR "Mauritania" OR "Mexico" OR "Micronesia" OR "Moldova" OR "Mongolia" OR "Montenegro" OR "Morocco" OR "Mozambique" OR "Myanmar" OR "Namibia" OR "Nepal" OR "Nicaragua" OR "Niger" OR "Nigeria" OR "North Macedonia" OR "Pakistan" OR "Papua New Guinea" OR "Paraguay" OR "Peru" OR "Philippines" OR "Russian Federation" OR "Rwanda" OR "Samoa" OR "São Tomé and Principe" OR "Senegal" OR "Serbia" OR "Sierra Leone" OR "Solomon Islands" OR "Somalia" OR "South Africa" OR "South Sudan" OR "Sri Lanka" OR "St. Lucia" OR "St. Vincent and the Grenadines" OR "Sudan" OR "Suriname" OR "Syrian Arab Republic" OR "Tajikistan" OR "Tanzania" OR "Thailand" OR "Timor-Leste" OR "Togo" OR "Tonga" OR "Tunisia" OR "Turkey" OR "Turkmenistan" OR "Tuvalu" OR "Uganda" OR "Ukraine" OR "Uzbekistan" OR "Vanuatu" OR "Venezuela" OR "Vietnam" OR "West Bank and Gaza" OR "Yemen Republic" OR "Zambia" OR "Zimbabwe") Filters: from 2000 - 2020	3,012
Other databases	
◦ CINAHL (Cumulative Index of Nursing and Allied Health Literature)	879
◦ Cochrane CENTRAL	36
◦ CNKI (China National Knowledge Infrastructure)	241
◦ Embase (Excerpta Medica Database)	623
◦ PsycINFO	489
◦ Scopus	164
◦ Web of Science	36
TOTAL SEARCH RESULT	**5,480**

** Search period was from 01 January 2000 to 31 December 2020.

Supplement 4: Cochrane RoB 2.0 risk of bias assessment and internal validity of included randomized controlled trials. (A): Assessment plot. (B): Summary plot

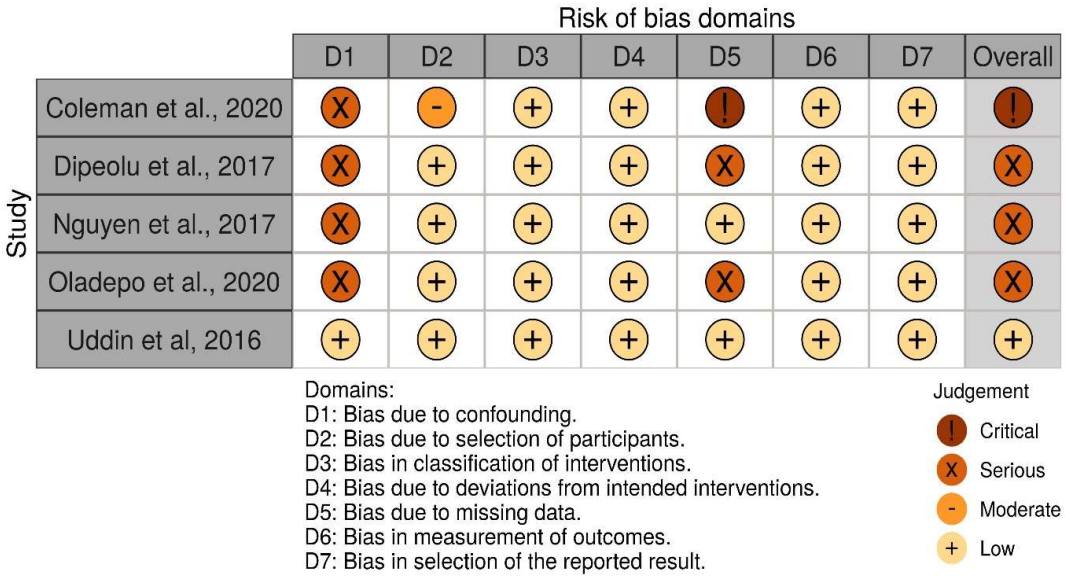


A: Assessment plot for risk of bias across five domains

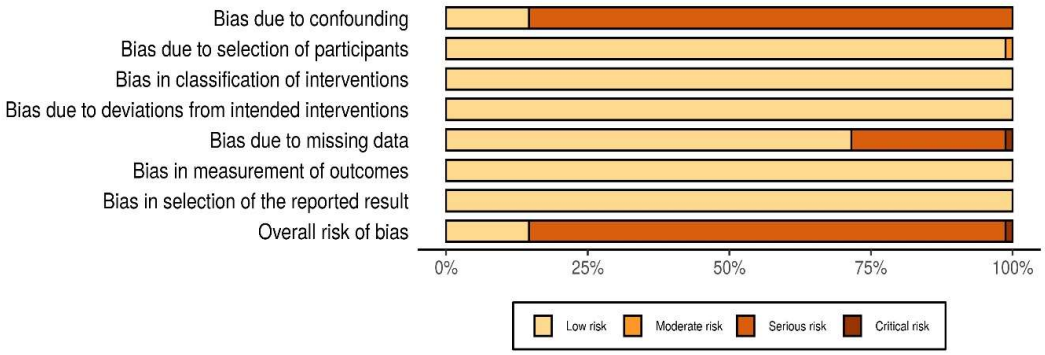


B: Summary plot using the sample size of included studies as weight.

Supplement 5: Cochrane ROBINS-I risk of bias assessment and internal validity of included Non-randomized controlled trials. (A): Assessment plot. (B): Summary plot

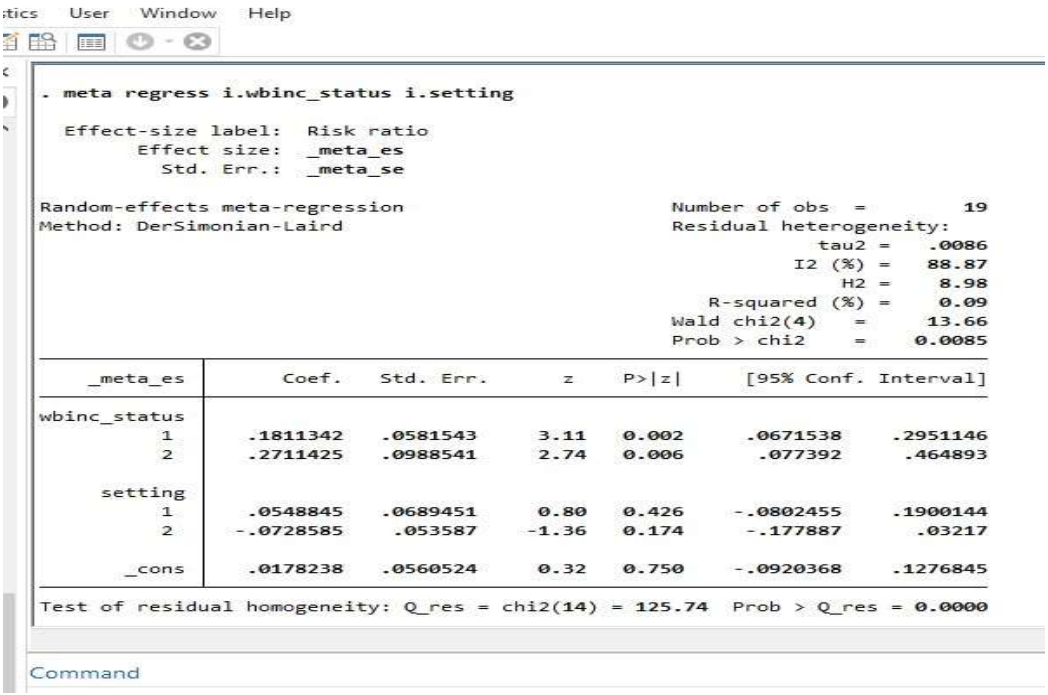


A: Assessment plot for risk of bias across seven domains



B: Summary plot using the sample size of included studies as weight.

Supplement 6: STATA output of Meta-regression analysis for Routine immunization Coverage.

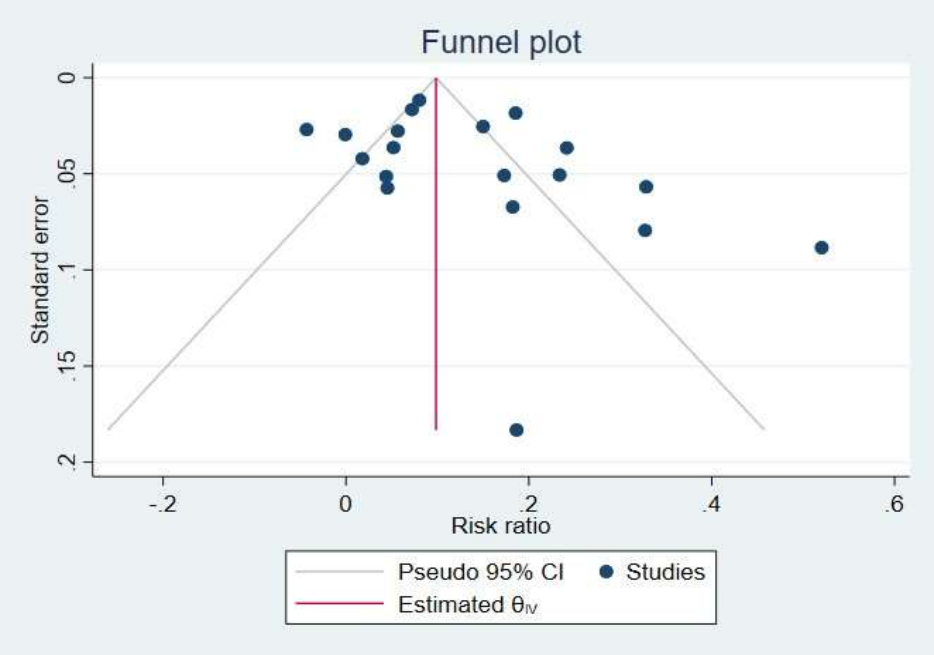


```
itics   User   Window   Help

. meta regress i.wbinc_status i.setting

  Effect-size label:  Risk ratio
        Effect size:  _meta_es
          Std. Err.:  _meta_se

Random-effects meta-regression                  Number of obs   =         19
Method: DerSimonian-Laird                       Residual heterogeneity:
                                                          tau2  =     .0086
                                                       I2 (%)   =    88.87
                                                          H2    =     8.98
                                                R-squared (%)   =     0.09
                                                Wald chi2(4)    =    13.66
                                                Prob > chi2     =   0.0085

------------------------------------------------------------------------------
    _meta_es |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
wbinc_status |
           1 |   .1811342   .0581543     3.11   0.002     .0671538    .2951146
           2 |   .2711425   .0988541     2.74   0.006      .077392     .464893
             |
     setting |
           1 |   .0548845   .0689451     0.80   0.426    -.0802455    .1900144
           2 |  -.0728585    .053587    -1.36   0.174     -.177887     .03217
             |
       _cons |   .0178238   .0560524     0.32   0.750    -.0920368    .1276845
------------------------------------------------------------------------------
Test of residual homogeneity: Q_res = chi2(14) = 125.74  Prob > Q_res = 0.0000

Command
```

LEGEND: Variable **wbinc_status** refers to income status of countries based on 2020 World Bank classification. Reference group is wbinc_status 0: upper middle-income country; and setting 0: urban setting.

- wbinc_status 1: Lower middle-income country;
- wbinc_status 2: Low-income country
- setting 1: mixed setting
- setting 2: rural setting

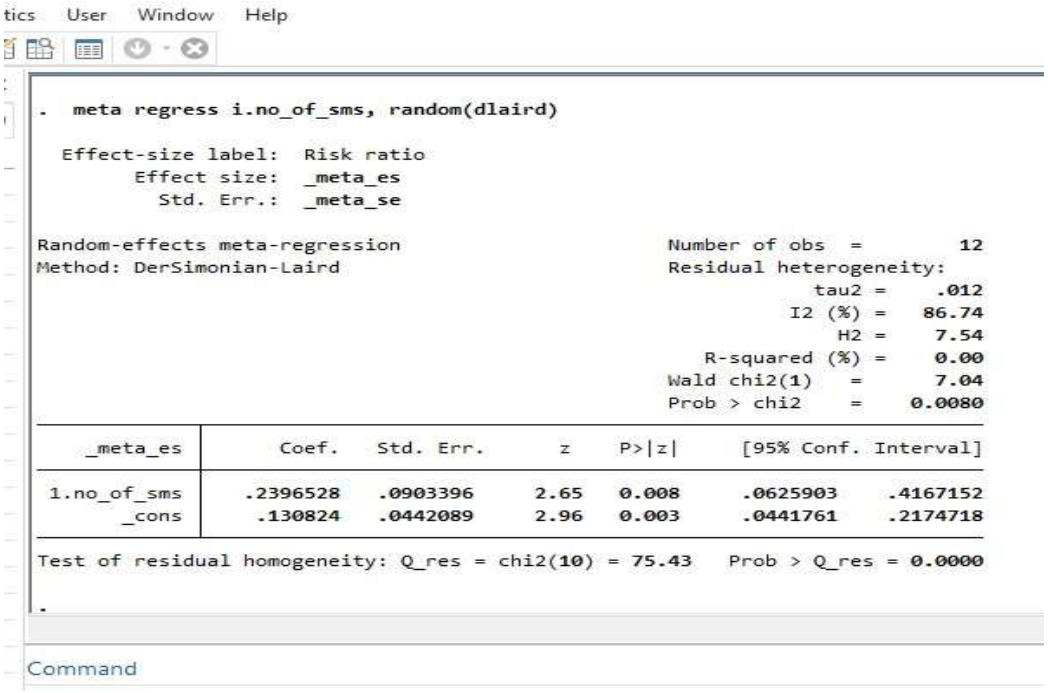
Supplement 7: Funnle plot graph of publication bias assessment (Immunization coverage).



Supplement 8: STATA output of Harbord test to assess publication bias in included studies (Immunization coverage).

```
. meta bias i.wbinc_status i.design i.setting i.no_of_sms i.last_sms_sent i.quality, harbord

  Effect-size label:  Risk ratio
        Effect size:  _meta_es
          Std. Err.:  _meta_se

Regression-based Harbord test for small-study effects
Random-effects model
Method: DerSimonian-Laird
Moderators: wbinc_status design setting no_of_sms last_sms_sent quality

H0: beta1 = 0; no small-study effects
            beta1 =      1.02
      SE of beta1 =     0.813
                z =      1.26
       Prob > |z| =    0.2088
```

Supplement 9: STATA output of Meta-regression analysis for Routine immunization Timeliness.

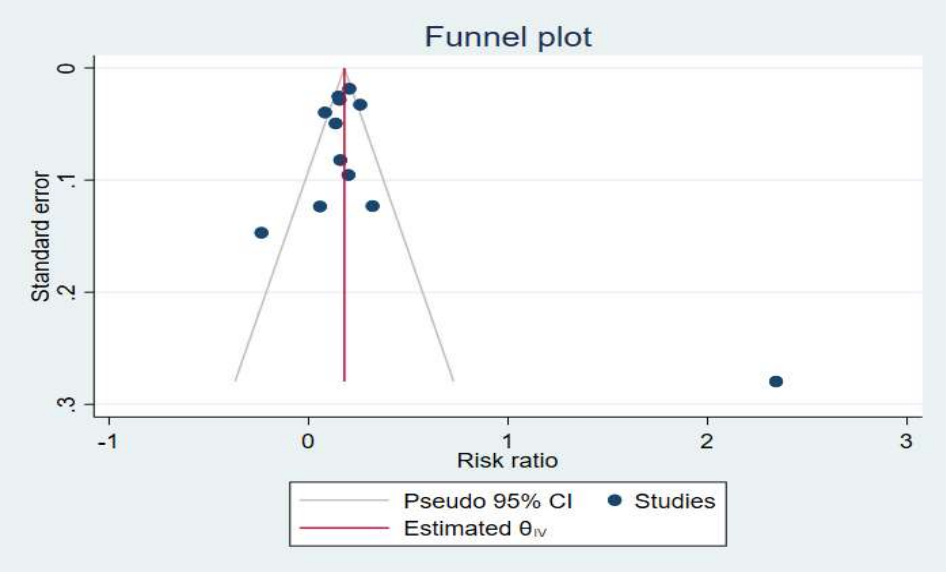


```
tics   User   Window   Help

.  meta regress i.no_of_sms, random(dlaird)

  Effect-size label:  Risk ratio
        Effect size:  _meta_es
          Std. Err.:  _meta_se

Random-effects meta-regression                  Number of obs  =        12
Method: DerSimonian-Laird                       Residual heterogeneity:
                                                          tau2 =      .012
                                                       I2 (%)  =    86.74
                                                          H2   =     7.54
                                                R-squared (%)  =     0.00
                                                Wald chi2(1)   =     7.04
                                                Prob > chi2    =   0.0080
------------------------------------------------------------------------------
    _meta_es |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 1.no_of_sms |   .2396528   .0903396     2.65   0.008     .0625903    .4167152
       _cons |    .130824   .0442089     2.96   0.003     .0441761    .2174718
------------------------------------------------------------------------------
Test of residual homogeneity: Q_res = chi2(10) = 75.43   Prob > Q_res = 0.0000

.

Command
```

LEGEND: no_of_sms refers to the number of SMS reminders sent prior to the appointment
Reference group is no_of_sms 0: sent only one or two SMS reminders.

- no_of_sms 1: sent more than two SMS reminders.

Supplement 10: Funnle plot graph of publication bias assessment (Immunization timeliness)



Supplement 11: STATA output of Harbord test to assess publication bias in included studies (Immunization timeliness)

```
. meta bias i.wbinc_status i.design i.setting i.outcome i.definition i.no_of_sms i.last_sms_sent i.quality, harbord

  Effect-size label: Risk ratio
        Effect size: _meta_es
          Std. err.: _meta_se

Regression-based Harbord test for small-study effects
Random-effects model
Method: DerSimonian-Laird
Moderators: wbinc_status design setting outcome definition no_of_sms last_sms_sent quality

H0: beta1 = 0; no small-study effects
            beta1 =     54.01
      SE of beta1 =   146.568
                z =      0.37
       Prob > |z| =    0.7125
```

Supplement 12: GRADE assessment of the certainty of evidence in included studies (Immunization coverage and timeliness)

Author(s): Paul Eze, Lucky Osaheni Lawani, and Yubraj Acharya
Question: SMS reminders compared to Usual care for improving childhood immunization coverage and timeliness
Setting: Low- and middle-income countries (LMIC)
Bibliography:

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	SMS reminders	Usual care	Relative (95% CI)	Absolute (95% CI)		
Immunization coverage (follow up: mean 9 months; assessed with: change in childhood immunization coverage)												
13	randomised trials	serious [a]	serious [b]	not serious	not serious	strong association	6296/8685 (72.5%)	4876/7291 (66.9%)	**RR 1.13** (1.06 to 1.20)	**87 more per 1,000** (from 40 more to 134 more)	⨁⨁⨁◯ MODERATE	CRITICAL
Immunization coverage (follow up: mean 9 months; assessed with: change in childhood immunization coverage)												
6	observational studies	serious [c]	serious [d]	not serious	not serious	all plausible residual confounding would reduce the demonstrated effect	5742/7134 (80.5%)	4919/7062 (69.7%)	**RR 1.22** (1.12 to 1.32)	**153 more per 1,000** (from 84 more to 223 more)	⨁⨁⨁◯ MODERATE	CRITICAL
Immunization timeliness (follow up: mean 9 months; assessed with: change in timely completion of immunization)												
10	randomised trials	serious [e]	serious [f]	not serious	not serious	strong association dose response gradient	3615/7355 (49.2%)	2561/5932 (43.2%)	**RR 1.21** (1.09 to 1.34)	**91 more per 1,000** (from 39 more to 147 more)	⨁⨁⨁⨁ HIGH	IMPORTANT
Immunization timeliness (follow up: mean 9 months; assessed with: change in timely completion of immunization)												
2	observational studies	not serious	not serious	not serious	not serious	strong association all plausible residual confounding would reduce the demonstrated effect dose response gradient	4143/5828 (71.1%)	3611/5747 (62.8%)	**RR 1.25** (1.19 to 1.32)	**157 more per 1,000** (from 119 more to 201 more)	⨁⨁⨁⨁ HIGH	IMPORTANT

CI: Confidence interval; **RR:** Risk ratio

Explanations

a. Based on weighted risk using trials' sample size, 30% of the included RCTs were rated as having a low risk of bias, about 60% as having some concerns, and about 10% high risk of bias
b. High heterogeneity as evidenced by I-square = 89.6% and little overlapping of confidence intervals of included trials
c. Based on weighted risk using trials' sample size, 15% of the included non-RCTs were rated as having a low risk of bias, 82% as having serious risk of bias, and about 3% critical risk of bias
d. High heterogeneity as evidenced by I-square = 92.2% and little overlapping of confidence intervals of included trials
e. Based on weighted risk using trials' sample size, 30% of the included RCTs were rated as having a low risk of bias, about 60% as having some concerns, and about 10% high risk of bias
f. High heterogeneity as evidenced by I-square = 87.9% and little overlapping of confidence intervals of included trials