How well do mothers recall their own and their infants' perinatal events? a two-district study using cross-sectional stratified random sampling in Bihar, India

Journal:	BMJ Open
Manuscript ID	bmjopen-2019-031289.R3
Article Type:	Research
Date Submitted by the Author:	n/a
Complete List of Authors:	Valadez, Joseph; Liverpool School of Tropical Medicine, International Public Health Devkota, Baburam; Liverpool School of Tropical Medicine, International Public Health Jeffery, Caroline; Liverpool School of Tropical Medicine Hadden, Wilbur; University of Maryland at College Park, Sociology
Primary Subject Heading :	Global health
Secondary Subject Heading:	Epidemiology, Global health, Public health, Research methods
Keywords:	Public health < INFECTIOUS DISEASES, maternal recall, Bihar, India, perinatal, surveys, LQAS
	·



BMJ Open

1		
2		
3 4	1	
5	2	
6	3	How well do mothers recall their own and their infants' perinatal events? a two-district
7	4	study using cross-sectional stratified random sampling in Bihar, India
8	5	
9	6	
10	7	
 10	8	Joseph J Valadez ^{1*} , Baburam Devkota ¹ , Caroline Jeffery ¹ , Wilbur C. Hadden ²
12	9	
14	10	¹ Department of International Public Health, Liverpool School of Tropical Medicine,
15	11	Liverpool, United Kingdom
16	10	2 Demontry out of Contan Contan for Investigation University of Mandau J. UCA
17	12	² Department of Sociology, Center for Innovation, University of Maryland, USA
18	13	* Corresponding author: Professor Joseph J Valadez, Department of International Public
20	14	Health Liverpool School of Tropical Medicine Pembroke Place Liverpool L3 50A
21	15	United Kingdom Email: joseph valadez@lstmed ac uk: Mobile: +44(0)754 8523717
22	16	
23	10	
24	17	Manuscript word length: 2255
25	18	
20 27		
27		
29		
30		
31		
32		
33		
34 35		
36		
37		
38		
39		
40		
41		
42 43		
44		
45		
46		
47		
48 40		
49 50		
51		
52		
53		
54		
55		
56 57		
57		

1	Abstract
23	Objective: Global monitoring of maternal, newborn and child
4	health (MNCH) programmes use self-reported data subject to
5	recall error which may lead to incorrect decisions for
6	improving health services and wasted resources. To minimize
7	this risk, samples of mothers of infants aged 0-2 and 3-5 $$
8	months are sometimes used. We test whether a single sample
9	of mothers of infants 0-5 months provides the same
10	information.
11	Design: An annual MNCH household survey in 2-districts of
12	Bihar, India (N=6million).
13	Participants: Independent samples (n=475 each) of mothers
14	of infants $0-5$, $0-2$ and $3-5$ months.
15	Outcome measures: Main analyses compare responses from the
16	0-5 and 0-2 month samples with Mantel-Haenszel-Cochran
17	statistics using 51 indicators in 2-districts.
18	Results: No measurable differences detected in 79.4%
19	(81/102) comparisons; 20.6% (21/102) display differences
20	for the main comparison. Sub-analyses produce similar
21	results. A difference detected for exclusive breastfeeding
22	is due to premature complementary-feeding by older infants.
23	Measurable differences were detected in 33% (8/24) of the
24	indicators on Front Line Worker (FLW) support, 26.9% (7/26)
25	of indicators of birth preparedness and place of birth and

Page 3 of 78

BMJ Open

2	1	
4	I	attendant, and 9.5% (4/42) of the indicators on neonatal
5 6	2	and antenatal care.
7 8 9 10 11 12 13	3	Conclusions: Differences in FLW visits and compliance with
	4	their advice may be due to seasonal effects: mothers of
	5	older infants 3-5 months were pregnant during the dry
14 15	6	season; mothers of infants 0-2 months were pregnant during
16 17	7	the monsoons, making transportation difficult. Useful
18 19	8	coverage estimates can be obtained by sampling mothers with
20 21	9	infants 0-5 months as with two samples suggesting that
22 23 24	10	mothers of young infants recall their own perinatal events
25 26	11	and those of their children. For some indicators (e.g.,
27 28	12	exclusive breast feeding) it may be necessary to adjust
29 30	13	targets. Excessive stratification wastes resources, does
31 32 33	14	not improve the quality of information, and increases the
34 35	15	burden placed on data collectors and communities, which can
36 37	16	increase non-sampling error.
38 39	17	
40 41	10	
42 43	18	STRENGTHS AND LIMITATIONS OF THIS STUDY
44 45	19	• Strength: The data were produced using stratified random sampling with no apparent
46 47	20	design effect leading to an efficient use of information.
48 49	21	• Strength: Data were collected from female participants by female data collectors
50 51 52 53 54 55	22	which is likely to have reduced non-sampling error.

1	• Strength: The large study population covers a large geographical area, reducing the
2	likelihood that the results are pertinent only to a small group of mothers with infants,
3	and may be generalizable.
4	• Strength: Both weighted and unweighted results are presented giving strength to the
5	conclusions.
6	• Limitation: Due to insufficient overlap of variables in the 0-5 month sample and
7	the 3-5 month sample, comparison between the 3-5 month sample vis a vis the
8	0-5 month sample was not possible.
9	Key Words:
10	Maternal recall, surveys, maternal health, MNCH, LQAS,
11	Bihar, India
12	
13	INTRODUCTION
13 14	INTRODUCTION The progress toward United Nations' Sustainable Development
13 14 15	INTRODUCTION The progress toward United Nations' Sustainable Development Goal (SDG) 3 is measured with 9 targets, including the
13 14 15 16	INTRODUCTION The progress toward United Nations' Sustainable Development Goal (SDG) 3 is measured with 9 targets, including the Maternal Mortality Ratio (MMR) and the under 5 mortality
13 14 15 16 17	INTRODUCTION The progress toward United Nations' Sustainable Development Goal (SDG) 3 is measured with 9 targets, including the Maternal Mortality Ratio (MMR) and the under 5 mortality rate (U5MR) (1, 2). In India, Bihar is one of the largest
13 14 15 16 17 18	<pre>INTRODUCTION The progress toward United Nations' Sustainable Development Goal (SDG) 3 is measured with 9 targets, including the Maternal Mortality Ratio (MMR) and the under 5 mortality rate (U5MR) (1, 2). In India, Bihar is one of the largest (population 110 million) and poorest (53% of households are</pre>
13 14 15 16 17 18 19	<pre>INTRODUCTION The progress toward United Nations' Sustainable Development Goal (SDG) 3 is measured with 9 targets, including the Maternal Mortality Ratio (MMR) and the under 5 mortality rate (U5MR) (1, 2). In India, Bihar is one of the largest (population 110 million) and poorest (53% of households are in the lowest wealth index quintile of India (3)) states</pre>
13 14 15 16 17 18 19 20	<pre>NTRODUCTION The progress toward United Nations' Sustainable Development Goal (SDG) 3 is measured with 9 targets, including the Maternal Mortality Ratio (MMR) and the under 5 mortality rate (U5MR) (1, 2). In India, Bihar is one of the largest (population 110 million) and poorest (53% of households are in the lowest wealth index quintile of India (3)) states with high child and maternal mortality (U5MR=54,</pre>
13 14 15 16 17 18 19 20 21	<pre>NTRODUCTION The progress toward United Nations' Sustainable Development Goal (SDG) 3 is measured with 9 targets, including the Maternal Mortality Ratio (MMR) and the under 5 mortality rate (U5MR) (1, 2). In India, Bihar is one of the largest (population 110 million) and poorest (53% of households are in the lowest wealth index quintile of India (3)) states with high child and maternal mortality (U5MR=54, MMR=208)(4), and is a priority for donor support for health</pre>
 13 14 15 16 17 18 19 20 21 22 	<pre>HTRODUCTION The progress toward United Nations' Sustainable Development Goal (SDG) 3 is measured with 9 targets, including the Maternal Mortality Ratio (MMR) and the under 5 mortality rate (U5MR) (1, 2). In India, Bihar is one of the largest (population 110 million) and poorest (53% of households are in the lowest wealth index quintile of India (3)) states with high child and maternal mortality (U5MR=54, MMR=208)(4), and is a priority for donor support for health systems strengthening (see (5) for an evaluation of the</pre>
 13 14 15 16 17 18 19 20 21 22 23 	<pre>HTRODUCTION The progress toward United Nations' Sustainable Development Goal (SDG) 3 is measured with 9 targets, including the Maternal Mortality Ratio (MMR) and the under 5 mortality rate (U5MR) (1, 2). In India, Bihar is one of the largest (population 110 million) and poorest (53% of households are in the lowest wealth index quintile of India (3)) states with high child and maternal mortality (U5MR=54, MMR=208)(4), and is a priority for donor support for health systems strengthening (see (5) for an evaluation of the health care system in Bihar).</pre>

BMJ Open

2		
3 4	1	To accelerate progress toward achieving SDG 3, state
5 6	2	governments in India pursue programmes of community-based
7 8	3	care (see (6, 7) for descriptions and assessments of this
9 10 11	4	approach). Since 2011, the Bihar Ministry of Health has
12 13	5	supported an Integrated Family Health Initiative to improve
14 15	6	the availability, quality and use of prenatal, perinatal
16 17	7	and postnatal care for mothers and infants (8).
18 19	8	The usual way to monitor progress toward achieving these
20 21 22	9	goals is with household surveys. Perhaps the most commonly
23 24	10	used surveys are cluster sample surveys such as the
25 26	11	Demographic and Health Surveys and the Multiple Indicator
27 28 20	12	Cluster Surveys (9, 10). An alternative design is Lot
29 30 31	13	Quality Assurance Sampling (LQAS), which provides
32 33	14	comparable data but is decentralized to local health
34 35	15	services organisations and more useful for management and
36 37 38	16	programme planning(11). Several states in India find it
39 40	17	benefits their programs (12). Surveys rely on the reports
41 42	18	of mothers of infants and young children, but these reports
43 44 45	19	are subject to several sources of potential error and bias
45 46 47	20	through interviewees not knowing, forgetting, and having
48 49	21	memory errors (13, 14). Studies have shown both that
50 51	22	mothers can accurately report significant facts about the
52 53 54	23	birth and care of their children many years after the event
55 56	24	(15), but also that even immediately after giving birth
57		

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

mothers may misreport details (16-18). Studies of mothers recall of their children's vaccination status concluded that due to offsetting errors of maternal reports, the resulting data accurately measured vaccination rates (19); the pattern of error revealed that mothers whose children are up-to-date or nearly so tended to underestimate their child's vaccination status whilst mothers whose children have few vaccinations, overestimate their coverage. To improve the validity of collected data, knowledge, practice and coverage surveys have used samples of mothers of infants 0-11 months of age or 0-5 months of age and children 6-11 months of age. In Bihar, local organisations departed from this convention of sampling among these three cohorts of children under one year of age and have been monitoring their programs' progress by sampling five dedicated cohorts: mothers of children 0-2, 3-5, 6-8, 9-11and 12-23 months old with indicators focused on antenatal care, safe delivery practices, infant and young child feeding practices, immunisation, treatment seeking, and more. To avoid the possibility of maternal recall error, each of the five cohorts was asked questions particularly relevant to a child's specific age group. In countries such as India with high maternal and

24 child mortality rates, regular monitoring of related health

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

3 4	1	service coverage is critical to reducing these rates.
5 6	2	However, survey designs should be affordable and
7 8	3	sustainable for local health systems; they should also
9 10 11	4	produce precise, unbiased estimates (20). In this study, we
11 12 13	5	explore whether information is gained by sampling cohorts
14 15	6	of children aged $0-2$ and $3-5$ months or whether sample sizes
16 17	7	can be reduced by 50% by creating one sample cohort aged 0-
18 19	8	5 months.
20 21 22	9	The research question we address is: "Do the health service
23 24	10	delivery coverage estimates from a sample of mothers of
25 26	11	infants aged 0-5 months differ from those obtained from a
27 28	12	sample of mothers of infants ages 0-2 months?" A corollary
29 30 31	13	to this question is: "Do mothers of infants 3-5 months of
32 33	14	age display more recall error relative to mothers of
34 35	15	infants 0-2 months of age for antenatal, delivery or young
36 37	16	infant health practices?" We compare district coverage
38 39 40	17	estimates obtained from two independent samples of infants
40 41 42	18	0-2 months and 0-5 months of age. The implications of this
43 44	19	study are important for health systems researchers needing
45 46	20	results to appraise and improve their programmes.
47 48	_ •	

METHODS

To answer this question, we collected information from a sample of mothers with infants 0-5 months old and a sample

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Page 8 of 78

3	1	of mothers with infants $0-2$ month old in two districts.
5 6	2	This study took place within the context of a larger survey
7 8	3	that also sampled children 3-5, 6-8, 9-11 and 12-23 months
9 10	4	of age. These four latter samples used questionnaires with
11 12 13	5	variables that either did not overlap at all or overlapped
14 15	6	on very few indicators with the questionnaires used to
16 17	7	interview the $0-5$ month and $0-2$ month samples. Due to this
18 19	8	constraint, in this study, we only use the two
20 21 22	9	aforementioned groups to assess the measurement of the
23 24	10	indicators and refer only to them for the remainder of this
25 26	11	paper. The household sampling design we used is a
27 28	12	stratified random sample (21). Within each district, the
29 30 21	13	strata are administrative units of the health system, which
32 33	14	in Bihar is called a <i>block</i> . Within each block the primary
34 35	15	sampling unit is the Anganwadi Centre (Community Health
36 37	16	Subcentre) Catchment Area (ACCA); 19 ACCA are selected from each block
38 39	17	with probability proportional to size From each ACCA one respondent is
40 41 42	10	wan producting proportional to size. From each and model and respondence in
42 43	18	randomly selected from each age-group under study using
44 45	19	segmentation sampling (22, 23). The sample size 19 for each block is
46 47	20	chosen to maximize the probability of correctly classifying a block with reference to
48 49 50	21	performance targets on health related indicators (95% reliability) while balancing the
51 52	22	probability (10% margin of error) of incorrectly classifying a block and thereby
53 54 55	23	failing to recognize either the accomplishments of local health care delivery systems or
56 57		

Page 9 of 78

BMJ Open

3 4	1	the local population's health care needs (22). For this purpose, principles of Lot Quality
5 6	2	Assurance Sampling were used along with established probability tables (24-26).
7 8	3	There are 14 and 11 blocks in Gopalganj and Aurangabad (N=6 $$
9 10 11	4	million), the two districts selected for this study,
12 13	5	respectively. The total sample sizes are: (a) Gopalganj: 19
14 15	6	x 14 blocks= 266 infants 0-2 months and 266 infants 0-5
16 17	7	months, and (b) Aurangabad: 19 x 11 blocks= 209 infants 0-2
18 19 20	8	months and 209 infants 0-5 months. The 0-5 month old sample
21 22	9	is 60% 0-2 months old and 40% 3-5 months old.
23 24	10	Using summary data from each of the two samples we analyse
25 26 27	11	the data with Cochran-Mantel-Haenszel (CMH) (27) tests for
27 28 29	12	51 dichotomous indicators (See Supplementary File Table S1)
30 31	13	common to the two samples. The CMH tests theoretically have
32 33	14	a Chi-square probability distribution with 1 degree of
34 35 36	15	freedom. With a sufficient number of respondents or a
37 38	16	sufficient number of blocks the CMH test is equivalent to a
39 40	17	conditional logistic regression (28: 114-115). In this
41 42	18	analysis both the number of respondents and the number of
43 44 45	19	blocks only approach sufficiency. Consequently, the
46 47	20	calculated chi-squares and probabilities must be considered
48 49	21	as approximations of their true values.
50 51	22	We calculate both unweighted and weighted estimates. The
52 53 54	23	unweighted estimates permit the results from smaller blocks
55 56	24	to have equal weight vis à vis larger ones. Since the
57 58		

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

3
4
5
6
7
8
9
10
11
12
13
14
15
16
1/
18
19
20
∠ ı วว
22
25
24 25
25
20
27
20
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1 2

1	research question concerns an analysis of which age cohort
2	is most informative, the weighted estimates may not be as
3	useful as the unweighted ones. However, the weighted
4	estimates provide better point estimates of the indicators
5	at the district level. The effect of the weights on the
6	Chi-square statistics is to increase the contribution of
7	the larger blocks and decrease the contribution of the
8	smaller blocks. Hence, we report both sets of results (See
9	Supplementary File Tables S2-S3).
10	The Chi-square probability distribution puts the
11	differences between the districts on a probability scale
12	(See Supplementary File Table S2). To determine meaningful
13	differences in responses between the two age cohorts we
14	used a probability of 0.05 as a cut-off value and consider
15	differences with probabilities less than 0.05 to be
16	possibly meaningful and those with larger probabilities to
17	be likely due to sampling errors. With 102 comparisons (51
18	indicators weighted or unweighted) we must expect some to
19	exceed this cut-off by chance alone. If all of the
20	comparisons were independent, we might randomly find 5
21	differences, but many of the indicators measure related
22	events (e.g., number of ANC visits and tetanus toxoid
23	vaccinations) and the weighted and unweighted estimates are
24	similar, so these indicators are not all independent and it

BMJ Open

1	is not possible to calculate an expected number of
2	differences nor is it appropriate to interpret these
3	probabilities as measures of "statistical significance".
4	Patient and Public Involvement
5	This study does not involve patients. Also, the public was
6	not involved in the design, conduct and reporting of the
7	research. The public was engaged as interviewees. To
8	ensure local engagement we coordinated with the Bihar
9	Ministry of Health, local implementing non-governmental
10	organizations and our donor. We also shared the results
11	with them and offered further dissemination of results.
12	RESULTS
13	We find a high level of agreement between the two samples
14	(Table 1). Out of 102 weighted and unweighted comparisons
15	between the estimates from the $0-2$ month and $0-5$ month
16	samples there is no probable difference in 81 (79.4%) in
17	both the unweighted and weighted estimates. We detect that
18	probable differences exist for 13 comparisons (12.7%). For
18 19	probable differences exist for 13 comparisons (12.7%). For the remaining eight comparisons the weighted and unweighted
18 19 20	probable differences exist for 13 comparisons (12.7%). For the remaining eight comparisons the weighted and unweighted estimates disagree. The weighted estimates find seven
18 19 20 21	probable differences exist for 13 comparisons (12.7%). For the remaining eight comparisons the weighted and unweighted estimates disagree. The weighted estimates find seven differences that the unweighted estimates do not; the
18 19 20 21 22	probable differences exist for 13 comparisons (12.7%). For the remaining eight comparisons the weighted and unweighted estimates disagree. The weighted estimates find seven differences that the unweighted estimates do not; the unweighted estimates find one difference that the weighted
18 19 20 21 22 23	probable differences exist for 13 comparisons (12.7%). For the remaining eight comparisons the weighted and unweighted estimates disagree. The weighted estimates find seven differences that the unweighted estimates do not; the unweighted estimates find one difference that the weighted estimates do not find.

2	
3	
4	
5	
6	
7	
, 8	
0	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
20 21	
∠ I วว	
22	
23	
24	
25	
26	
27	
28	
29	
30	
21	
22	
32	
33	
34	
35	
36	
37	
38	
39	
40	
д 0 //1	
41 42	
42	
43	
44	
45	
46	
47	
48	
49	
50	
50	
51	
52	
53	
54	
55	
56	

	Table 1. Numbe	r of india	cators b	by probat	pility c	of a	
	difference bet	ween the (J-2 mont	ths and t	the $0-5$	months	
	Samples for we	ignted and	unweig	Mojaht	ipres		
	Unwergnied	Auranca	had	Conalga	ea ni	Total	
		Auranya		GOPAIYA	.11J * 05	iotai	05
		05	.05	05	•05	05	• 0 0
	>= .05	40	.3	41	4	81	7
	< .05	0	8	1	5	1	13
2 3							
4	For different h	nealth ser	vice do:	mains, th	ne numbe	er of	
5	indicator compa	arisons va	ries fr	om two (I	Exclusiv	ve	
6	Breastfeeding-E	CBF) to 24	concer	ning home	e visit:	s by Fron	t
7	Line Worker (FI	W) suppor	t (Tabl	e 2). Th	ne two p	principal	FLW
8	are Anganwadi w	orkers and	d Accre	dited So	cial Hea	alth	
9	Activists (ASHA	A).					

3		
4		
5		
6	_	
7		
8		
9		
10	-	
11		
12		
13		
14		
15		
17		
18	-	
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33 24		
25		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		

Table 2. Number of ind	icator comparison	s by subject dom	main showing a m	neasurable
difference using weigh	ted and unweighte	d estimates of C	0-2 months and 0)-5 months
samples				
			11 1'CC	

Health Service Domain	Total	No measurable	Me	asurable	differend	ce between
	compariso	difference		0-2 and $0-$	5 months	results
	ns	between	Both	Unweight	Weight	Percent (%)
		0-2 and		ed only	ed	indicators
		0-5 months			only	with
		results				different
						results
Antenatal care	22	21	0	0	1	5
Place of birth & attendant	8	6	1	0	1	25
Birth preparedness	18	13	3	0	2	28
Front Line Worker support	24	16	6	0	2	33
Maternal health	8	8	0	0	0	0
Neonatal care	20	17	1	1	1	15
Exclusive Breastfeeding	2	0	2	0	0	100
Totals	102	81	13	1	7	21.9

Page 14 of 78

1	
2	In the FLW support domain 33% of comparisons have probable
3	differences. The neonatal health domain has 20 comparisons
4	and the birth preparedness domain has 18; in these domains
5	15% and 28% show probable differences, respectively. Place
6	of birth and attendant, and maternal health each have eight
7	comparisons with 25%, or two comparisons, and 0
8	comparisons, respectively, showing a possible difference.
ç	The differences between the two samples cluster around home
10	visits from FLW and behaviours associated with birth
11	preparedness and neonatal care. Details of these
12	differences are listed in Table 3.
13	For two indicators, both the weighted and unweighted
14	estimates display probable differences between the 0-2 and
15	0-5 months samples in both districts. For indicator $#52$,
16	the proportion exclusively breastfeeding, the 0-5 months
17	cohort has the lower estimate, and indicator $\#24$, the
18	proportion of mothers visited by an ASHA at least once
19	during their last pregnancy, the 0-5 months sample gives
20	the higher estimate, about 74%, compared to 63% in the 0-2 $$
21	months sample (See Supplementary Tables S2-3).
22	
23	Additional analyses comparing subsamples of mothers of
24	infants 0-2 months and 3-5 months from the 0-5 months
	For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

1		
2 3 4	1	sample, the sample of mothers of infants $0-2$ months and the
5 6	2	subsample of infants 0-2 month, and the sample of mothers
7 8	3	of infants 3-5 months and the subsample of infants $3-5$
9 10 11	4	months produced similar results (See Supplementary Text and
12 13	5	Tables S4a-b, Tables S5a-b and Table S6).
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59		For beer terien only

Page 16 of 78

	Indica		Weig Covera	hted ge (%)	p-va.	lue	
Health Service Domain and Indicator	tor No.	District	0-2 months	0-5 months	Unweighte d Estimate	Weighte d Estimat e	Estimate type
Antenatal care							
Proportion of mothers of infants (0-2/0-5 months) registered during their last pregnancy	1	Aurangabad	85.2	77.6	0.0552	0.0365	Weighted
Place of birth & attendant							
Proportion of mothers of infants (0-2/0-5 months) whose last child was delivered at a public facility	38	Gopalganj	51.2	61.6	0.0363	0.0159	Both
Proportion of mothers of infants (0-2/0-5 months) whose last child was delivered at a health facility (private or public facility)	37	Gopalganj	78.9	85.5	0.0643	0.0459	Weighted
Birth preparedness						1	
Proportion of mothers of infants (0-2/0-5 months) who planned transportation to health facility in their last pregnancy (home & institutional delivery)	15	Gopalganj	45.7	56.0	0.0266	0.0158	Both
Proportion of mothers of infants $(0-2/0-5 \text{ months})$ who identified persons to care for the baby immediately after birth (home + institutional delivery)	17	Gopalganj	51.8	62.6	0.0255	0.0103	Both
Proportion of mothers of infants (0-2/0-5 months) who planned for institutional delivery and	23	Aurangabad	62.5	47.0	0.0039	0.0052	Both

Page 17 of 78

 BMJ Open

her during the delivery							
Proportion of mothers who planned for institutional delivery of infants (0-2/0-5 months) who had a new blade & thread for their delivery	19	Aurangabad	23.5	14.5	0.062	0.0429	Weig
Proportion of mothers who planned institutional delivery of infants (0-2/0-5 months) who arranged clean cloth for mothers and baby	21	Aurangabad	43.6	31.2	0.0546	0.0137	Weigh
Front Line Worker support		1					
Proportion of mothers of infants	24	Aurangabad	62.2	75.2	0.0023	0.0042	Bot
visited by ASHA at least once during their last pregnancy	0	Gopalganj	63.5	73.0	0.0284	0.0175	Bot
Proportion of mothers of infants (0-2/0-5 months) visited at home by FLWs at least once during their last pregnancy	26	Aurangabad	63.5	76.7	0.0021	0.0032	Bot
Proportion of mothers of infants (0-2/0-5 months) visited at home by ASHA within 24 hours of last delivery	31	Aurangabad	29.9	44.9	0.0009	0.0016	Bot
Proportion of mothers of infants (0-2/0-5 months) visited at home by any FLW within 24 hours of last delivery	33	Aurangabad	32.2	46.7	0.0015	0.0026	Bot
Proportion of mothers of infants (0-2/0-5 months) visited at home by any FLW within first week of last delivery	35	Aurangabad	44.5	59.3	0.0018	0.0026	Bot
Proportion of mothers of infants $(0-2/0-5 \text{ months})$ visited at home by any AWW within the first week of the last delivery	34	Gopalganj	14.4	8.9	0.0959	0.0471	Weigł
Proportion of mothers of infants (0-2/0-5 months) visited by	27	Gopalganj	52.6	61.1	0.0617	0.0449	Weigl

BMJ	Open
-----	------

ASHAs at least once during their last trimester of pregnancy							
Infant care		1 1					1
Proportion of infants aged (0-	51	Aurangabad	78.0	45.4	0.0001	0.0006	Both
2/0-5 months) who were delivered at home continued with dry cord care		Gopalganj	63.7	41.1	0.0431	0.0627	Unweighte d
Proportion of infants aged (0- 2/0-5 months) weighed after birth (Public facility/Private facility/Home)	48	Gopalganj	70.7	78.2	0.0727	0.0464	Weighted
Exclusive Breastfeeding							
Proportion of infants (0-2/0-5	52	Aurangabad	69.2	59.7	0.0229	0.0411	Both
months) breast-fed in the past 24 hours (Exclusively Breast- Fed)	5	Gopalganj	82.1	68.4	0.0001	0.0003	Both

1		
2	_	
5 4	1	
5		
6	2	DISCUSSION
7	2	DISCOSION
8		
9 10	3	Statement of principal findings
10		
12	4	There are no measurable differences in coverage estimates
13		
14	5	for 79.4% (81 comparisons) of the indicator comparisons
15	6	
10	6	between the samples of mothers with infants 0-2 months old
18	7	
19	/	versus mothers of infants U-5 months old; 12.1% (13
20	8	comparisons) display measurable differences. The remaining
21	0	comparisons) display measurable differences. The remaining
22	9	7.8% (eight comparisons) display discrepancies between the
24		1.0% (eight comparisons) display discrepancies between the
25	10	weighted and unweighted estimates.
26	10	
27		
28 29	11	Strengths and weaknesses of the study
30		
31	12	The strengths of this study are that it compares estimates
32	10	
33	13	from two independent samples and that there are many
34	14	actimates from diverse demains. The weaknesses of this
36	14	eschilaces from diverse domains. The weaknesses of this
37	15	study are that the data were collected in only 2 districts
38	10	Study are that the data were corrected in only 2 districts
39	16	of 1 state in India and in different months of a single
40 41	-	
42	17	year, and that indicators from the sample of mothers of 3-5
43		
44	18	month old infants comparable to those of the 0-2 month old
45 46		
40 47	19	infants, using the same questionnaire, were not collected.
48		
49	20	Supplemental analyses comparing 0-2 and 3-5 month
50	0.1	
51	21	subsamples of the 0-5 sample did not uncover evidence of
52	22	bies due to the combination of these two and means
54	22	DIAS QUE LO LHE COMDINALION OF CHESE TWO AGE GROUPS.
55		
56		
57 58		
59		
60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Strengths and weaknesses in relation to other studies Other studies of maternal recall bias have sought a "gold standard" to represent reality and to evaluate measures. Our study, of course, is interested in reality, but this study compares alternative measures needed to assess the Bihar health program. It also uses a complete sample of the age grouping under study rather than just a sub-sample of a larger age grouping. A weakness of this approach is that the analysis does not result in a formal statistical test; our conclusion is based on the weight of the evidence.

12 Meaning of the study

The evidence indicates that samples of the broader group yield comparable results to those of the narrower age group. It is not necessary to double the total sample by measuring independently 0-2 months and 3-5 months cohorts of children. These results also tend to dispel the hypothesis that maternal recall is problematic for mothers during the first 6 months following delivery. Our results are more consistent with conclusions presented in earlier research (15) and they support those organizations collecting data with 0-5 month cohorts.

BMJ Open

3 4	1	Indicator #52, EBF, displayed two comparisons measuring
5 6	2	decreases in both districts. This is not surprising as
7 8	3	fewer infants are expected to be exclusively breast fed in
9 10 11	4	a sample ranging from 0 to 5 months than a sample ranging 0
12 13	5	to 2 months; mothers introduce complementary feeding and
14 15	6	liquids as infants age despite this being a health risk.
16 17	7	This difference could be accommodated by adjusting
18 19 20	8	expectations and targets for the indicator.
21 22 23	9	Unanswered questions and future research
24 25	10	Further investigation and consideration of the differences
26 27	11	is warranted. The eight differences found in the FLW
28 29	12	support indicators deserve more scrutiny. Seven show higher
30 31 32	13	estimates for the 0-5 cohort and one has a higher estimate
33 34	14	for the 0-2 month cohort. The former seven differences may
35 36	15	be due to excessive rainfall during the July-September
37 38 39	16	(monthly average 318.95mm, range:195.99-395.8mm) versus the
40 41	17	lesser rainfall during June-April (monthly average 25.52mm,
42 43	18	range: 0.3-27.88mm) which in the last trimester may have
44 45 46	19	reduced the access of ASHA in the 0-2 month cohort (29).
40 47 48	20	Indicators such as these may be particularly sensitive to
49 50	21	rainfall and may explain why more mothers in the 0-5 month
51 52 53	22	cohort displayed higher FLW visitation estimates since FLW

Page 22 of 78

	BMJ Open
1	were not impeded by the monsoon and the resulting muddy
2	roads.
3	Differences in birth preparedness and institutional birth
4	may be a consequence of differences in rainfall or in FLW
5	support; the results signal a need for more careful
6	planning when transportation is difficult and decreases the
7	effectiveness of FLW by reducing their access to women. Or,
8	some of these differences may just be due to noise in the
9	data.
10	
11	CONCLUSIONS
12	Overall, the answer to the research question, "Can one get
13	the same district coverage estimates from a sample of
14	mothers of infants aged 0-5 months as from a sample of
15	mothers of infants ages 0-2 months?" is yes. This result
16	can be paraphrased as: mothers do not display increased
17	recall errors of their perinatal health care behaviour in a
18	cohort of mothers with infants 0-5 months as compared with
19	mothers with younger infants. Substantial resources and
20	effort can be saved using a survey design that avoids
21	needless expenses to collect data that provides
22	insubstantial amounts of information. It also reduces the
23	burden on data collectors and community participants.
	For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

1									
2 3	1	Fatique to	hoth	arouns	Can	rogult	in	noodloss	non-sampling
4	1	racigue co	DOCII	groups	Call	IESUIC	T 11	IIEEUTESS	non sampring
5 6	2	error.							
7									
8									
9 10									
11									
12 13									
14									
15									
16 17									
18									
19 20									
20 21									
22									
23 24									
25									
26									
27 28									
29									
30 31									
32									
33									
34 35									
36									
37 38									
39									
40 41									
42									
43									
44 45									
46									
47 48									
48 49									
50									
51 52									
53									
54 55									
56									
57									
58 59									
60		For	peer revie	w only - htt	p://bm	jopen.bmj.c	om/si	te/about/guide	lines.xhtml

ACKNOWLEDGMENTS

We gratefully acknowledge the essential roles of Hemant Das, Alok Prahdan and Sanjay Biswa for their careful field work supporting the LQAS survey and the HMIS data retrieval. We thank Prof Imelda Bates, Prof Brian Faragher and Nancy Vollmer for their valuable feedback on an earlier version of this manuscript. This work was supported by the Bill and Melinda Gates Foundation (Investment ID OPP1142889).

ETHICS

The Ethical Committees of the Indian Institute of Public Health (No IIPHB-IEC-2016/010) and the Liverpool School of Tropical Medicine Research Ethics Committee approved the protocol, study instruments and consent procedures for the data collection of the household surveys (Research Protocol 16-023).

COMPETING INTERESTS

The authors have read the statement on competing interests and declare that they have none.

AUTHORS' CONTRIBUTIONS

JJV, BD developed the research question and survey design; WH, CJ carried out the statistical analyses; JJV obtained the funding and donor support for the research; BD trained and managed the survey teams in Bihar; JJV, WH, CJ interpreted the data; CJ responsible for data curation; all authors wrote and reviewed the paper.

FUNDING

This research was funded by the Bill and Melinda Gates Foundation Investment ID OPP1142889

DATA SHARING STATEMENT

Data are available upon reasonable request.

REFERENCES

1. UNSTATS. Official list of MDG indicators: United Nations Statistics Division, Department of Economic and Social Affairs; 2005 [Available from:

https://unstats.un.org/unsd/mdg/Host.aspx?Content=Indicators/OfficialList.htm.

2. UN DESA. Sustainable Development Goals: Division for Sustainable Development Goals, United Nations Department of Economic and Social Affairs; 2015 [Available from: <u>https://www.un.org/sustainabledevelopment/sustainable-development-goals/</u>.

3. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-4), 2015-16: India. Mumbai: IIPS; 2017.

4. MOSPI. Millennium Development Goals India Country Report 2015. New Delhi: Social Statistics Division, Central Statistics Office, Ministry of Statistics and Programme Implementation; 2015.

5. Karvande S, Sonawane D, Chavan S, Mistry N. What does quality of care mean for maternal health providers from two vulnerable states of India? Case study of Bihar and Jharkhand. Journal of Health, Population and Nutrition. 2016;35(6):1-10.

6. Mohan P, Kishore B, Singh S, Bahl R, Puri A, Kumar R. Assessment of implementation of integrated management of neonatal and childhood illness in India. Journal of Health, Population and Nutrition. 2011;29(6):639-38.

7. Neogi SB, Sharma J, Chauhan M, Khanna R, Chokshi M, Srivastava, et al. Care of newborn in the community and at home. Journal of Perinatology. 2016;36(Suppl 3):s13-7.

8. CARE Family Health. Integrated Family Health Initiative: Catalysing change for healthy communities. 2013.

9. Blanc AK, Warren CE, McCarthy KJ, Kimani J, Ndwiga C, RamaRao S. Assessing the validity of indicators of the quality of maternal and newborn health care in Kenya. Journal of Global Health. 2016;6(1):1-11.

10. Eisele TP, Rhoda DA, Cutts FT, Keating J, Ren R, Barros AJD, et al. Measuring coverage in MNCH: Total survey error and the interpretation of intervention coverage estimates from household surveys. PLoS Medicine. 2013;10(5):e1001386.

11. Anoke SC, Mwai P, Jeffery C, Valadez JJ, Pagano M. Comparing two survey methods of measuring health-related indicators: Lot Quality Assurance Sampling and Demographic Health Surveys. Tropical Medicine and International Health. 2015;20(12):1756-70.

12. Valadez JJ, Devkota B, Pradhan MM, Meherda P, Sonal GS, Dhariwal A, et al. Improving malaria treatment and prevention in India by aiding district managers to manage their programmes with local information: a trial assessing the impact of Lot Quality Assurance Sampling on programme outcomes. Trop Med Int Health. 2014.

13. Tourangeau R. Remembering what happened: Memory errors and survey reports. In: Stone AA, Jobe JB, Bachrach CA, Cain VS, Kurtzman HS, editors. The Science of Self-report : Implications for research and practice. Mahwah, NJ: Lawrence Erlbaum; 2000.

14. Bradburn NM. Temporal representation and event dating. In: Stone AA, Jobe JB, Bachrach CA, Cain VS, Kurtzman HS, editors. The Science of Self-report : Implications for research and practice. Mahwah, NJ: Lawrence Erlbaum; 2000.

15. Tomeo CA, Rich-Edwards JW, Michels KB, Berkey CS, Hunter DJ, Frazier AL, et al. Reproducibility and validity of maternal recall of pregnancy-related events. Epidemiology. 1999;10(6):774-7.

16. Elkadry E, Kenton K, White P, Creech S, Brubaker L. Do mothers remember key events during labor? American Journal of Obstetrics and Gynecology. 2003;189(1):195-200.

17. Li R, Scanlon KS, Serdula MK. The validity and reliability of maternal recall of breastfeeding practice. Nutrition Reviews. 2005;63(4):103-10.

18. Miles M, Ryman TK, Dietz V, Zell E, Luman ET. Validity of vaccination cards and parental recall to estimate vaccination coverage: A systematic review of the literature. Vaccine. 2013;31:1560-8.

19. Valadez JJ, Weld LH. Maternal recall error of child vaccination status in a developing nation. Am J Public Health. 1992;82(1):120-2.

20. Chan M, Kazatchkine M, Lob-Levyt J, Obaid T, Schweizer J, Sidibe M, et al. Meeting the demand for results and accountability: a call for action on health data from eight global health agencies. PLoS Med. 2010;7(1):e1000223.

21. Valadez JJ, Weiss W, Leburg C, Davis R. Assessing Community Health Programs: A Trainer's Guide. Using LQAS for Baseline Surveys and Regular Monitoring. 2nd ed. St Albans: Teaching-aids At Low Cost; 2007.

22. Turner AG, Magnani RJ, Shuaib M. A not quite as quick but much cleaner alternative to the Expanded Programme on Immunization (EPI) Cluster Survey design. International Journal of Epidemiology. 1996;25(4):198-203.

23. Davis RH, Valadez JJ. Improving the collection of knowledge, attitude and practice data with community surveys: a comparison of two second-stage sampling methods. Health Policy Planning. 2014;29(8):1054-60.

24. Dodge HF, Romig HG. Sampling inspection tables: single and double sampling. 2nd ed. New York: John Wiley & Sons; 1959.

25. Robertson SE, Joseph J V. Global review of health care surveys using lot quality assurance sampling (LQAS), 1984–2004. Social Science & Medicine. 2006;63:1648-60.

26. Valadez JJ. Assessing child survival programmes in developing countries: testing lot quality assurance sampling. Boston: Harvard University Press; 1991.

27. Mantel N. Chi-square tests with one degree of freedom: extensions of the Mantel-Haenszel procedure. J Am Stat Assoc. 1963;58(303):690-700.

28. Agresti A. An Introduction to Categorical Data Analysis. 2nd ed. Hoboken, New Jersey: Wiley-Interscience; John Wiley & Sons; 2007.

1	
2	
3	20 World Wasther Online Dates Monthly Climate Averages Dihar India 2018
4	29. World Weather Online. Fatha Montuny Chinate Averages, Binar, India 2018.
5	Available from: <u>https://www.worldweatheronline.com/patna-weather-</u>
6	averages/bihar/in.aspx.
0	<u>·</u>
/	
8	
9	
10	
11	
12	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
21 22	
22	
23	
24	
25	
26	
27	
28	
29	
30	
50	
31	
32	
33	
34	
35	
36	
37	
38	
20	
39	
40	
41	
42	
43	
44	
45	
46	
47	
18	
+0 40	
49	
50	
51	
52	
53	
54	
55	
55	
50	
5/	
58	
59	
60	For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Supplementary Text for Tables S4a through S6

We make four comparisons to inform an evaluation of these data. The first compares the 0-5 month sample to the 0-2 month sample and is presented in Table 2 in the main text and Tables S2-3. In a second comparison, indicators estimated for the 0-2 month old **subsample** are compared to the 3-5 month old **subsample** to assess the internal consistency of estimates for the entire 0-5 sample (Table 4a-b). In the third comparison, the 0-2 **subsample** of the 0-5 sample is compared to the 0-2 month **sample** to assess the sampling variability for this age group (Tables S5a-b). Finally, in the fourth comparison, the 3-5 **subsample** of the 0-5 sample is compared to the 3-5 month **sample** (Table S6). This last comparison is limited because the 3-5 month sample collected limited data; there are only 3 indicators common to the two samples.

Table S4a has the complete results for the second comparison with point estimates for the two subsamples 0-2 and 3-5 of the 0-5 sample, differences and estimated confidence intervals for the estimates and differences of 104 comparisons. Fourteen indicators for which the estimated confidence interval of the difference does not include zero are listed in Table S4b. The table has 2 panels. In the top panel are 6 indicators for which a difference is also reported in Table S2. Table S2 compares the 0-2 month sample and the 0-5 month sample. For each of these indicators the reported difference is in the same direction. Two of these indicators are indicator 52, exclusive infant breast feeding, in the 2 provinces. These differences are not surprising as it is common for mothers to introduce supplemental foods as infants age. The authors speculate in their paper that the timing of the monsoon may have reduced some of the indicators for the younger infants. Of the remaining four indicators of the top panel, three of the indicator differences are negative, lower for the younger infants and might plausibly be related to a monsoon. In the bottom panel of Table S4b are 8 indicators where zero is not in the confidence interval of the difference between subsamples, which suggests difference, but the results between two full-samples in Tables S2 and S3 suggest there is no meaningful difference, except that one of them, indicator 37 in Gopalgan; it does show a difference in Table S2. Of these 8, the difference between samples is in the same direction five times and in a different direction three times. For the 5 indicators where the differences are in the same direction, the absolute value of the differences between 0-2 subsample and the 3-5 subsample are larger than the absolute values of the differences between the 0-2 month sample and the 3-5 subsample. For these 5 indicators the 0-2 month sample is more like the 3-5 subsample than the 0-2 subsample. For the 3 indicators where the differences are in the different directions the 0-2 subsample closely resembles the 0-2 month sample; two of the estimates are different by less than 1 percent and the third by 2.4 percent.

A third comparison is in Tables S5a-b. In Table S5a the 0-2 **subsample** is compared to the 0-2 month **sample**. The expectation here would be that there are no differences because these two samples are designed to represent the same population. However, this expectation is not met; there are 10 differences where the confidence interval for the difference does not contain 0. These differences are listed in Table S5b. Nine of these 10 indicators are also among the differences in Table S3 and Table 3 in the paper. For 3 of these 9 differences the 3-5 subsample is closer to the 0-2 month sample than it is the 0-2 subsample (indicators 15, 17-2, 51); and for 3 indicators the 3-5 subsample is further from the 0-2 month sample than the 0-2 subsample (indicators 31, 33, 35). For 3 indicators the 0-2 and 3-5 subsample indicator values are nearly equal (indicators 23, 24, 26). For the final indicator in this list (indicator 17-1, the indicator for which zero is in the confidence interval of the difference between the 0-2

month sample and the 0-5 sample in Table S3) the difference between the indicator values for the 0-2 and 3-5 subsamples and the 0-2 month sample are about equal in magnitude but have opposite signs.

Results from the fourth comparison, comparing the 3-5 **subsample** of the 0-5 **sample** to the 3-5 month sample are limited, as noted above. There are only 3 indicators in the 2 districts – six comparisons. Zero is within the confidence interval of 5 of the differences (Table S6).

We note in the paper that in making this number of comparisons one must expect that some will be large enough to be considered meaningful by chance alone. In the above analysis there are 3 comparisons of 51 indicators in 2 provinces producing 16, 14 and 10 differences and a fourth comparison with 1 difference in 6. In their paper the authors find that some of these differences are readily understood and others may be interpreted effects of monsoon rains. Post hoc interpretation is risky here; many of these differences may be noise in the data. There is evidence in the third comparison to support this position with 3 differences moving the 0-5 sample closer to the 0-2 month sample, 3 moving it away, and 4 not moving it one way or the other. Furthermore, 9 of the 10 differences in the third comparison are also differences in the first comparison, suggesting that about half the differences between the 0-2 month sample and the 0-5 sample of the 0-5 sample.

The second comparison, comparing the 0-2 subsample to the 3-5 subsample, provides evidence both undermining and supporting the conclusion that a 0-5 sample will provide the same answers as two samples 0-2 and 3-5. On the one hand 5 of the fourteen differences in the third comparison are also in the first, the comparison of the 0-5 sample to the 0-2 sample, suggesting that the inclusion of 3-5 month olds in the 0-5 sample might contribute to the differences. On the other hand, in 5 out of the 8 indicators that are not different between the 0-2 and 0-5 samples, the 3-5 subsample more closely matches the 0-2 month sample than does the 0-2 subsample of the 0-5 sample. That this is true in general and not only for these extreme differences is suggested by the mean absolute differences between samples which are 5.2 for the differences between the 0-2 month **sample** and 3-5 month **subsample** and 6.6 for the differences between the 0-2 month **subsample**.

Finally, the overall result of all these comparisons is the same as that of the comparison presented in the main text of the paper: in each comparison 85% or more of the indicators show no differences between the samples. The most consistent evidence of differencCae is between the 0-2 **subsample** of the 0-5 sample and the 0-2 month **sample**.

2
3
1
5
6
7
8
9
10
11
11
12
13
14
15
16
17
18
10
19
20
21
22
23
24
25
26
20
27
28
29
30
31
32
33
3/
25
55
30
37
38
39
40
41
12
+Z
43
44
45
46
47

Table S1. Sub	ject domain a	nd indicators labels
Domain ^a	Indicator	Indicator text
1	1	Proportion of mothers of infants (0-2/0-5) months who were registered during their last pregnancy
1	2	Proportion of mothers of infants (0-2/0-5) months whose last pregnancy was registered in the first
		three months of pregnancy
1	3	Proportion of mothers of infants (0-2/0-5) months attended at least one ANC visit during their last
		pregnancy
1	4	Proportion of mothers of infants (0-2/0-5) months attended 3 or more ANC visits during their last
		pregnancy
1	5	Proportion of mothers of infants (0-2/0-5) months attended 4 or more ANC visits during their last
		pregnancy
1	6	Proportion of mothers of infants (0-2/0-5) months who attended at least one ANC visit where BP was
		checked during her last pregnancy
1	7	Proportion of mothers of infants (0-2/0-5) months who attended at least one ANC where at least one
		sonography was performed during her last pregnancy
1	8	Proportion of mothers of infants (0-2/0-5) months who attended at least one ANC where at least one
		abdominal examination was performed during her last pregnancy
1	9	Proportion of mothers of infants (0-2/0-5) months who attended at least one ANC where at least one
		urine test was performed during her last pregnancy
1	10	Proportion of mothers of infants (0-2/0-5) months who attended at least one ANC where at least one
		blood test was performed during her last pregnancy
1	40	Proportion of mothers of infants (0-2/0-5) months who have used an ambulance to reach an institution
		for last delivery
2	11	Proportion of mothers of infants (0-2/0-5) months who were protected against tetanus in their last
		pregnancy (Neonatal TT)
2	12	Proportion of mothers of infants (0-2/0-5) months who received two or more doses of TT injection in
		their last pregnancy
2	13	Proportion of mothers of infants (0-2/0-5) months who received IFA for 100 days or more during their
		pregnancy
2	14	Proportion of mothers of infants (0-2/0-5) months consumed IFA for 100 days or more in their
		pregnancy
3	15	Proportion of mothers (home + institutional delivery) of infants (0-2/0-5) months who planned
		transportation to health facility in their last pregnancy
3	16	Proportion of mothers (home + institutional delivery) of infants (0-2/0-5) months who have identified
		anybody who would donate blood in the case of emergency in their last pregnancy

BMJ Open

2	3	17	Proportion of mothers (home + institutional delivery) of infants (0-2/0-5) months who have identified persons who would take care of the baby immediately after birth
4 5	3	18	Proportion of mothers (home + institutional delivery) of infants $(0-2/0-5)$ months who have arranged
6		10	new blade & thread for their last delivery
7	3	19	Proportion of mothers who planned for institutional delivery of infants (0-2/0-5) months who arranged new blade & thread for their delivery
8	3	20	Proportion of mothers (home + institutional delivery) of infants $(0_2/0_5)$ months who have arranged
9 10	5	20	clean cloth for mothers and baby
11	3	21	Proportion of mothers who planned institutional delivery of infants (0-2/0-5) months who arranged
12			clean cloth for mothers and baby
13	3	22	Proportion of mothers of infants $(0-2/0-5)$ months who have saved money for the delivery
14	3	22	Proportion of mothers who planned for institutional delivery of infants $(0.2/0.5)$ months identified
15 16	5	23	person to accompany her during the delivery
10	4	24	Proportion of mothers of infants (0-2/0-5) months who were visited by ASHA at least once during
17			their last pregnancy
19	4	25	Proportion of mothers of infants $(0-2/0-5)$ months who were visited by AWW at least once during
20		20	their last programmy
21	1	26	Departing of mothers of inforts (0.2/0.5) months who were visited by ELWs at least once during
22	4	20	Proportion of mothers of infants (0-2/0-5) months who were visited by FLWs at least once during
23			their last pregnancy
24	4	27	Proportion of mothers of infants (0-2/0-5 months) visited by ASHAs at least once during their last trimester of pregnancy.
25	1	20	Dependency $D_{\text{respective}}$ of methods of infants (0, 2/0, 5) menthe who were visited by AWW at least once during
26 27	4	28	their last pregnancy
28	4	29	Proportion of mothers of infants (0-2/0-5) months who were visited by any FLW in the last trimester
29			during their last pregnancy
30	4	30	Proportion of mothers of infants (0-2/0-5) months who were visited 2 or more times by any FLW in
3 I 2 2			the last trimester during their last pregnancy
22 22	4	31	Proportion of mothers of infants $(0.2/0.5)$ months who were visited home by ASHA within 24 hours
33		51	of last delivery
35	1	20	Dependent derivery $(0.2/0.5)$ months who were visited home by AWW within 24 hours
36	4	32	Proportion of mothers of matrix $(0-2/0-5)$ months who were visited nome by A w w within 24 hours
37			of last delivery
38	4	33	Proportion of mothers of infants (0-2/0-5) months who were visited home by any FLW within 24
39			hours of last delivery
40	4	34	Proportion of mothers of infants (0-2/0-5) months who were visited home by any AWW within the
41			first week of last delivery
42	-		
43			
44			
45			For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Page 32 of 78

BMJ Open

4	35	Proportion of mothers of infants (0-2/0-5) months who were visited home by any FLW within first week of last delivery
5	37	Proportion of mothers of infants $(0-2/0-5)$ months whose last child was delivered at a health facility (private or public facility)
5	38	Proportion of mothers of infants (0-2/0-5) months whose last child was delivered at public facility
5	39	Proportion of mothers (home delivery) of infants (0-2/0-5) months who had home delivery attended by skilled birth attendant (SBA)
5	39.5	Proportion of mothers (home + institutional delivery) of infants (0-2/0-5) months who had home delivery attended by skill birth attendant (SBA)
6	42	Proportion of infants (home + institutional delivery) aged (0-2/0-5) months with nothing applied to the umbilical cord after cutting and tving in their last delivery
6	43	Proportion of mothers (home + institutional delivery) of infants (0-2/0-5) months who have delivered baby practiced skin to skin care (STSC) immediately after birth
6	44	Proportion of mothers with institutional delivery of infants (0-2/0-5) months who continued skin to skin care (STSC) at home
6	45	Proportion of mothers with home delivery of infants (0-2/0-5) months who continued skin to skin care (STSC) later
6	46	Proportion of mothers of infants $(0-2/0-5)$ months who were breastfed within one hour of birth
6	47	Proportion of infants aged (0-2/0-5) months who have received delayed bath (between 48 hours and before 7 days after birth) (Public facility/Private facility/Home)
6	48	Proportion of infants aged (0-2/0-5) months who were weighed after birth (Public facility/Private facility/Home)
6	49	Proportion of infants aged (0-2/0-5) months who were delivered at HF received dry cord care
6	50	Proportion of infants aged (0-2/0-5) months who were delivered at HF continued with dry cord care
6	51	Proportion of infants aged (0-2/0-5) months who were delivered at home continued with dry cord care
7	52	Proportion of infants $(0-2/0-5)$ months who were breast-fed in the past 24 hours (Exclusively Breast-fed)

Page 33 of 78

 BMJ Open

months: Estimates, Cochran-Mantel-Haenszel Chi-squares, and probabilities: Bihar 2015										
			 	Unwe	eighted			V	Veighted	
Domain ^a	Indicator ^b	District ^c	Percent	Percent	Chi-	Probability	Percent	Percent	Chi-square	Prob
			0-2	0-5	square		0-2	0-5		
1	1	1	86.6	79.9	3.6775	0.0552	85.2	77.6	4.3758	(
1	1	2	85.3	85.3	0.0000	1.0000	85.0	85.4	0.0187	(
1	2	1	44	40.7	0.4996	0.4797	43.0	38.3	1.0147	(
1	2	2	47.7	47.0	0.0304	0.8616	47.5	48.2	0.0212	(
1	3	1	84.7	80.9	1.2398	0.2655	83.8	80.4	0.9592	(
1	3	2	81.2	78.6	0.5985	0.4391	80.6	77.8	0.6424	(
1	4	1	60.3	63.6	0.4931	0.4826	61.1	63.1	0.1792	(
1	4	2	59.4	63.2	0.8252	0.3637	57.4	61.0	0.7211	(
1	5	1	42.1	45.0	0.3491	0.5546	43.2	45.7	0.2561	(
1	5	2	44.7	47.7	0.4866	0.4854	43.4	46.9	0.6302	(
1	6	1	59.8	59.3	0.0107	0.9177	58.9	60.1	0.0644	(
1	6	2	67.7	63.5	1.0487	0.3058	66.3	63.3	0.5176	(
1	7	1	42.6	39.2	0.5043	0.4776	42.0	39.5	0.2824	(
1	7	2	70.3	73.3	0.6025	0.4376	69.2	72.6	0.7537	(
1	8	1	44.0	45.9	0.1685	0.6815	42.7	44.8	0.2028	(
1	8	2	53.4	54.1	0.0322	0.8576	52.4	54.5	0.2438	(
1	9	1	45.9	42.6	0.5004	0.4793	45.8	41.7	0.7523	(
1	9	2	42.9	43.6	0.0321	0.8579	42.8	43.5	0.0231	(
1	10	1	67.0	59.8	2.6555	0.1032	67.2	59.6	2.9924	(
1	10	2	55.3	58.3	0.5191	0.4712	54.8	58.5	0.7674	(
1	40	1	11.5	17.7	3.4797	0.0621	10.6	16.0	2.8329	(
1	40	2	8.6	10.2	0.3686	0.5438	8.5	9.5	0.1374	(
2	11	1	98.6	98.1	0.1451	0.7033	98.5	98.1	0.0844	(
2	11	2	97.0	96.6	0.0614	0.8044	96.9	97.1	0.0131	(
2	12	1	68.4	66.5	0.1763	0.6746	69.3	67.5	0.1626	(
2	12	2	79.7	79.3	0.0116	0.9141	81.9	80.4	0.2143	(
2	13	1	3.8	2.4	0.7384	0.3902	4.0	2.6	0.6021	(
2	13	2	34	56	1.5745	0 2096	3.0	5.1	1.6016	(

Table S2. 0-5 month	Table S2. Indicators from mothers two samples in Aurangabad and Gopalganj of mothers of infants aged 0-2 months compared to 0-5 months; Estimates, Cochran-Mantel-Haenszel Chi-squares, and probabilities; Bihar 2015 - Continued									
		,		Unwei	ighted	1		V	Veighted	
Domain ^a	Indicator ^b	District ^c	Percent	Percent	Chi-	Probability	Percent	Percent	Chi-square	Probability
			0-2	0-5	square		0-2	0-5		
2	14	1	1.4	1.9	0.1474	0.7010	1.6	2.0	0.1025	0.7489
2	14	2	1.9	3.8	1.7161	0.1902	1.7	3.6	1.8535	0.1734
3	15	1	26.3	34.0	3.1510	0.0759	25.9	33.3	2.9594	0.0854
3	15	2	47.0	56.4	4.9192	0.0266	45.7	56.0	5.8262	0.0158
3	16	1	4.3	3.8	0.0639	0.8004	4.3	3.6	0.1410	0.7073
3	16	2	10.2	13.9	1.8263	0.1766	9.7	14.3	2.8157	0.0933
3	17	1	48.8	56.5	2.5852	0.1079	48.5	55.6	2.2155	0.1366
3	17	2	53.4	62.8	4.9914	0.0255	51.8	62.6	6.5790	0.0103
3	18	1	24.9	22.5	0.3601	0.5485	26.1	23.4	0.4531	0.5009
3	18	2	39.5	45.1	2.2194	0.1363	38.2	43.7	2.1362	0.1439
3	19	1	22.6	14.4	3.4821	0.0620	23.5	14.5	4.0983	0.0429
3	19	2	45.2	40.7	1.1508	0.2834	43.4	39.4	0.6771	0.4106
3	20	1	40.7	37.8	0.4565	0.4993	44.1	39.5	1.1927	0.2748
3	20	2	51.9	57.1	1.8538	0.1733	50.0	55.9	2.3539	0.1250
3	21	1	40.1	30.4	3.6953	0.0546	43.6	31.2	6.0749	0.0137
3	21	2	58.1	52.8	1.7277	0.1887	55.6	51.6	0.8220	0.3646
3	22	1	65.1	59.3	1.5561	0.2122	65.5	59.4	1.7643	0.1841
3	22	2	62.4	68.4	2.2445	0.1341	60.2	68.0	3.6903	0.0547
3	23	1	65.0	49.0	8.3301	0.0039	62.5	47.0	7.8078	0.0052
3	23	2	68.8	63.0	1.8993	0.1682	68.0	62.5	1.5725	0.2098
4	24	1	61.2	75.1	9.2638	0.0023	62.2	75.2	8.2048	0.0042
4	24	2	65.8	74.4	4.8055	0.0284	63.5	73.0	5.6444	0.0175
4	25	1	11.5	12.9	0.2096	0.6471	11.1	12.5	0.2064	0.6496
4	25	2	20.7	18.4	0.4319	0.5111	19.3	19.1	0.0019	0.9656
4	26	1	62.7	76.6	9.4840	0.0021	63.5	76.7	8.6936	0.0032
4	26	2	68.4	75.9	3.8007	0.0512	66.9	74.3	3.5169	0.0607
4	27	1	42.1	47.8	1.4400	0.2301	42.3	47.6	1.2194	0.2695
4	27	2	54.5	62.4	3.4903	0.0617	52.6	61.1	4.0230	0.0449

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

Page 35 of 78

BMJ Open

1	
2	
3 4	
5	
6 7	
8	
9	
10	
12	
13	
14	
16	
17	
18	
20	
21	
22	
23	
25	
26 27	
28	
29	
30	
32	
33	
34 35	
36	
37	
39	
40	
41 ⊿ว	
43	
44	
45 46	
47	

Table S2. 0-5 month	Indicators fins: Estimates	rom mothe s, Cochran	ers two samp -Mantel-Hae	les in Aurar enszel Chi-s	ngabad and quares, and	Gopalganj of r probabilities:	nothers of i Bihar 2015	infants age - Continue	d 0-2 months c	ompared to
			Unweighted				Weighted			
Domain ^a	Indicator ^b	District ^c	Percent	Percent	Chi-	Probability	Percent	Percent	Chi-square	Probability
			0-2	0-5	square		0-2	0-5		
4	28	1	8.6	8.1	0.0323	0.8575	8.2	7.6	0.0561	0.8127
4	28	2	16.2	13.9	0.5345	0.4647	15.4	13.8	0.2732	0.6012
4	29	1	43.1	48.8	1.4361	0.2308	43.3	48.5	1.1846	0.2764
4	29	2	57.5	64.7	2.9183	0.0876	55.9	63.5	3.2352	0.0721
4	30	1	29.7	35.4	1.6374	0.2007	28.7	34.2	1.5497	0.2132
4	30	2	48.1	53	1.2686	0.2600	46.9	51.4	1.0908	0.2963
4	31	1	30.1	45.9	10.9581	0.0000	29.9	44.9	9.9713	0.0016
4	31	2	47.4	53.0	1.6849	0.1943	44.5	52.7	3.6136	0.0573
4	32	1	5.3	3.8	0.4948	0.4818	5.3	3.6	0.7401	0.3896
4	32	2	9.8	9.0	0.0897	0.7646	9.1	9.9	0.0974	0.7550
4	33	1	32.5	47.8	10.1305	0.0015	32.2	46.7	9.0939	0.0026
4	33	2	50.8	56.4	1.7133	0.1906	48.2	56.2	3.5264	0.0604
4	34	1	6.2	10.0	2.0808	0.1492	6.2	9.9	1.9617	0.1613
4	34	2	13.5	9.0	2.7721	0.0959	14.4	8.9	3.9431	0.0471
4	35	1	45.0	60.3	9.7398	0.0018	44.5	59.3	9.0930	0.0026
4	35	2	64.7	69.5	1.4491	0.2287	62.5	69.0	2.5201	0.1124
5	37	1	73.2	76.6	0.6496	0.4203	72.9	74.9	0.2182	0.6404
5	37	2	80.1	86.1	3.4220	0.0643	78.9	85.5	3.9858	0.0459
5	38	1	55.5	56.5	0.0389	0.8436	54.7	55.3	0.0117	0.9139
5	38	2	52.3	61.3	4.3834	0.0363	51.2	61.6	5.8090	0.0159
5	39	1	5.7	0	3.3034	0.0691	5.4	0	3.6637	0.0556
5	39	2	10.2	8.3	0.2393	0.6247	9.1	6.6	0.3451	0.5569
5	39.5	1	1.4	0	0.0003	0.0833	1.4	0	2.8978	0.0887
5	39.5	2	1.9	1.1	0.5139	0.4735	1.8	0.9	0.7629	0.3824
6	42	1	42.6	47.4	1.0165	0.3134	43.8	47.6	0.6553	0.4182
6	42	2	41.4	46.2	1.3134	0.2518	41.8	46.3	1.1228	0.2893
6	43	1	24.9	29.7	1.3262	0.2495	25.6	30.4	1.3008	0.2541
6	43	2	27.1	29.7	0.4968	0.4809	26.9	31.2	1.2586	0.2619

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml
				Unwe	eighted	•		V	Veighted	
Domain ^a	Indicator ^b	District ^c	Percent	Percent	Chi-	Probability	Percent	Percent	Chi-square	Probability
			0-2	0-5	square	5	0-2	0-5	1	5
6	44	1	9.8	12.5	1.2833	0.2573	12.2	13.0	0.3958	0.5293
6	44	2	21.1	20.1	0.0586	0.8087	21.6	18.7	0.5178	0.4718
6	45	1	7.5	10.2	0.6321	0.4266	7.8	11.1	0.8502	0.3565
6	45	2	8.2	5.6	0.4009	0.5266	5.2	8.3	0.1670	0.6828
6	46	1	55.5	58.9	0.4904	0.4837	56.6	59.2	0.2960	0.5864
6	46	2	62.8	68.0	1.6764	0.1954	61.7	66.3	1.2736	0.2591
6	47	1	34.0	32.1	0.1768	0.6741	35.9	32.8	0.4369	0.5086
6	47	2	67.3	66.5	0.0344	0.8528	66.6	68.3	0.1745	0.6762
6	48	1	65.6	67.5	0.1782	0.6729	64.9	66.6	0.1312	0.7172
6	48	2	71.1	77.8	3.2208	0.0727	70.7	78.2	3.9664	0.0464
6	49	1	62.7	59.4	0.1537	0.6950	64.5	61.2	0.1691	0.6809
6	49	2	68.1	67.2	0.0166	0.8974	67.3	66.8	0.0011	0.9735
6	50	1	49.0	55.0	1.2527	0.2630	48.4	54.7	1.3188	0.2508
6	50	2	56.8	55.9	0.0964	0.7562	56.1	55.5	0.0615	0.8042
6	51	1	81.1	44.9	14.9736	0.0000	78.0	45.4	11.7395	0.0000
6	51	2	63.3	38.9	4.0901	0.0431	63.7	41.1	3.4654	0.0627
7	52	1	70.3	59.8	5.1727	0.0229	69.2	59.7	4.1723	0.0411
7	52	2	82.3	67.3	16.2014	0.0000	82.1	68.4	13.3711	0.0000
a . 1 Ante Exclusive	enatal care, 2 breastfeedir	2 Maternal 1g	health, 3 B	irth prepare	dness, 4 FI	LW Support, 5	Place of b	irth & atte	ndant, 6 Neon	atal Health, 7

c. 1 Aurangabad, 2 Gopalganj

]	Table S3. V	Weighted in	ndicators and	als from ty	wo sampl	es in two	o districts of Bihar				
			0-2 Mc	onth Sam	ple	0-5 M	lonth San	nple	D	ifference	
I	Indicatora	District ^b	Point	Confi	dence	Point	Confi	dence	Point	Confi	dence
1	maleator	District	estimate	inter	valc	estimate	inter	val ^c	estimate	inte	rval
				Lower	Upper		Lower	Upper		Lower	Upper
	1	1	85.2	80.2	90.2	77.6	72.6	82.6	7.6	0.1	15.2
	1	2	85.0	80.5	89.6	85.4	80.9	90.0	-0.4	-6.7	5.9
	2	1	43.0	36.3	49.8	38.3	31.5	45.0	4.7	-4.5	14.0
	2	2	47.5	41.5	53.6	48.2	42.1	54.2	-0.6	-9.5	8.2
	3	1	83.8	78.8	88.8	80.4	75.4	85.4	3.4	-3.6	10.4
	3	2	80.6	75.7	85.5	77.8	72.9	82.7	2.8	-4.5	10.0
	4	1	61.1	54.4	67.8	63.1	56.4	69.9	-2.0	-11.4	7.3
	4	2	57.4	51.2	63.6	61.0	54.8	67.2	-3.5	-12.3	5.2
	5	1	43.2	36.4	50.1	45.7	38.9	52.6	-2.5	-12.2	7.2
	5	2	43.4	37.1	49.8	46.9	40.5	53.2	-3.4	-12.4	5.6
	6	1	58.9	52.3	65.6	60.1	53.5	66.7	-1.2	-10.4	8.0
	6	2	66.3	60.2	72.4	63.3	57.2	69.4	2.9	-5.7	11.6
	7	1	42.0	35.3	48.8	39.5	32.7	46.3	2.5	-7.0	12.1
	7	2	69.2	63.2	75.2	72.6	66.6	78.6	-3.4	-11.7	4.9
	8	1	42.7	36.1	49.3	44.8	38.2	51.4	-2.1	-11.4	7.2
	8	2	52.4	46.2	58.7	54.5	48.2	60.8	-2.1	-10.9	6.7
	9	1	45.8	39.0	52.6	41.7	34.9	48.4	4.1	-5.4	13.6
	9	2	42.8	36.6	49.1	43.5	37.3	49.7	-0.6	-9.5	8.2
	10	1	67.2	60.9	73.6	59.6	53.2	65.9	7.6	-1.2	16.5
	10	2	54.8	48.5	61.1	58.5	52.2	64.8	-3.7	-12.5	5.2
	11	1	98.5	96.7	100.2	98.1	96.4	99.9	0.4	-2.2	2.9
	11	2	96.9	94.8	99.1	97.1	94.9	99.3	-0.2	-3.0	2.7
	12	1	69.3	63.0	75.7	67.5	61.2	73.9	1.8	-7.2	10.8
	12	2	81.9	77.3	86.6	80.4	75.7	85.0	1.6	-5.2	8.4
	13	1	4.0	1.2	6.7	2.6	-0.1	5.4	1.3	-2.2	4.9
	13	2	3.0	1.0	5.0	5.1	3.1	7.1	-2.2	-5.5	1.2
	14	1	1.6	-0.2	3.4	2.0	0.2	3.8	-0.4	-3.1	2.3
	14	2	1.7	0.2	3.2	3.6	2.1	5.1	-1.9	-4.7	0.9
	15	1	25.9	20.1	31.6	33.3	27.5	39.0	-7.4	-15.9	1.1
	15	2	45.7	39.6	51.8	56.0	49.9	62.1	-10.3	-19.0	-1.5
	16	1	4.3	1.5	7.0	3.6	0.8	6.3	0.7	-3.0	4.4
	16	2	9.7	6.1	13.3	14.3	10.8	17.9	-4.7	-10.5	1.1
	17	1	48.5	41.8	55.2	55.6	48.9	62.3	-7.1	-16.5	2.4
	17	2	51.8	45.6	58.0	62.6	56.4	68.8	-10.8	-19.6	-2.1
	18	1	26.1	20.2	32.1	23.4	17.5	29.4	2.7	-5.5	10.9
	18	2	38.2	33.0	43.3	43.7	38.5	48.8	-5.5	-13.2	2.2
	19	-	23.5	16.4	30.7	14.5	7.3	21.7	9.1	0.4	17.7
	19	2	43.4	37.3	49.5	39.4	33.3	45.5	4.0	-4.6	12.6
	20	1	44 1	38.3	50.0	39.5	33.7	45.4	4.6	-3.7	12.0
	20	2	50.0	44 7	55.4	55.9	50.5	61.3	-5.9	-13 7	2.0
	20	- 1	43.6	36.7	50.5	31.2	20.5 24 3	38.1	12.2	33	2.0
	21	2	55.6	49 5	61 7	51.6	45 5	577	4 0	-4.6	121.5
	21	- 1	65 5	59.0	72 0	59.4	52.9	65.9	6.1	-3.0	15.0
	22	2	60.2	54.0	66.3	68 D	61.8	74.2	_7 8	-16.4	07
	23	- 1	62.5	54.9	70.2	47.0	39.3	54 7	15 5	5 4	25.7
	23	2	68 0	61.2	74.8	62.5	55.5 55.7	693	5 5	-3.8	14.8
I		-	00.0	01.2	, 1.0	02.3	22.1	07.5	5.5	5.0	11.0
			For peer review	w only - ht	tp://bmjop	ben.bmj.com	/site/abou	t/guidelin	es.xhtml		

1	24	1	62.2	55.5	68.9	75.2	68.5	81.9	-13.0	-22.0	-4.1
1	24	2	63.5	57.4	69.7	73.0	66.9	79.2	-9.5	-17.9	-1.1
∠ 3	25	1	11.1	7.0	15.1	12.5	8.4	16.5	-1.4	-7.5	4.7
4	25	2	19.3	14.4	24.2	19.1	14.3	24.0	0.1	-6.9	7.2
5	26	1	63.5	56.8	70.1	76.7	70.1	83.4	-13.2	-22.1	-4.4
6	26	2	66.9	60.9	73.0	74.3	68.3	80.3	-7.4	-15.7	1.0
7	27	1	42.3	35.6	49.1	47.6	40.8	54.4	-5.3	-14.8	4.3
8	27	2	52.6	46.3	58.9	61.1	54.8	67.4	-8.5	-17.2	0.3
9 10	28	1	8.2	4.6	11.8	7.6	4.0	11.2	0.6	-4.4	5.7
10	28	2	15.4	11.0	19.8	13.8	9.4	18.3	1.6	-4.7	7.8
12	29	1	43.3	36.5	50.1	48.5	41.7	55.3	-5.2	-14.8	4.3
13	29	2	55.9	49.7	62.2	63.5	57.2	69.8	-7.5	-16.3	1.2
14	30	1	28.7	22.6	34.7	34.2	28.1	40.2	-5.5	-14.3	3.2
15	30	2	46.9	40.5	53.3	51.4	45.0	57.8	-4.5	-13.5	4.5
16	31	1	29.9	23.5	36.3	44.9	38.5	51.3	-15.0	-24.4	-5.6
1/	31	2	44.5	38.2	50.8	52.7	46.5	59.0	-8.2	-17.2	0.7
10 10	32	1	5.3	2.2	8.5	3.6	0.4	6.7	1.7	-2.3	5.8
20	32	2	9.1	5.7	12.6	9.9	6.4	13.4	-0.8	-6.0	4.4
21	33	1	32.2	25.8	38.7	46.7	40.2	53.2	-14.5	-23.9	-5.0
22	33	2	48.2	41.9	54.5	56.2	49.9	62.5	-8.1	-16.9	0.8
23	34	1	6.2	2.8	9.6	9.9	6.5	13.3	-3.7	-8.9	1.5
24	34	2	14.4	9.8	19.0	8.9	4.4	13.5	5.5	-0.3	11.3
25	35	1	44.5	37.7	51.4	59.3	52.5	66.2	-14.8	-24.4	-5.1
20 27	35	2	62.5	56.4	68.7	69.0	62.9	75.2	-6.5	-15.1	2.1
28	37	1	72.9	66.7	79.1	74.9	68.7	81.0	-2.0	-10.5	6.5
29	37	2	78.9	73.5	84.2	85.5	80.2	90.8	-6.6	-13.7	0.4
30	38	1	54.7	47.8	61.7	55.3	48.4	62.2	-0.5	-10.3	9.2
31	38	2	51.2	44.7	57.6	61.6	55.2	68.0	-10.4	-19.4	-1.5
32	39	1	5.4	-0.9	11.8	0.0	-6.4	6.4	5.4	-0.9	11.8
33	39	2	9.1	1.3	16.9	6.6	-1.2	14.4	2.5	-9.1	14.1
34 35	39.5	1	1.4	-0.2	3.0	0.0	-1.6	1.6	1.4	-0.2	3.0
36	39.5	2	1.8	0.2	3.4	0.9	-0.6	2.5	0.9	-1.0	2.8
37	40	1	10.6	6.5	14.7	16.0	12.0	20.1	-5.4	-11.7	0.8
38	40	2	8.5	4.9	12.2	9.5	5.8	13.1	-0.9	-5.9	4.1
39	42	1	43.8	36.9	50.6	47.6	40.7	54.5	-3.8	-13.3	5.6
40	42	2	41.8	35.6	48.1	46.3	40.1	52.6	-4.5	-13.4	4.4
41 42	43	1	25.6	19.8	31.5	30.4	24.6	36.2	-4.8	-13.3	3.7
42 43	43	2	26.9	21.5	32.4	31.2	25.7	36.6	-4.2	-12.0	3.5
44	44	1	12.2	7.3	17.1	13.0	8.1	17.9	-0.8	-7.7	6.1
45	44	2	21.6	16.3	26.8	18.7	13.4	24.0	2.8	-4.4	10.1
46	45	1	7.8	0.4	15.2	11.1	3.7	18.5	-3.3	-16.2	9.6
47	45	2	5.2	0.3	10.1	8.3	3.4	13.2	-3.1	-17.4	11.2
48 40	46	- 1	56.6	49.9	63.2	59.2	52.5	65.8	-2.6	-12.2	7.0
49 50	46	2	61.7	55.5	67.9	66.3	60.1	72.6	-4.6	-13.3	4.1
50 51	47	- 1	35.9	29.3	42.5	32.8	26.2	39.5	3.0	-6.2	12.3
52	47	2	66.6	60.6	72.7	68.3	62.3	74.4	-1.7	-10.1	6.7
53	48	1	64.9	58.5	71.4	66.6	60.1	73.0	-1.6	-10.8	7.5
54	48	2	70.7	64.9	76.5	78.2	72.4	84.0	-7.5	-15.2	0.2
55	49	1	64 5	57 1	71.8	61.2	53.9	68 5	33	-67	133
56	49	2	67 3	60.6	739	66.8	60.1	73.4	0.5	-8.9	99
5/ 52	50	1	48.4	40 3	56 4	54 7	46 7	62.8	-64	-174	47
50 59	50	2	56 1	49.0	63.7	55.5	48 4	62.6	0.7	_9 <i>2</i>	10.5
60	50	-	For peer review	only - htt	p://bmjop	en.bmj.com/	site/about	/guideline	s.xhtml	1.4	10.2

Page 3	89 of 78				BMJ	Open					
1 2 3 4 5 6 7 8	51 51 52 52 a. For text b. 1 Aurar c. Estimat	1 2 1 2 see Table ngabad, 2 C ed with Sta	78.0 63.7 69.2 82.1 S1 Gopalganj tta command s	65.9 48.8 62.7 77.1	90.2 78.5 75.6 87.0	45.4 41.1 59.7 68.4	33.3 26.2 53.3 63.5	57.6 56.0 66.1 73.4	32.6 22.5 9.5 13.6	13.0 -2.2 0.2 6.0	52.2 47.2 18.8 21.2
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26											
20 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45											
45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60			For peer review	r only - httj	p://bmjope	n.bmj.com/s	site/about	:/guidelines	s.xhtml		

1	Table S4a:	Point estin	nates and c	onfidence	e interval	s of indicat	tors for su	bsamples	of 0-2 and	3-5 mont	h old
2	infants in t	wo districts	s: Bihar, In	dia, 2015					_		
3			0-2 mo	nth subsa	mple	3-5 mo	onth subsat	mple	D	ifference	
4	Indicator ^a	District ^b	Point	Confic	lence	Point	Confie	dence	Point	Confid	lence
5		21501100	estimate	inter	val ^c	estimate	inter	val ^c	estimate	inter	val
ю 7				Lower	Upper		Lower	Upper		Lower	Upper
, 8	1	1	79.2	71.9	86.5	75.2	66.0	84.4	4.0	-7.7	15.7
9	1	2	80.8	74.4	87.2	92.3	87.5	97.2	-11.5	-19.5	-3.5
10	2	1	36.1	27.8	44.4	41.5	31.7	51.3	-5.4	-18.2	7.4
11	2	2	46.5	38.1	54.8	50.6	40.3	61.0	-4.2	-17.5	9.1
12	3	1	81.0	75.0	87.1	79.5	71.5	87.5	1.5	-8.5	11.6
13	3	2	79.9	73.4	86.5	74.7	65.8	83.7	5.2	-5.9	16.3
14 15	4	1	61.8	53.1	70.4	65.2	55.0	75.3	-3.4	-16.7	10.0
16	4	2	62.7	54.7	70.7	58.4	48.4	68.3	4.4	-8.4	17.1
17	5	1	45.0	36.2	53.9	46.8	35.5	58.0	-1.7	-16.0	12.6
18	5	2	49.1	40.8	57.4	43.5	33.3	53.7	5.6	-7.6	18.7
19	6	1	60.3	51.9	68.7	59.8	49.6	70.0	0.5	-12.7	13.7
20	6	2	68.5	60.8	76.1	55.8	45.7	65.8	12.7	0.0	25.4
21	7	1	40.3	31.8	48.8	38.4	27.4	49.3	1.9	-11.9	15.8
22 23	7	2	74.5	67.2	81.9	69.8	60.3	79.3	4.7	-7.3	16.8
24	8	1	49.3	41.2	57.3	38.2	27.9	48.5	11.1	-2.0	24.2
25	8	2	60.0	52.0	67.9	46.4	36.7	56.2	13.6	1.0	26.1
26	9	1	39.8	31.3	48.4	44.4	33.9	54.8	-4.5	-18.0	9.0
27	9	2	44.7	36.6	52.8	41.7	31.5	51.9	3.0	-10.0	16.0
28	10	1	61.9	54.4	69.4	56.1	45.3	66.9	5.7	-7.4	18.9
29	10	2	63.9	56.1	71.7	50.5	40.3	60.6	13.5	0.7	26.2
30 31	11	1	98.4	96.3	100.6	97.6	94.3	100.9	0.8	-3.1	4.8
32	11	2	96.7	94.1	99.3	97.7	95.1	100.3	-1.0	-4.7	2.7
33	12	1	65.0	56.4	73.6	71.3	61.8	80.7	-6.3	-19.1	6.5
34	12	2	77.8	71.1	84.6	84.1	76.7	91.4	-6.2	-16.2	3.8
35	13	1	3.3	0.1	6.5	1.6	-1.5	4.8	1.7	-2.8	6.2
36	13	2	6.7	2.6	10.9	2.8	0.0	5.6	3.9	-1.1	8.9
37 38	14	1	2.2	-0.4	4.8	1.6	-1.5	4.8	0.6	-3.5	4.7
39	14	2	4.5	1.0	8.0	2.3	-0.4	4.9	2.2	-2.2	6.6
40	15	1	35.2	26.8	43.6	30.4	20.9	39.9	4.8	-7.8	17.5
41	15	2	56.8	48.7	64.9	54.8	44.3	65.3	2.0	-11.3	15.2
42	16	1	5.3	1.4	9.3	0.9	-0.8	2.6	4.5	0.2	8.7
43	16	2	16.6	10.2	23.0	11.0	4.8	17.1	5.7	-3.2	14.5
44 45	17	1	59.6	51.4	67.9	49.5	38.7	60.3	10.1	-3.5	23.7
46	17	2	64.4	56.5	72.4	59.9	49.8	70.0	4.5	-8.3	17.4
47	18	1	24.2	16.8	31.6	22.2	13.9	30.5	2.0	-9.1	13.1
48	18	2	45.9	38.1	53.8	40.3	32.0	48.6	5.7	-5.7	17.1
49	19	1	17.9	11.2	24.5	9.2	2.4	16.1	8.6	-0.9	18.2
50	19	2	40.5	32.4	48.6	37.7	29.0	46.4	2.8	-9.0	14.6
51	20	1	42.5	34.8	50.2	35.1	26.0	44.2	7.4	-4.5	19.4
52 53	20	2	59.4	51.7	67.0	50.7	42.3	59.1	8.6	-2.7	20.0
55 54	21	1	37.0	29.2	44.8	22.1	13.1	31.2	14.9	2.9	26.8
55	21	2	54.2	46.1	62.3	47.7	38.9	56.6	6.5	-5.6	18.5
56	22	1	62.5	54.0	70.9	54.7	44.8	64.6	7.8	-5.2	20.8
57	22	2	69.7	62.3	77.1	65.5	55.4	75.5	4.2	-8.2	16.7
58 59	23	1	47.5	39.1	55.9	46.1	35.0	57.3	1.4	-12.5	15.3

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

	23	2	64.9	56.9	73.0	58.9	48.4	69.5	6.0	-7.3	19.3
1	24	1	75.1	67.4	82.9	75.3	66.0	84.7	-0.2	-12.4	11.9
2	24	2	67.6	59.7	75.5	81.0	72.7	89.3	-13.4	-24.8	-1.9
3	25	1	12.1	61	18.0	13.1	59	20.2	-1.0	-10.3	83
4 5	25	2	16.7	10.3	23.1	22.7	13.8	31.6	-6.0	-16.9	0.5 4 9
5	25	1	76.2	68.6	23.1 83.8	77 5	68.5	86.6	-0.0	13.1	10.5
7	20	1	70.2 60.4	61.6	05.0	016	00.J 72.2	80.0	-1.5	-13.1	10.5
8	20	ے 1	09.4 50.4	01.0	//.Z	01.0 42.4	/ 5.5	89.8 52.0	-12.2	-25.0	-0.8
9	27	1	57.2	41.3	59.5 (5.4	43.4	55.0 57.7	33.9	0.9	-0.8	20.7
10	27	2	57.2	48.9	05.4	00.9	5/./	/6.0	-9.7	-22.0	2.7
11	28	1	8.6	3.7	13.6	0.0	1.3	10.6	2.7	-4.1	9.5
12	28	2	9.8	5.1	14.5	19./	11.4	28.1	-9.9	-19.5	-0.3
13	29	1	50.4	41.5	59.3	45.6	35.4	55.9	4.8	-8.8	18.4
14	29	2	59.2	51.1	67.4	69.7	60.5	79.0	-10.5	-22.9	1.8
15 16	30	1	32.7	24.5	41.0	36.3	25.9	46.7	-3.6	-16.9	9.7
10	30	2	49.2	41.0	57.4	54.7	44.3	65.1	-5.5	-18.8	7.7
18	31	1	42.0	33.0	51.1	49.2	39.0	59.5	-7.2	-20.9	6.5
19	31	2	48.6	40.3	56.8	58.9	48.8	69.0	-10.3	-23.3	2.7
20	32	1	3.9	0.4	7.3	3.2	-0.4	6.8	0.7	-4.3	5.7
21	32	2	9.4	4.2	14.5	10.7	4.7	16.8	-1.4	-9.3	6.5
22	33	1	43.6	34.5	52.6	51.4	41.1	61.7	-7.8	-21.6	5.9
23	33	2	52.9	44.8	61.0	61.1	51.1	71.2	-8.2	-21.1	4.7
24	34	1	7.0	2.5	11.5	14.2	7.0	21.4	-7.2	-15.7	1.2
25 26	34	2	8.6	3.8	13.4	9.5	4.0	15.0	-0.9	-8.2	6.4
20	35	1	57.2	48.2	66.2	62.5	52.7	72.4	-5.3	-18.7	8.0
28	35	2	63.2	55.1	71.4	77.6	68.6	86.6	-14.3	-26.5	-2.2
29	37	1	76.6	69.1	84.1	72.3	62.7	81.8	4.3	-7.8	16.4
30	37	2	81.6	74 9	88.3	91.3	85.8	96.8	-97	-18.4	-1.0
31	38	1	59.0	49.9	68.0	49.7	393	60.2	9.7	-4.6	23.1
32	38	2	56.1	17.9	64 A	60.7	-61.2	78.2	-13.6	-25.5	_1 7
33	30	1	0.0	۰، ۱۳	0.0	0.7	01.2	0.0	-13.0	-25.5	-1.7
34 25	30	2	5.8	3.1	147	0.0	10.1	50.3	3.8	54.3	0.0 16 7
35	30.5	2 1	5.8	-5.1	0.0).0 0.0		0.0	-5.8	-55-	-0.7
30	39.5	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	39.3	2 1	1.1	-0.4	2.0	12.6	-0.7	2.1	0.3	-1.7	12.4
39	40	1	17.0	2.0	24.4 12.1	13.0	7.5 5.6	19.8	4.0	-3.2	13.2
40	40	ے 1	8.0 52.6	5.9 44.2	12.1	11.0	20.6	17.7	-3./	-11.0	5.0 25.0
41	42	1	52.0	44.5	01.0 55 (40.1	29.0	54.0	12.3	-0.9	23.9
42	42	2	47.5	39.4 27.4	33.0	44.0	34.4	34.8	2.9	-10.2	10.0
43	43	1	35.6	27.4	43.8	22.0	13.0	31.5	13.1	0.9	25.2
44 45	43	2	35.5	28.0	43.0	24.8	16.4	33.1	10.8	-0.5	22.0
45 46	44	1	10.1	4.2	16.0	1/.6	9.5	25.7	-/.5	-1/.6	2.5
47	44	2	20.6	14.1	27.0	16.2	8.7	23.8	4.3	-5.6	14.3
48	45	1	9.0	-4.7	22.7	13.7	-0.7	28.1	-4.7	-24.6	15.2
49	45	2	6.6	-9.9	23.2	14.4	14.4	14.4	-7.7	-24.3	8.8
50	46	1	63.4	54.6	72.2	52.8	41.5	64.0	10.7	-3.6	24.9
51	46	2	68.9	61.1	76.7	62.5	52.6	72.4	6.4	-6.2	19.0
52	47	1	33.0	24.7	41.4	32.5	22.2	42.9	0.5	-12.8	13.8
53	47	2	70.4	62.8	77.9	65.3	55.9	74.8	5.1	-7.1	17.2
54 55	48	1	68.8	60.6	77.0	63.2	52.5	73.8	5.7	-7.8	19.1
55 56	48	2	76.2	69.3	83.0	81.3	73.9	88.6	-5.1	-15.2	5.0
57	49	1	66.5	57.9	75.1	52.7	41.0	64.3	13.8	-0.6	28.3
58	49	2	68.6	59.9	77.3	64.4	53.8	75.0	4.2	-9.5	17.9
59	50	1	51.7	42.1	61.4	59.5	47.6	71.5	-7.8	-23.1	7.6
60	I		For peer revi	ew only - ł	nttp://bmjo	pen.bmj.co	m/site/abo	ut/guidelines.>	html		

50	2	55.2	46.3	64.1	55.8	45.1	66.6	-0.7	-14.6	1
51	1	33.2	14.6	51.7	61.0	36.7	85.4	-27.9	-58.5	
51	2	40.6	17.5	63.7	43.0	-6.7	92.7	-2.4	-57.2	5
52	1	73.0	65.1	80.9	39.7	28.6	50.7	33.3	19.8	4
52	2	83.8	78.2	89.3	45.8	35.6	55.9	38.0	26.4	4
a. For text	see Table	S1								
b. 1 Aurar	ngabad, 2 G	opalganj								
c Estimat	ed with Sta	ta comman	d svv							

BMJ Open

			Point es	stimate		Confidence	interval ^b
	Indicator	District ^a	0-2 month	3-5 month	Difference	Lower	Upper
				In Tal	ole S4a and in	n Table S2	
21	Proportion of mothers who planned institutional delivery of infants (0-	1	37.0	22.1	14.9	2.9	26.8
	2/0-5) months who arranged clean cloth for mothers and baby						
24	Proportion of mothers of infants (0-2/0-5) months who were visited by	2	67.6	81.0	-13.4	-24.8	-1.9
	ASHA at least once during their last pregnancy						
37	Proportion of mothers of infants (0-2/0-5) months whose last child was	2	81.6	91.3	-9.7	-18.4	-1.0
	delivered at a health facility (private or public facility)						
38	Proportion of mothers of infants (0-2/0-5) months whose last child was	2	56.1	69.7	-13.6	-25.5	-1.'
	delivered at public facility						
52	Proportion of infants $(0-2/0-5)$ months who were breast-fed in the past	1	73.0	39.7	33.3	19.8	46.
52	24 hours (Exclusively Breast-fed)	2	83.8	45.8	38.0	26.4	49.
				In Table	e S4a but not	in Table S2	
1	Proportion of mothers of infants (0-2/0-5) months who were registered	• 2	80.8	92.3	-11.5	-19.5	-3.
	during their last pregnancy						
8	Proportion of mothers of infants (0-2/0-5) months who attended at least	2	60.0	46.4	13.6	1.0	26.
	one ANC where at least one abdominal examination was performed						
	during her last pregnancy						
10	Proportion of mothers of infants (0-2/0-5) months who attended at least	2	63.9	50.5	13.5	0.7	26.
	one ANC where at least one blood test was performed during her last						
	pregnancy						
16	Proportion of mothers (home + institutional delivery) of infants (0-2/0-5)	1	5.3	0.9	4.5	0.2	8.
	months who have identified anybody who would donate blood in the						
	case of emergency in their last pregnancy						
26	Proportion of mothers of infants (0-2/0-5) months who were visited by	2	69.4	81.6	-12.2	-23.6	-0.
	FLWs at least once during their last pregnancy						
28	Proportion of mothers of infants (0-2/0-5) months who were visited by	2	9.8	19.7	-9.9	-19.5	-0.
	AWW in the last trimester during their last pregnancy						
35	Proportion of mothers of infants (0-2/0-5) months who were visited	2	63.2	77.6	-14.3	-26.5	-2.
	home by any FLW within first week of last delivery						

		. age
43	Proportion of mothers (home + institutional delivery) of infants (0-2/0-5) 1 35.6 22.6 13.1 0.9 months who have delivered baby practiced skin to skin care (STSC) immediately after birth	25.2
a.	1 = Aurangabad; 2 = Gopalganj	
b.	Calculated from standard errors for point estimates estimated with Stata command svy	

 Page 44 of 78

			Doint activ	motoc		Difference	
	Indicator	District ^a	Point esti	mates	Estimato	Confidence	interval ^b
			Subsample	Sample	Estimate	Lower	Upper
15	Proportion of mothers (home + institutional delivery) of infants (0-2/0-	2	56.8	45.7	11.1	0.9	21.2
	5) months who planned transportation to health facility in their last pregnancy						
17	Proportion of mothers (home + institutional delivery) of infants (0-2/0-	1	59.6	48.5	11.1	0.5	21.7
	5) months who have identified persons who would take care of the baby immediately after birth	2	64.4	51.8	12.7	2.6	22.7
23	Proportion of mothers who planned for institutional delivery of infants (0-2/0-5) months identified person to accompany her during the delivery	1	47.5	62.5	-15.0	-26.4	-3.6
24	Proportion of mothers of infants (0-2/0-5) months who were visited by ASHA at least once during their last pregnancy	1	75.1	62.2	12.9	2.7	23.2
26	Proportion of mothers of infants (0-2/0-5) months who were visited by FLWs at least once during their last pregnancy	1	76.2	63.5	12.7	2.6	22.8
31	Proportion of mothers of infants (0-2/0-5) months who were visited home by ASHA within 24 hours of last delivery	1	42.0	29.9	12.1	1.1	23.2
33	Proportion of mothers of infants (0-2/0-5) months who were visited home by any FLW within 24 hours of last delivery	1	43.6	32.2	11.3	0.2	22.5
35	Proportion of mothers of infants (0-2/0-5) months who were visited home by any FLW within first week of last delivery	1	57.2	44.5	12.7	1.3	24.0
51	Proportion of infants aged (0-2/0-5) months who were delivered at home continued with dry cord care	1	33.2	78.0	-44.9	-67.0	-22.7

Table S5a: Point estimates and confidence intervals of indicators for a sample 0-2 month old infants and a subsample of 0-2 month old infants from a sample of 0-5 month old infants in two districts: Bihar, India,

	2015								r		
			0-2 mo	onth subsa	imple	0-2 n	nonth sam	ple	D	ifference	
	Indicator ^a	Districtb	Point	Confi	dence	Point	Confi	dence	Point	Confi	dence
	mulcator	District	estimate	inter	val ^c	estimate	inter	val ^c	estimate	inter	rval
				Lower	Upper		Lower	Upper		Lower	Upper
	1	1	79.2	71.9	86.5	85.2	80.2	90.2	-6.0	-14.8	2.8
	1	2	80.8	74.4	87.2	85.0	80.5	89.6	-4.2	-12.1	3.6
	2	1	36.1	27.8	44.4	43.0	36.3	49.8	-6.9	-17.6	3.8
	2	2	46.5	38.1	54.8	47.5	41.5	53.6	-1.1	-11.3	9.2
	3	1	81.0	75.0	87.1	83.8	78.8	88.8	-2.8	-10.7	5.1
	3	2	79.9	73.4	86.5	80.6	75.7	85.5	-0.7	-8.8	7.5
	4	1	61.8	53.1	70.4	61.1	54.4	67.8	0.7	-10.3	11.6
	4	2	62.7	54.7	70.7	57.4	51.2	63.6	5.3	-4.8	15.4
	5	1	45.0	36.2	53.9	43.2	36.4	50.1	1.8	-9.4	13.0
	5	2	49.1	40.8	57.4	43.4	37.1	49.8	5.7	-4.8	16.2
	6	1	60.3	51.9	68 7	58.9	523	65.6	14	-93	12.1
	6	2	68.5	60.8	76.1	66.3	60.2	72.4	2.2	-7.6	12.1
	0 7	1	40.3	31.8	48.8	42.0	35.3	48.8	-17	-12.6	9.2
	7	2	74.5	67.2	81.0	69.2	63.2	75.2	53	-4.2	14.8
	8	1	/10.3	07.2 /1 2	57.3	12 7	36.1	/0.2	5.5 6.5	-7.2	16.0
	8	$\frac{1}{2}$		52.0	67.9		<i>16</i> 2	58 7	0.5	-3.7	10.7
	0	1	30.8	31.3	18 /	15.8	30.0	52.6	5.0	-2.0	5.0
	9	1	39.0 44.7	26.6	52.8	43.8	26.6	<i>J</i> 2.0 <i>A</i> 0.1	-5.9	-10.8	12.0
	9	2 1	61 0	54.0	52.0 60.4	42.0	50.0 60.0	49.1 72.6	1.0	-0.5	12.0
	10	1	62.0	56 1	09.4	51.2	00.9 49 5	/ 5 .0	-3.3	-13.2	4.5
	10	2 1	03.9	06.2	100.6	09.5	40.5	100.2	9.1	-0.9	19.1
	11	1	90.4	90.5	100.0	96.5	90.7	100.2	-0.0	-2.0	2.0
	11	2 1	90.7	94.1 56.4	99.5 72.6	90.9	94.0	99.1 75 7	-0.2	-3./	5.Z
	12	1	03.0	50.4 71.1	/ 5.0	09.3	03.0	13.1	-4.5	-13.0	0.4
	12	2 1	//.0	/1.1	04.0	81.9 4.0	17.5	80.0 6 7	-4.1	-12.3	4.1
	13	1	5.5 6.7	0.1	0.3	4.0	1.2	0.7	-0.0	-4.9	5.0 0.2
	13	2 1	0.7	2.0	10.9	5.0	1.0	5.0	5.7	-0.9	0.3
	14	1	2.2	-0.4	4.8	1.0	-0.2	3.4	0.7	-2.3	5.8
	14	<u> </u>	4.5	1.0	8.0	1./	0.2	3.2	2.8	-1.1	0./
	15		35.2 56.9	26.8	43.6	25.9	20.1	51.6	9.3	-0.8	19.5
	15	<u> </u>	50.8	48./	04.9	45.7	39.0	51.8		0.9	21.2
	16	1	5.5	1.4	9.3	4.3	1.5	/.0	1.1	-3./	5.9
	16	2	16.6	10.2	23.0	9.7	6.I	13.3	/.0	-0.4	14.3
	17	1	59.6	51.4	67.9	48.5	41.8	55.2	11.1	0.5	21.7
	17	2	64.4	56.5	72.4	51.8	45.6	58.0	12.7	2.6	22.7
	18	l	24.2	16.8	31.6	26.1	20.2	32.1	-1.9	-11.4	7.6
	18	2	45.9	38.1	53.8	38.2	33.0	43.3	7.8	-1.6	17.1
	19	1	17.9	11.2	24.5	23.5	16.4	30.7	-5.7	-15.5	4.1
ļ	19	2	40.5	32.4	48.6	43.4	37.3	49.5	-2.9	-13.0	7.3
ļ	20	1	42.5	34.8	50.2	44.1	38.3	50.0	-1.6	-11.3	8.0
	20	2	59.4	51.7	67.0	50.0	44.7	55.4	9.3	0.0	18.7
	21	1	37.0	29.2	44.8	43.6	36.7	50.5	-6.6	-17.0	3.8
	21	2	54.2	46.1	62.3	55.6	49.5	61.7	-1.4	-11.6	8.7
	22	1	62.5	54.0	70.9	65.5	59.0	72.0	-3.0	-13.7	7.7
	22	2	69.7	62.3	77.1	60.2	54.0	66.3	9.5	-0.1	19.2

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

	23	1	47.5	39.1	55.9	62.5	54.9	70.2	-15.0	-26.4	-3.6
1	23	2	64.9	56.9	73.0	68.0	61.2	74.8	-3.1	-137	74
2	23	1	75.1	67.4	82.9	62.2	55.5	68.9	12.9	27	23.2
3	24	2	67.6	507.4	75.5	63.5	55.5 57.4	69.7	12.9	_5.9	1/1
4 r	24	1	12.1	6.1	18.0	11 1	7.0	15 1	1.1	-5.5	۱۲.1 وم
5 6	25	1 2	12.1	10.2	10.0	11.1	1.0	13.1	1.0	-0.2	0.2 5 5
0 7	23	<u>ک</u>	10.7	10.5	23.1	19.5	14.4	24.2 70.1	-2.0	-10.0	3.3
, 8	26	1	/6.2	08.0	83.8	63.5	50.8	/0.1	12.7	2.6	22.8
9	26	2	69.4	61.6	11.2	66.9	60.9	/3.0	2.4	-/.4	12.3
10	27	1	50.4	41.5	59.3	42.3	35.6	49.1	8.1	-3.1	19.3
11	27	2	57.2	48.9	65.4	52.6	46.3	58.9	4.6	-5.8	15.0
12	28	1	8.6	3.7	13.6	8.2	4.6	11.8	0.5	-5.7	6.6
13	28	2	9.8	5.1	14.5	15.4	11.0	19.8	-5.6	-12.0	0.8
14	29	1	50.4	41.5	59.3	43.3	36.5	50.1	7.1	-4.1	18.3
15	29	2	59.2	51.1	67.4	55.9	49.7	62.2	3.3	-7.0	13.6
16 17	30	1	32.7	24.5	41.0	28.7	22.6	34.7	4.1	-6.1	14.3
17 19	30	2	49.2	41.0	57.4	46.9	40.5	53.3	2.3	-8.1	12.7
10	31	1	42.0	33.0	51.1	29.9	23.5	36.3	12.1	1.1	23.2
20	31	2	48.6	40.3	56.8	44.5	38.2	50.8	4.1	-6.3	14.5
21	32	1	3.9	0.4	7.3	5.3	2.2	8.5	-1.5	-6.2	3.2
22	32	2	9.4	4 2	14.5	91	57	12.6	0.2	-6.0	64
23	33	1	43.6	34.5	52.6	32.2	25.8	38.7	11.3	0.0	22.5
24	33	2	52.9	1.5 1.5 1.5	61.0	<u> </u>	23.0 41.9	54.5	11.5 4 7	-5.5	15.0
25	34	2 1	7.0	2 5	11.5	-0.2 6.2	-1.J 28	9.6	ч./ О 8	-5.5	15.0 6.4
26	24	1	7.0	2.5	12.4	14.4	2.0	9.0	0.8 5 8	12.5	0.4
27	54 25	<u>ل</u> 1	0.0 57.0	5.0 49.2	15.4	14.4	9.0 777	19.0	-3.0	-12.3	0.0
28	33 25	1	57.2	48.2	00.2	44.5	5/./	51.4	12.7	1.5	24.0
29 30	35	2	63.2	55.I	/1.4	62.5	56.4	68.7	0.7	-9.5	10.9
30	37	1	76.6	69.1	84.1	72.9	66.7	79.1	3.7	-6.0	13.4
32	37	2	81.6	/4.9	88.3	78.9	73.5	84.2	2.7	-5.8	11.3
33	38	1	59.0	49.9	68.0	54.7	47.8	61.7	4.2	-7.2	15.6
34	38	2	56.1	47.8	64.4	51.2	44.7	57.6	4.9	-5.6	15.4
35	39	1	0.0	0.0	0.0	5.4	-0.9	11.8	-5.4	-11.8	0.9
36	39	2	5.8	-3.1	14.7	9.1	1.3	16.9	-3.3	-15.1	8.5
37	40	1	0.0	0.0	0.0	1.4	-0.2	3.0	-1.4	-3.0	0.2
38	40	2	1.1	-0.4	2.6	1.8	0.2	3.4	-0.7	-2.9	1.4
39	40	1	17.6	10.9	24.4	10.6	6.5	14.7	7.0	-0.9	14.9
40 41	40	2	8.0	3.9	12.1	8.5	4.9	12.2	-0.6	-6.0	4.9
42	42	1	52.6	44.3	61.0	43.8	36.9	50.6	8.9	-2.0	19.7
43	42	2	47.5	39.4	55.6	41.8	35.6	48.1	5.7	-4.6	15.9
44	43	1	35.6	27.4	43.8	25.6	19.8	31.5	10.0	-0.1	20.1
45	43	2	35.5	28.0	43.0	26.9	21.5	32.4	8.6	-0.7	17.8
46	44	1	10.1	4 2	16.0	12.2	73	17.1	-2.1	-9.8	5.6
47	44	2	20.6	14.1	27.0	21.6	16.3	26.8	-1.0	_9.3	73
48	45	1	20.0	_1 7	27.0	21.0 7.8	0.4	15.2	1.0	-1/1.3	16.8
49	45	2	5.0	00	22.7	5.2	0.4	10.1	1.2 1.4	15.8	18.7
50	43	ے 1	62.4	-9.9 516	23.2 72.2	566	40.0	10.1	1. 4 6.0	-13.0	10.7
51	40	1	03.4	54.0	12.2	50.0	49.9	05.2	0.9	-4.2	17.9
52 53	40	ے 1	08.9	01.1	/0./	01./	33.3	0/.9 42 5	1.2	-2.8	1/.2
54	4/		55.0	24./	41.4	55.9	29.3	42.5	-2.8	-13.5	/.8
55	4/	2	/0.4	62.8	//.9	00.0	60.6	12.1	3.7	-6.0	13.4
56	48	1	68.8	60.6	77.0	64.9	58.5	71.4	3.9	-6.5	14.3
57	48	2	76.2	69.3	83.0	70.7	64.9	76.5	5.4	-3.6	14.4
58	49	1	66.5	57.9	75.1	64.5	57.1	71.8	2.1	-9.2	13.3
59	49	2	68.6	59.9	77.3	67.3	60.6	73.9	1.3	-9.7	12.3
60			For peer revi	ew only - h	nttp://bmjop	pen.bmj.con	n/site/abou	lt/guidelines.	kntml		

51	2	40.6	14.0	63.7	63.7	48.8	90.2 78.5	-23.0	-50.5	-22. 4.:
52	1	73.0	65.1	80.9	69.2	62.7	75.6	3.8	-6.3	14.
52	2	83.8	78.2	89.3	82.1	77.1	87.0	1.7	-5.7	9.

For beer terien only

1
2
3
4
5
6
0
/
8
9
10
11
12
13
14
15
16
17
18
10
19
20
21
22
23
24
25
26
27
28
29
30
31
37
22
22 24
34 25
35
36
37
38
39
40
41
42
43
44
45
46
40
4/

Indicator ^a 37 37 38 38 52 52 a. For text b. 1 Auran c. Estimate	District ^b	3-5 mo Point estimate 72.3 91.3 49.7 69.7	Confide interv Lower 62.7 85.8 39.3	ple ence ⁷ al ^c Upper 81.8 96.8	3-5 r Point estimate 70.4	nonth sampl Confid interv Lower 64.2	e ence /al ^c Upper 76.5	Point estimate	Difference Confidiinterv Lower	ence val Upper
Indicator ^a 37 37 38 38 52 52 a. For text b. 1 Aurar c. Estimat	District ^b	Point estimate 72.3 91.3 49.7 69.7	Confide interv Lower 62.7 85.8 39.3	ence <u>/al^c</u> Upper 81.8 96.8	Point estimate 70.4	Confid interv Lower 64.2	ence /al ^c Upper 76.5	Point estimate	Confid interv Lower	ence val Upper
37 37 38 38 52 52 a. For text b. 1 Aurar c. Estimate	1 2 1 2 1 2	estimate 72.3 91.3 49.7 69.7	interv Lower 62.7 85.8 39.3	7al ^c Upper 81.8 96.8	estimate 70.4	Lower 64.2	val ^c Upper 76.5	estimate	Lower	val Upper
37 37 38 38 52 52 a. For text b. 1 Auran c. Estimate	1 2 1 2 1 2 1 2	72.3 91.3 49.7 69.7	Lower 62.7 85.8 39.3	Upper 81.8 96.8	70.4	Lower 64.2	Upper 76.5		Lower	Upper
37 37 38 38 52 52 a. For text b. 1 Aurar c. Estimate	1 2 1 2 1 2	72.3 91.3 49.7 69.7	62.7 85.8 39.3	81.8 96.8	70.4	64.2	76.5	19	133	0.4
37 38 38 52 52 a. For text b. 1 Aurar c. Estimat	2 1 2 1 2 1 2	91.3 49.7 69.7	85.8 39.3	96.8	86 2		,	1.7	15.5	-9.2
38 38 52 52 a. For text b. 1 Aurar c. Estimate	1 2 1 2	49.7 69.7	39.3		00.2	81.8	90.6	5.1	12.2	-2.0
38 52 52 a. For text b. 1 Aurar c. Estimate	$\begin{array}{c} 2\\ 1\\ 2\\ \hline \end{array}$	69.7		60.2	45.8	38.9	52.6	4.0	16.4	-8.5
52 52 a. For text b. 1 Aurar c. Estimat	$\frac{1}{2}$		61.2	78.2	64.4	58.3	70.5	5.4	15.8	-5.
52 a. For text b. 1 Aurar c. Estimat	2	39.7	28.6	50.7	65.3	58.8	71.8	-25.6	-12.8	-38.4
a. For textb. 1 Aurarc. Estimate	T 11 C1	45.8	35.6	55.9	55.2	49.1	61.2	-9.4	2.4	-21.2
	ngabad, 2 Gopa ed with Stata co	lganj ommand svy	<u>)</u>							

1		
2		
3	1	
4	1	
5		
6	3	How well do mothers recall their own and their infants's perinatal events? a two-district
7	4	study using cross-sectional stratified random sampling in Bihar, India
, 8	5	
0	6	
10	0	
10	1	
11	8	Joseph J Valadez ^{1*} , Baburam Devkota ¹ , Caroline Jeffery ¹ , Wilbur C. Hadden ²
12	9	
13	10	¹ Department of International Public Health I iverpool School of Tropical Medicine
14	10	
15	11	Liverpool, United Kingdom
16	10	
17	12	² Department of Sociology, Center for Innovation, University of Maryland, USA
18		
19	13	* Corresponding author: Professor Joseph J Valadez, Department of International Public
20	14	Health, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, L3 50A
21	15	United Kingdom Email: josenh valadez@lstmed ac.uk: Mohile: +44(0)754.8523717
22	10	$\frac{1}{10000000000000000000000000000000000$
22	10	
23	17	
24	17	Manuscript word length: 2255
25	18	
20		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
<u>⊿</u> 2		
75 N N		
44 15		
45		
46		
4/		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		

1	Abstract
3	Objective: Global monitoring of maternal, newborn and child
4	health (MNCH) programmes use self-reported data subject to
5	recall error which may lead to incorrect decisions for
e	improving health services and wasted resources. To minimize
7	this risk, samples of mothers of infants aged 0-2 and 3-5
8	months are sometimes used. We test whether a single sample
ç	of mothers of infants 0-5 months provides the same
10	information.
11	Design: An annual MNCH household survey in 2-districts of
12	<u>Bihar, India (N=6million).</u>
13	Participants: Independent samples (n=475 each) of mothers
14	of infants 0-5, 0-2 and 3-5 months.
15	Outcome measures: Main analyses compare responses from the
16	0-5 and 0-2 month samples with Mantel-Haenszel-Cochran
17	statistics using 51 indicators in 2-districts.
18	Results: No measurable differences detected in 79.4%
19	(81/102) comparisons; 20.6% (21/102) display differences
20	for the main comparison. Sub-analyses produce similar
21	results. A difference detected for exclusive breastfeeding
22	is due to premature complementary-feeding by older infants.
23	Measurable differences were detected in 33% (8/24) of the
24	indicators on Front Line Worker (FLW) support, 26.9% (7/26)
25	of indicators of birth preparedness and place of birth and
I	

Page 52 of 78

BMJ Open

1	attendant, and 9.5% (4/42) of the indicators on neonatal
2	and antenatal care.
3	Conclusions: Differences in FLW visits and compliance with
4	their advice may be due to seasonal effects: mothers of
5	older infants 3-5 months were pregnant during the dry
6	<pre>season; mothers of infants 0-2 months were pregnant during</pre>
7	the monsoons, making transportation difficult. Useful
8	coverage estimates can be obtained by sampling mothers with
9	infants 0-5 months as with two samples suggesting that
10	mothers of young infants recall their own perinatal events
11	and those of their children. For some indicators (e.g.,
12	exclusive breast feeding) it may be necessary to adjust
13	targets. Excessive stratification wastes resources, does
14	not improve the quality of information, and increases the
15	burden placed on data collectors and communities, which can
16	increase non-sampling error.
17	INTRODUCTION
18	Global monitoring of maternal, newborn and child health
19	(MNCH) programmes use self-reported data subject to recall
20	error which leads to incorrect decisions for improving
21	health services and wasted resources. To minimize this
22	risk, samples of mothers of infants aged 0-2 and 3-5 months
23	are sometimes used. We report a test of whether a single

1	sample of mothers of infants 0-5 months provides the same
2	information.
3	METHODS
4	An annual MNCH household survey in two districts of Bihar,
5	India (N=6million), collected data from independent samples
6	of mothers of infants 0-5, 0-2 and 3-5 months. Analyses
7	compare responses from the 0-5 and 0-2 month samples
8	(n=950), 0-2 and 3-5 month subsamples (n=475), 0-2 month
9	sample and 0-2 month subsample (n=713 <u>6759</u>), and 3-5 month
10	sample and 3-5 month subsample (n=713 <u>666</u>) to assess recall
11	bias using 51 indicators with Mantel-Haenszel-Cochran
12	statistics.
12	
15	RESULTS
13	No measurable differences are detected in 79.4% of
13 14 15	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main
13 14 15 16	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main comparison of the 0-5 and 0-2 month samples. The other sub-
13 14 15 16 17	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main comparison of the 0-5 and 0-2 month samples. The other sub- analyses produced similar results. A difference detected
13 14 15 16 17 18	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main comparison of the 0-5 and 0-2 month samples. The other sub- analyses produced similar results. A difference detected for exclusive breastfeeding is due to early commencement of
13 14 15 16 17 18 19	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main comparison of the 0-5 and 0-2 month samples. The other sub- analyses produced similar results. A difference detected for exclusive breastfeeding is due to early commencement of complementary-feeding by older infants. There are
13 14 15 16 17 18 19 20	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main comparison of the 0-5 and 0-2 month samples. The other sub- analyses produced similar results. A difference detected for exclusive breastfeeding is due to early commencement of complementary-feeding by older infants. There are measurable differences in a third of the indicators on
13 14 15 16 17 18 19 20 21	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main comparison of the 0-5 and 0-2 month samples. The other sub- analyses produced similar results. A difference detected for exclusive breastfeeding is due to early commencement of complementary-feeding by older infants. There are measurable differences in a third of the indicators on front line worker (FLW) support, about a quarter of
13 14 15 16 17 18 19 20 21 22	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main comparison of the 0-5 and 0-2 month samples. The other sub- analyses produced similar results. A difference detected for exclusive breastfeeding is due to early commencement of complementary-feeding by older infants. There are measurable differences in a third of the indicators on front line worker (FLW) support, about a quarter of indicators of birth preparedness and place of birth and
13 14 15 16 17 18 19 20 21 22 23	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main comparison of the 0-5 and 0-2 month samples. The other sub- analyses produced similar results. A difference detected for exclusive breastfeeding is due to early commencement of complementary-feeding by older infants. There are measurable differences in a third of the indicators on front line worker (FLW) support, about a quarter of indicators of birth preparedness and place of birth and attendant, a sixth or less of indicators on neonatal and
 13 14 15 16 17 18 19 20 21 22 23 24 	No measurable differences are detected in 79.4% of comparisons while 20.6% display differences for the main comparison of the 0-5 and 0-2 month samples. The other sub- analyses produced similar results. A difference detected for exclusive breastfeeding is due to early commencement of complementary-feeding by older infants. There are measurable differences in a third of the indicators on front line worker (FLW) support, about a quarter of indicators of birth preparedness and place of birth and attendant, a sixth or less of indicators on neonatal and antenatal care. Differences in FLW visits and compliance

1	with their advice may be due to seasonal effects: mothers
2	of older infants 3-5 months were pregnant during the dry
3	<pre>season; mothers of children 0-2 months were pregnant during</pre>
4	the monsoons, making transportation difficult.
5	CONCLUSIONS
6	Useful coverage estimates can be obtained by sampling
7	mothers with infants $0-5$ months as with two cohorts: $0-2$
8	and 3-5 months suggesting that mothers of young infants
9	recall their own perinatal events and those of their
10	children, but for some indicators, for example exclusive
11	breast feeding, it may be necessary to adjust targets.
12	Excessive stratification wastes resources, does not improve
13	the quality of information, and increases the burden placed
14	on data collectors and communities. This burden can
15	increase non-sampling error.
16	STRENGTHS AND LIMITATIONS OF THIS STUDY
17	• Strength: The data were produced using stratified random sampling with no apparent
18	design effect leading to an efficient use of information.
19	Strength, Determine cellected from formale negliging to be formale date cellectors
	• Strength: Data were collected from remaie participants by remaie data collectors
20	• Strength: Data were collected from remaie participants by remaie data collectors which is likely to have reduced non-sampling error.
20 21	 Strength: Data were collected from remale participants by remale data collectors which is likely to have reduced non-sampling error. Strength: The <u>large</u> study population is very large coversing a large geographical
20 21 22	 Strength: Data were collected from remain participants by remain data collectors which is likely to have reduced non-sampling error. Strength: The <u>large</u> study population is very large coversing a large geographical area, reducing the likelihood that the results are pertinent only to a small group of
20 21 22 23	 Strength: Data were collected from remain participants by remain data collectors which is likely to have reduced non-sampling error. Strength: The <u>large</u> study population is very large coversing a large geographical area, reducing the likelihood that the results are pertinent only to a small group of mothers with infants, and ; results may be generalizable.

1	• Strength: Both weighted and unweighted results are presented giving strength to the
2	conclusions.
3	Limitation: Due to insufficient overlap of variables in the 0-5 month sample and
4	the 3-5 month sample, The study is confined to assessing data in the 0-2 month
5	sample vis a vis a 0-5 month sample of infants; a comparison between the 3-5
6	month sample vis a vis the 0-5 month sample <u>was not possible. would have been</u>
7	informative; however, insufficient overlap of variables in the 0-5 month sample
8	and 3-5 month sample prevented us for doing so.
9	Limitation: Non-independence of indicators precludes formal statistical testing
10	of difference between samplesOur study compares a 0-2 month subsample with
11	a 3-5 month subsample as an alternative.
12	•
13	Key Words:
14	Maternal recall, surveys, maternal health, MNCH, LQAS,
15	Bihar, India
16	
17	INTRODUCTION
18	The progress toward United Nations' Sustainable Development
19	Goal (SDG) 3 — is measured with 9 targets, including the
20	Maternal Mortality Ratio (MMR) and <u>the</u> under 5 mortality
21	rate (U5MR)_(1, 2). In India, Bihar is one of the largest
22	(population 110 million) and poorest (53% of households are
23	in the lowest wealth index quintile of India_(3)) states
I	

Page 56 of 78

2	
3	
4	
5 6	
7	
8	
9	
10	
12	
13	
14	
15	
10 17	
18	
19	
20	
21	
22	
24	
25	
26	
27	
29	
30	
31	
32 33	
34	
35	
36	
37	
39	
40	
41	
42 42	
43 44	
45	
46	
47	
48 49	
50	
51	
52	
53 5⊿	
55	
56	
57	
58 50	
60	

1

1	with high child and maternal mortality (U5MR=54,
2	MMR=208)(4) (see(5) for an evaluation of the health care
3	system in Bihar), and is a priority for donor support for
4	health systems strengthening (see (5) for an evaluation of
5	the health care system in Bihar).
6	To accelerate progress toward achieving SDG 3, state
7	governments in India pursue program <u>me</u> s of community-based
8	care (see_(6, 7) for descriptions and assessments of this
9	approach). Since 2011, the Bihar Ministry of Health has
10	supported an Integrated Family Health Initiative to improve
11	the availability, quality and use of prenatal, perinatal
12	and postnatal care for mothers and infants_(8).
13	The usual way to monitor progress toward achieving these
14	goals is with household surveys. Perhaps the most commonly
15	used surveys are cluster sample surveys such as the
16	Demographic and Health Surveys and the Multiple Indicator
17	Cluster Surveys_(9, 10). An alternative design is Lot
18	Quality Assurance Sampling (LQAS), which provides
19	comparable data but is decentralized to local health
20	services organisations and more useful for management and
21	programme planning(11). Several states in India find it
22	benefits their programs_(12). Surveys rely on the reports
23	of mothers of infants and young children, but these reports
24	are subject to several sources of potential error and bias

Page 57 of 78

1

BMJ Open

1	through interviewees not knowing, forgetting, and having
2	memory errors_(13, 14). Studies have shown both that
3	mothers can accurately report significant facts about the
4	birth and care of their children many years after the event
5	(15), but also that even immediately after giving birth
6	mothers may misreport details_(16-18). Studies of maternal
7	<pre>mothers recall of her their children's vaccination status</pre>
8	concluded that due to offsetting errors of maternal
9	reports, the resulting data accurately measured vaccination
10	rates_(19); the pattern of error revealed that mothers
11	whose children are up-to-date or nearly so tended to
12	underestimate their child's vaccination status whilst
13	mothers whose children have few vaccinations, overestimate
14	their coverage.
15	To improve the validity of collected data, knowledge,
16	practice and coverage surveys have used samples of mothers
17	of infants 0-11 months of age or 0-5 months of age and
18	children 6-11 months of age. In Bihar, local organisations
19	departed from this convention of sampling among these three
20	cohorts of children under one year of age and have been
21	monitoring their programs' progress by sampling five
22	dedicated cohorts: mothers of children 0-2, 3-5, 6-8, 9-11
23	and 12-23 months old with indicators focused on antenatal
24	care, safe delivery practices, infant and young child

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
1 <i>1</i>	
15	
16	
17	
1 V	
10	
י רכ	
20 21	
י∠ בר	
∠∠ יי	
2.J 7.A	
24	
25 76	
20 27	
21 つの	
20 20	
20	
20 21	
יכ ככ	
ວ∠ ວວ	
ככ זגכ	
34 35	
22 26	
30 27	
יכ 20	
20 20	
29 ⊿∩	
40 11	
41 13	
42 12	
43 11	
44 15	
45 16	
40 17	
47 10	
40 70	
49 50	
50	
ン1 5つ	
ン2 5つ	
53	
54 55	
55 56	
50 57	
/ נ הם	
20 20	
29 60	
σU	

1 2 3

1 feeding practices, immunisation, treatment seeking, and 2 more. To avoid the possibility of maternal recall error, 3 each of the five cohorts was asked questions particularly 4 relevant to a child's specific age group.

5 In countries such as India with high maternal and 6 child mortality rates, regular monitoring of related health 7 service coverage is critical to reducing these rates. 8 However, the survey designs should be affordable and 9 sustainable for local health systems; they should also 10 produce precise, unbiased estimates (20). In this study, we 11 explore whether information is gained by sampling cohorts of children aged 0-2 and 3-5 months or whether the sample 12 13 sizes can be reduced by 50% by creating one sample cohort 14 aged 0-5 months.

15 The research question we address is: "Do the health service 16 delivery coverage estimates from a sample of mothers of 17 infants aged 0-5 months differ from those obtained from a 18 sample of mothers of infants ages 0-2 months?" A corollary 19 to this question is: "Do mothers of infants 3-5 months of 20 age display more recall error relative to mothers of 21 infants 0-2 months of age for antenatal, delivery or young 22 infant health practices?" We compare district coverage 23 estimates obtained from two independent samples of infants 24 0-2 months and 0-5 months of age. The implications of this

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

BMJ Open

1	study are important for health systems researchers needing
2	results to appraise and improve their programmes.
3	METHODS
4	To answer this question, we collected information from a
5	sample of mothers with infants $0-5$ months old and a sample
6	of mothers with <u>infants</u> 0-2 month old infants in two
7	districts. This study took place within the context of a
8	larger survey that also sampled children 3-5, 6-8, 9-11 and
9	12-23 months of age. These four latter samples used
10	questionnaires with variables that either did not overlap
11	at all <u>or overlapped on very few indicators with the</u>
12	questionnaires used to interview the 0-5 month and 0-2 $$
13	month samples. Due to this constraint, in this study, we
14	only use the two aforementioned groups- to assess the
15	measurement of the indicators and refer only to them for
16	the remainder of this paper. The household sampling design
17	we used is a stratified random sample_(21). Within each
18	district, the strata are administrative units of the health
19	system, which in Bihar is called a <i>block</i> . Within each block
20	the primary sampling unit is the Anganwadi Centre
21	(Community Health Subcentre) Catchment Area (ACCA); 19 ACCA
22	are selected from each block with probability proportional to size. From each ACCA
23	one respondent is randomly selected from each age-group

	1	under study using segmentation sampling_(22, 23). The sample
I	2	size 19 for each block is chosen to maximize the probability of correctly classifying a
	3	block with reference to performance targets on health related indicators (95% reliability)
	4	while balancing the probability (10% margin of error) of incorrectly classifying a
	5	block and thereby failing to recognize either the accomplishments of local health care
	6	delivery systems or the local population's health care needs (22). For this purpose,
	7	principles of Lot Quality Assurance Sampling were used along with established
	8	probability tables (24-26).
	9	There are 14 and 11 blocks in Gopalganj and Aurangabad (N=6
	10	million), the two districts selected for this study,
	11	respectively. The total sample sizes are: (a) Gopalganj: 19
	12	x 14 blocks= 266 infants 0-2 months and 266 infants 0-5
	13	months, and (b) Aurangabad: 19 x 11 blocks= 209 infants $0-2$
	14	months and 209 infants 0-5 months. The 0-5 month old sample
	15	is 60% 0-2 months old and 40% 3-5 months old.
	16	Using summary data from each of the two samples we analyse
	17	the data with Cochran-Mantel-Haenszel (CMH)_(27) tests for
	18	51 dichotomous indicators (See Supplementary File Table S1)
	19	common to the two samples. The CMH tests theoretically have
	20	a Chi-square probability distribution with 1 degree of
	21	freedom. With a sufficient number of respondents or a
	22	sufficient number of blocks $_{7}$ the CMH test is equivalent to
	23	a_conditional logistic regression_(28: 114-115). In this
	24	analysis both the number of respondents and the number of

Page 61 of 78

1

59

60

BMJ Open

2 3	1	blocks only approach sufficiency. Consequently, the
4 5		
6	2	calculated chi-squares and probabilities must be considered
7 8 0	3	as approximations of their true values.
9 10 11	4	We calculate both unweighted and weighted estimates. The
12 13	5	unweighted estimates permit the results from smaller blocks
14 15	6	to have equal weight vis à vis larger ones. Since the
16 17 18	7	research question concerns an analysis of which age cohort
19 20	8	is most informative, the weighted estimates may not be as
21 22	9	useful as the unweighted ones. However, the weighted
23 24	10	estimates provide better point estimates of the indicators
25 26 27	11	at the district level. The effect of the weights on the
28 29	12	Chi-square statistics is to increase the contribution of
30 31	13	the larger blocks and decrease the contribution of the
32 33	14	smaller blocks. Hence, we report both sets of results (See
34 35 36	15	Supplementary File Tables S2-S3).
37 38	16	The Chi-square probability distribution puts the
39 40	17	differences between the districts on a probability scale
41 42 42	18	(See Supplementary File Table S2). To determine meaningful
43 44 45	19	differences in responses between the two age cohorts we
46 47	20	used a probability of 0.05 as a cut-off value and consider
48 49	21	differences with probabilities less than 0.05 to be
50 51 52	22	possibly meaningful and those with larger probabilities to
52 53 54	23	be likely due to sampling errors. With 102 comparisons (51
55 56 57 58	24	indicators weighted or unweighted) we must expect some to

/		
3	1	exceed this cut-off by chance alone. If all of the
5	2	comparisons were independent, we might randomly find 5
7 8	3	differences, but many of the indicators measure related
9 10	4	events (e.g., number of ANC visits and tetanus toxoid
11 12	5	vaccinations) and the weighted and unweighted estimates are
13 14 15	6	similar, so these indicators are not all independent and it
16 17	7	is not possible to calculate an expected number of
18 19	8	differences nor is it appropriate to interpret these
20 21 22	9	probabilities as measures of "statistical significance".
23 24	10	Patient and Public Involvement
25 26	11	This study does not involve patients. Also, the public was
27 28 20	12	not involved in the design, conduct and reporting of the
29 30 31	13	research. The public was engaged as interviewees. To
32 33	14	ensure local engagement we coordinated with the Bihar
34 35	15	Ministry of Health, local implementing non-governmental
36 37	16	organizations and our donor. We also shared the results
39 40 41	17	with them and offered further dissemination of results.
42 43	18	RESULTS
44 45	19	We find a high level of agreement between the two samples
46 47 48	20	(Table 1). Out of 102 weighted and unweighted comparisons
40 49 50	21	between the estimates from the $0-2$ month and $0-5$ month
51 52	22	samples there is no probable difference in 81 (79.4%) in

both the unweighted and weighted estimates. We detect that

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

1 probable differences exist for 13 comparisons (12.7%). For 2 the remaining eight comparisons the weighted and unweighted 3 estimates disagree. The weighted estimates find seven 4 differences that the unweighted estimates do not; the 5 unweighted estimates find one difference that the weighted 6 estimates do not find. 7 Table 1. Number of indicators by probability of a difference between the 0-2 months and the 0-5 months samples for weighted and unweighted samples 0 nweighted Aurangabad Gopalganj Total >= <.05 < .05 >= <.05 >= <.05 >= <.05 .05 < .05	78		BMJ Ot	ben			
1probable differences exist for 13 comparisons (12.7%). For2the remaining eight comparisons the weighted and unweighted3estimates disagree. The weighted estimates find seven4differences that the unweighted estimates do not; the5unweighted estimates find one difference that the weighted6estimates do not find.7Table 1. Number of indicators by probability of a difference between the 0-2 months and the 0-5 months samples for weighted and unweighted samples 10 Nuweighted9Weighted Aurangabad 05 05 05 05 0 3 41 4 81 7 $< .05$ 0 8 1 5 1 13 8910For different health service domains, the number of indicator comparisons varies from two (Exclusive12Breastfeeding-EBF) to 24 concerning home visits by Front13Line Worker (FLW) support (Table 2). The two principal FLW are Anganwadi workers and Accredited Social Health14Activists (ASHA).							
the remaining eight comparisons the weighted and unweighted estimates disagree. The weighted estimates find seven differences that the unweighted estimates do not; the unweighted estimates find one difference that the weighted estimates do not find. Table 1. Number of indicators by probability of a difference between the 0-2 months and the 0-5 months samples for weighted and unweighted samples Unweighted Aurangabad Gopalganj Total >= < .05 >= < .05 >= < .05 >= < .05 >= .05 d0 3 41 4 81 7 < .05 0 8 1 5 1 13 For different health service domains, the number of indicator comparisons varies from two (Exclusive Breastfeeding-EBF) to 24 concerning home visits by Front Line Worker (FLW) support (Table 2). The two principal FLW are Anganwadi workers and Accredited Social Health Activists (ASHA).	1	probable diffe	rences exist for	13 comparis	sons (12.7%).	For
3 estimates disagree. The weighted estimates find seven 4 differences that the unweighted estimates do not; the 5 unweighted estimates find one difference that the weighted 6 estimates do not find. 7 7 7 7 7 7 7 7 7 7 7 7 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 7 7 7 9 7 8 9 7 8 9 7 8 9 7 8 9 7 7 9 7 8 9 7 8 9 9 10 9 7 9 10 9 10 9 10 9 10 9 10 9 10 9 10 9 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 1	2	the remaining e	eight comparisons	the weight	ed an	d unweig	hted
4 differences that the unweighted estimates do not; the 5 unweighted estimates find one difference that the weighted 6 estimates do not find. 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 7 8 9 9 9 8 9 9 9 9 9 10 9 10 9 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10	3	estimates disag	gree. The weighte	d estimates	s find	seven	
5 unweighted estimates find one difference that the weighted 6 estimates do not find. 7 Table 1. Number of indicators by probability of a difference between the 0-2 months and the 0-5 months samples for weighted and unweighted samples Unweighted Aurangabad Gopalganj Total >= <.05 >= <.05 >= <.05 >= <.05 .05 .05 .05 .05 >= <.05 d0 3 41 4 81 7 <.05 0 8 1 5 1 13 8 10 For different health service domains, the number of indicator comparisons varies from two (Exclusive Breastfeeding-EBF) to 24 concerning home visits by Front Line Worker (FLW) support (Table 2). The two principal FLW are Anganwadi workers and Accredited Social Health Activists (ASHA).	4	differences that	at the unweighted	estimates	do no	t; the	
<pre>6 estimates do not find. 7 Table 1. Number of indicators by probability of a difference between the 0-2 months and the 0-5 months samples for weighted and unweighted samples Unweighted Aurangabad Gopalganj Total >= < .05 >= < .05 >= < .05 >= .05 40 3 41 4 81 7 < .05 0 8 1 5 1 13 8 9 10 For different health service domains, the number of 11 indicator comparisons varies from two (Exclusive 12 Breastfeeding-EBF) to 24 concerning home visits by Front 13 Line Worker (FLW) support (Table 2). The two principal FLW 14 are Anganwadi workers and Accredited Social Health 15 Activists (ASHA).</pre>	5	unweighted est	imates find one d	ifference t	hat t	he weigh	ited
7 7 Table 1. Number of indicators by probability of a difference between the 0-2 months and the 0-5 months samples for weighted and unweighted samples 10 Weighted 8 Aurangabad 9 Solution 10 For different health service domains, the number of indicator comparisons varies from two (Exclusive 11 Indicator comparisons varies from two (Exclusive 12 Breastfeeding-EBF) to 24 concerning home visits by Front 13 Line Worker (FLW) support (Table 2). The two principal FLW 14 are Anganwadi workers and Accredited Social Health 15 Activists (ASHA).	6	estimates do no	ot find.				
Table 1. Number of indicators by probability of a difference between the 0-2 months and the 0-5 months samples for weighted and unweighted samples Unweighted Weighted Aurangabad Gopalganj Total >= < .05 .05 .9 >= .05 40 3 41 4 81 7 < .05 0 8 1 5 1 13 8 9 10 For different health service domains, the number of 11 indicator comparisons varies from two (Exclusive 12 Breastfeeding-EBF) to 24 concerning home visits by Front 13 Line Worker (FLW) support (Table 2). The two principal FLW are Anganwadi workers and Accredited Social Health 15 Activists (ASHA).	7						
Aurangabad Gopalganj Total Aurangabad Gopalganj Total >= <.05 >= <.05 >= <.05 .05 .05 >= <.05 >= .05 40 3 41 4 81 7 <.05 0 8 1 5 1 13 8 9 10 For different health service domains, the number of 11 indicator comparisons varies from two (Exclusive 12 Breastfeeding-EBF) to 24 concerning home visits by Front 13 Line Worker (FLW) support (Table 2). The two principal FLW 14 are Anganwadi workers and Accredited Social Health 15 Activists (ASHA).		Table 1. Number difference bet samples for we	er of indicators l ween the 0-2 mon- eighted and unweig	by probabil ths and the ghted sampl	ity o: 0-5 r es	f a months	
$8 = .05 \qquad $		Unweighted	Aurangabad	Gopalganj	0.5	Total	0.5
<pre>>= .05 40 3 41 4 81 7 < .05 0 8 1 5 1 13</pre> 8 9 10 For different health service domains, the number of 11 indicator comparisons varies from two (Exclusive 12 Breastfeeding-EBF) to 24 concerning home visits by Front 13 Line Worker (FLW) support (Table 2). The two principal FLW 14 are Anganwadi workers and Accredited Social Health 15 Activists (ASHA).			>= < .05	>= < .	05	>= <	.05
8 9 10 For different health service domains, the number of 11 indicator comparisons varies from two (Exclusive 12 Breastfeeding-EBF) to 24 concerning home visits by Front 13 Line Worker (FLW) support (Table 2). The two principal FLW 14 are Anganwadi workers and Accredited Social Health 15 Activists (ASHA).		>= .05 < .05	40 3 0 8	41 1	4 5	81 1	7 13
For different health service domains, the number of indicator comparisons varies from two (Exclusive Breastfeeding-EBF) to 24 concerning home visits by Front Line Worker (FLW) support (Table 2). The two principal FLW are Anganwadi workers and Accredited Social Health Activists (ASHA).	8 9						
11 indicator comparisons varies from two (Exclusive 12 Breastfeeding-EBF) to 24 concerning home visits by Front 13 Line Worker (FLW) support (Table 2). The two principal FLW 14 are Anganwadi workers and Accredited Social Health 15 Activists (ASHA).	10	For different h	nealth service do	mains, the	numbe	r of	
Breastfeeding-EBF) to 24 concerning home visits by Front Line Worker (FLW) support (Table 2). The two principal FLW are Anganwadi workers and Accredited Social Health Activists (ASHA).	11	indicator compa	arisons varies fr	om two (Exc	clusiv	е	
13 Line Worker (FLW) support (Table 2). The two principal FLW 14 are Anganwadi workers and Accredited Social Health 15 Activists (ASHA).	12	Breastfeeding-H	EBF) to 24 concer	ning home v	visits	by Fron	ıt
14 are Anganwadi workers and Accredited Social Health 15 Activists (ASHA).	13	Line Worker (FI	LW) support (Tabl	e 2). The	two p	rincipal	FLW
15 Activists (ASHA).	14	are Anganwadi w	workers and Accre	dited Socia	al Hea	lth	
	15	Activists (ASHA	A).				
							1

Table 2. Number of indicator comparisons by subject domain showing a measurable										
difference using weigh	nted and unw	eighted estimate	es of C	-2 months	and 0-5 m	months				
samples										
Health Service Domain 📐 Total No measurable Measurable difference between										
	compariso	difference		0-2 and 0-	5 months	results				
	ns	between	Both	Unweight	Weight	Percent (%)				
		0-2 and		ed only	ed	indicators				
	6	0-5 months		_	only	with				
		results			_	different				
						results				
Antenatal care	22	21	0	0	1	5				
Place of birth & attendant	8	6	1	0	1	25				
Birth preparedness	18	13	3	0	2	28				
Front Line Worker support	24	16	6	0	2	33				
Maternal health	8	8	0	0	0	0				
Neonatal care	20	17	1	1	1	15				
Exclusive Breastfeeding	2	0	2	0	0	100				
Totals	102	81	13	1	7	21.9				

Τc

BMJ Open

3 4	1	
5	2	In the FLW support domain 33% of comparisons have probable
7 8	3	differences. The neonatal health domain has 20 comparisons
9 10	4	and the birth preparedness domain has 18; in these domains
11 12 13	5	15% and 28% show probable differences, respectively. Place
14 15	6	of birth and attendant, and maternal health each have eight
16 17	7	comparisons with 25%, or two comparisons, and 0
18 19	8	comparisons, respectively, showing a possible difference.
20 21 22	9	The differences between the two samples cluster around home
23 24	10	visits from FLW and behaviours associated with birth
25 26	11	preparedness and neonatal care. Details of these
27 28	12	differences are listed in Table 3.
29 30	13	For two indicators, both the weighted and unweighted
32 33	14	estimates display probable differences between the 0-2 and
34 35	15	0-5 months samples in both districts. For indicator #52,
36 37	16	the proportion exclusively breastfeeding, the 0-5 months
38 39	17	cohort has the lower estimate, and indicator #24, the
40 41 42	18	proportion of mothers visited by an ASHA at least once
43 44	19	during their last pregnancy, the 0-5 months sample gives
45 46	20	the higher estimate, about 74%, compared to 63% in the $0-2$
47 48	21	months sample (See Supplementary Tables S2-3).
49 50 51	22	
52 53	23	Additional analyses comparing subsamples of mothers of
54 55	23	infants $0-2$ months and $3-5$ months from the $0-5$ months
56 57	24	THEATES V 2 MONTHS AND 5 5 MONTHS FROM CHE V-5 MONTHS
58 59		For near review only - http://bmionon.hmi.com/cito/about/cuidolines.yhtml
nu		TO PECITEVIEW ONLY THUR, / DITIOPEN.DITI.COM/SILE/ADUUL/QUIDEITIES.XITUTI

sample, the sample of mothers of infants 0-2 months and the
 subsample of infants 0-2 month, and the sample of mothers
 of infants 3-5 months and the subsample of infants 3-5
 months produced similar results (See Supplementary Text and
 Tables S4a-b, Tables S5a-b and Table S6).

to occurrent of the terms of t

Page 67 of 78

	Tudian		Weighted Coverage (%)		p-value			
Health Service Domain and Indicator	tor No.	District	0-2 months	0-5 months	Unweighte d Estimate	Weighte d Estimat e	Estimate type	
Antenatal care		·				•		
Proportion of mothers of infants (0-2/0-5 months) registered during their last pregnancy	1	Aurangabad	85.2	77.6	0.0552	0.0365	Weighted	
Place of birth & attendant				1		1		
Proportion of mothers of infants (0-2/0-5 months) whose last child was delivered at a public facility	38	Gopalganj	51.2	61.6	0.0363	0.0159	Both	
Proportion of mothers of infants (0-2/0-5 months) whose last child was delivered at a health facility (private or public facility)	37	Gopalganj	78.9	85.5	0.0643	0.0459	Weighted	
Birth preparedness		1			1	1		
Proportion of mothers of infants (0-2/0-5 months) who planned transportation to health facility in their last pregnancy (home & institutional delivery)	15	Gopalganj	45.7	56.0	0.0266	0.0158	Both	
Proportion of mothers of infants (0-2/0-5 months) who identified persons to care for the baby immediately after birth (home + institutional delivery)	17	Gopalganj	51.8	62.6	0.0255	0.0103	Both	
Proportion of mothers of infants $(0-2/0-5 \text{ months})$ who planned for institutional delivery and	23	Aurangabad	62.5	47.0	0.0039	0.0052	Both	

Page 6	58 of	78
--------	-------	----

identified person to accompany							
her during the delivery							
	1.0		00 F	14 5	0.000	0.0400	F.7 1 1
Proportion of mothers who	19	Aurangabad	23.5	14.5	0.062	0.0429	weighte
planned for institutional							
delivery of infants (0-2/0-5							
months) who had a new blade &							
thread for their delivery							
Proportion of mothers who	21	Aurangabad	43.6	31.2	0.0546	0.0137	Weighted
planned institutional delivery							
of infants (0-2/0-5 months) who							
arranged clean cloth for mothers							
and baby							
Front Line Worker support							
Proportion of mothers of infants	24	Aurangabad	62.2	75.2	0.0023	0.0042	Both
(0-2/0-5 months) who were		Gopalganj	63.5	73.0	0.0284	0.0175	Both
visited by ASHA at least once							
during their last pregnancy							
Proportion of mothers of infants	26	Aurangabad	63.5	76.7	0.0021	0.0032	Both
(0-2/0-5 months) visited at home							
by FLWs at least once during							
their last pregnancy			•				
Proportion of mothers of infants	31	Aurangabad	29.9	44.9	0.0009	0.0016	Both
(0-2/0-5 months) visited at home			\mathbf{N}				
by ASHA within 24 hours of last							
delivery							
Proportion of mothers of infants	33	Aurangabad	32.2	46.7	0.0015	0.0026	Both
(0-2/0-5 months) visited at home							
by any FLW within 24 hours of							
last delivery							
Proportion of mothers of infants	35	Aurangabad	44.5	59.3	0.0018	0.0026	Both
(0-2/0-5 months) visited at home							
by any FLW within first week of							
last delivery							
Proportion of mothers of infants	34	Gopalganj	14.4	8.9	0.0959	0.0471	Weighted
(0-2/0-5 months) visited at home							
by any AWW within the first week							
of the last delivery							
Proportion of mothers of infants	27	Gopalganj	52.6	61.1	0.0617	0.0449	Weighted
(0-2/0-5 months) visited by							_

Page 69 of 78

last trimester of pregnancy Image: Constraint of the past of the pas								
Infant care Proportion of infants aged (0- 2/0-5 months) who were delivered at home continued with dry cord care 51 Aurangabad 78.0 45.4 0.0001 0.0006 Both Gopalganj 63.7 41.1 0.0431 0.0627 Unweigh d Proportion of infants aged (0- 2/0-5 months) weighed after birth (Public facility/Private facility/Home) 48 Gopalganj 70.7 78.2 0.0727 0.0464 Weights Proportion of infants (0-2/0-5 months) breast-fed in the past 24 hours (Exclusively Breast- fedFed) 52 Aurangabad 69.2 59.7 0.0229 0.0411 Both	last trimester of pregnancy							
Proportion of infants aged (0-2/0-5 months) who were delivered at home continued with dry cord care 51 Aurangabad 78.0 45.4 0.0001 0.0006 Both Gopalganj 63.7 41.1 0.0431 0.0627 Unweigh d Proportion of infants aged (0-2/0-5 months) weighed after birth (Public facility/Private facility/Home) 48 Gopalganj 70.7 78.2 0.0727 0.0464 Weight Proportion of infants (0-2/0-5 months) breast-fed in the past 24 hours (Exclusively Breast-fed in the past 24 hours (Exclus	Infant care				1		1	
Drob and home continued with dry cord care Gopalganj 63.7 41.1 0.0431 0.0627 Unweigr d d Proportion of infants aged (0- 2/0-5 months) weighed after birth (Public facility/Private facility/Home) 48 Gopalganj 70.7 78.2 0.0727 0.0464 Weight Exclusive Breastfeeding Exclusive Breastfeeding Exclusively Breast-feed in the past 24 hours (Exclusively Breast-feed) 52 Aurangabad 69.2 59.7 0.0229 0.0411 Both Gopalganj 82.1 68.4 0.0001 0.0003 Both	Proportion of infants aged (0- 2/0-5 months) who were delivered	51	Aurangabad	78.0	45.4	0.0001	0.0006	Both
Proportion of infants aged (0-2/0-5 months) weighed after birth (Public facility/Private facility/Home) 48 Gopalganj 70.7 78.2 0.0727 0.0464 Weight-facility/Private facility/Home) Exclusive Breastfeeding Proportion of infants (0-2/0-5 months) breast-fed in the past 24 hours (Exclusively Breast-fed facility/Breast-fed) 52 Aurangabad 69.2 59.7 0.0229 0.0411 Both Gopalganj 82.1 68.4 0.0001 0.0003 Both	at home continued with dry cord care		Gopalganj	63.7	41.1	0.0431	0.0627	Unweight d
Exclusive Breastfeeding Proportion of infants (0-2/0-5 months) breast-fed in the past 24 hours (Exclusively Breast-fed) 52 Aurangabad 69.2 59.7 0.0229 0.0411 Both Gopalganj 82.1 68.4 0.0001 0.0003 Both fedFed) 68.4 0.0001 0.0003 Both	Proportion of infants aged (0- 2/0-5 months) weighed after birth (Public facility/Private facility/Home)	48	Gopalganj	70.7	78.2	0.0727	0.0464	Weighte
Proportion of infants (0-2/0-5 months) breast-fed in the past 24 hours (Exclusively Breast-fed in the past fedFed) 52 Aurangabad 69.2 59.7 0.0229 0.0411 Both Gopalganj 82.1 68.4 0.0001 0.0003 Both	Exclusive Breastfeeding							
months) breast-fed in the past 24 hours (Exclusively Breast- fedFed) Gopalganj 82.1 68.4 0.0001 0.0003 Both 0.0003 Control Con	Proportion of infants (0-2/0-5	52	Aurangabad	69.2	59.7	0.0229	0.0411	Both
er review	months) breast-fed in the past 24 hours (Exclusively Breast- fedFed)	5	Gopalganj	82.1	68.4	0.0001	0.0003	Both
		20	1					

1		
2 3	1	
4	1	
5 6 7	2	DISCUSSION
8 9 10	3	Statement of principal findings
11 12	4	There are no measurable differences in coverage estimates
13 14 15	5	for 79.4% (81 comparisons) of the indicator comparisons
16 17	6	between the samples of mothers with infants 0-2 months old
18 19	7	versus mothers of infants 0-5 months old; 12.7% (13
20 21	8	comparisons) display measurable differences. The remaining
22 23 24	9	7.8% (eight comparisons) display discrepancies between the
24 25 26	10	weighted and unweighted estimates.
27 28 29	11	Strengths and weaknesses of the study
30 31	12	The strengths of this study are that it compares estimates
32 33	13	from two independent samples and that there are many
34 35 36	14	estimates from diverse domains. The weaknesses of this
37 38	15	study are that the data were collected in only 2 districts
39 40	16	of 1 state in India and in different months of a single
41 42 43	17	year, and that indicators from the sample of mothers of $-3-$
44 45	18	5 month old infants comparable to those of the 0-2 month
46 47	19	old infants, using the same questionnaire, were not
48 49	20	collected. Supplemental analyses comparing 0-2 and 3-5
50 51 52	21	month subsamples of the 0-5 sample did not uncover evidence
53 54 55 56	22	of bias due to the combination of these two age groups.
57		

BMJ Open

Strengths and weaknesses in relation to other studies Other studies of maternal recall bias have sought a "gold standard" to represent reality and to evaluate measures. Our study, of course, is interested in reality, but this study compares alternative measures needed to assess the Bihar health program. It also uses a complete sample of the age grouping under study rather than just a sub-sample of a larger age grouping. A weakness of this approach is that the analysis does not result in a formal statistical test; our conclusion is based on the weight of the evidence.

12 Meaning of the study

The evidence indicates that samples of the broader group yield comparable results to those of the narrower age group. It is not necessary to double the total sample by measuring independently 0-2 months and 3-5 months cohorts of children. These results also tend to dispel the hypothesis that maternal recall is problematic for mothers during the first 6 months following delivery. Our results are more consistent with conclusions presented in earlier research_(15) and they support those organizations collecting data with 0-5 month cohorts.
4	
5	
6 7	
8	
9 10	
10	
12	
13 14	
15	
16	
17	
19	
20 21	
22	
23	
24 25	
26	
27 28	
29	
30 31	
32	
33	
34 35	
36	
37 38	
39	
40 41	
42	
43	
44 45	
46	
47 48	
49	
50 51	
52	
53	
54 55	
56	
57 58	
59	
60	

1 2

1	Indicator #52, EBF, displayed two comparisons measuring
2	decreases in both districts. This is not surprising as
3	fewer infants are expected to be exclusively breast fed in
4	a sample ranging from 0 to 5 months than a sample ranging 0 $\!\!\!$
5	to 2 months; mothers introduce complementary feeding and
6	liquids as infants age despite this being a health risk.
7	This difference could be accommodated by adjusting
8	expectations and targets for the indicator.
0	
9	Unanswered questions and future research

Further investigation and consideration of the differences 10 11 is warranted. The eight differences found in the FLW 12 support indicators deserve more scrutiny. Seven show higher 13 estimates for the 0-5 cohort and one has a higher estimate for the 0-2 month cohort. - The former seven differences 14 15 may be due to excessive rainfall during the July-September (monthly average 318.95mm, range:195.99-395.8mm) versus the 16 17 lesser rainfall during June-April (monthly average 25.52mm, 18 range: 0.3-27.88mm) which in the last trimester may have 19 reduced the access of ASHA in the 0-2 month cohort (29). 20 Indicators such as these may be particularly sensitive to 21 rainfall and may explain why more mothers in the 0-5 month 22 cohort displayed higher FLW visitation estimates since FLW

2

BMJ Open

3	1	were not impeded by the monsoon and the resulting muddy
5	2	roads.
7 8	3	Differences in birth preparedness and institutional birth
9 10	4	may be a consequence of the differences in rainfall or in
11 12 12	5	FLW support; the results signal a with increases a response
13 14 15	6	to the needs for more careful planning when transportation
16 17	7	is difficult and decreases due to a reductions in the
18 19	8	educational offectiveness of the FIW by reducing
20	8	educational <u>effectiveness</u> eriores of <u>the</u> rim <u>by reducing</u>
21 22	9	their access to women. Or, some of these differences may
23 24	10	just be due to noise in the data.
25 26	11	
27 28	10	CONCLUSIONS
29	12	
30 31	13	Overall, the answer to the research question, "Can one get
32 33	14	the same district coverage estimates from a sample of
34 35 36	15	mothers of infants aged 0-5 months as from a sample of
37 38	16	mothers of infants ages 0-2 months?" is yes. This result
39 40	17	can be paraphrased as: mothers do not display increased
41 42	18	recall errors of their perinatal health care behaviour in a
43 44 45	19	cohort of mothers with infants 0-5 months as compared with
46 47	20	mothers with younger infants. Substantial resources and
48 49	21	effort can be saved using a survey design that avoids
50 51	22	needless expenses to collect data that provides
52 53 54	23	insubstantial amounts of information. It also reduces the
55 56 57 58	24	burden on data collectors and community participants.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

1										
2 3	1	Fatique t	o both	aroups	can	result	in ne	edless	non-sam	olina
4 5	1	1401940		groupo	oun	100410			non bam	222119
6	2	error.								
7										
8 9										
10										
11 12										
12										
14										
15 16										
17										
18 10										
20										
21										
22										
24										
25 26										
27										
28 20										
30										
31										
32 33										
34										
35 36										
37										
38 39										
40										
41 42										
43										
44 45										
45 46										
47										
48 49										
50										
51 52										
53										
54 55										
55 56										
57										
58 59										С
60		F	or peer revi	ew only - ht	tp://bm	jopen.bmj.c	om/site/	about/guid	elines.xhtml	Z

ACKNOWLEDGMENTS

We gratefully acknowledge the essential roles of Hemant Das, Alok Prahdan and Sanjay Biswa for their careful field work supporting the LQAS survey and the HMIS data retrieval. We thank Prof Imelda Bates, Prof Brian Faragher and Nancy Vollmer for their valuable feedback on an earlier version of this manuscript. This work was supported by the Bill and Melinda Gates Foundation (Investment ID OPP1142889).

ETHICS

The Ethical Committees of the Indian Institute of Public Health (No IIPHB-IEC-2016/010) and the Liverpool School of Tropical Medicine Research Ethics Committee approved the protocol, study instruments and consent procedures for the data collection of the household surveys (Research Protocol 16-023).

The Ethical Committees of the authors' institutes approved the protocol, study instruments and consent procedures for the survey data collection.

COMPETING INTERESTS

The authors have read the statement on competing interests and declare that they have none.

AUTHORS' CONTRIBUTIONS

JJV, BD developed the research question and survey design; WH, CJ carried out the statistical analyses; JJV obtained

the funding and donor support for the research; BD trained and managed the survey teams in Bihar; JJV, WH, CJ interpreted the data; CJ responsible for data curation; all authors wrote and reviewed the paper.

COMPETING INTERESTS

The authors have no competing interests.

FUNDING

This research was funded by the Bill and Melinda Gates Foundation Investment ID OPP1142889

DATA SHARING STATEMENT

Data are available upon reasonable request.

REFERENCES

1. UNSTATS. Official list of MDG indicators: United Nations Statistics Division, Department of Economic and Social Affairs; 2005 [Available from:

https://unstats.un.org/unsd/mdg/Host.aspx?Content=Indicators/OfficialList.htm.

2. UN DESA. Sustainable Development Goals: Division for Sustainable Development Goals, United Nations Department of Economic and Social Affairs; 2015 [Available from: <u>https://www.un.org/sustainabledevelopment/sustainable-development-goals/</u>.

3. International Institute for Population Sciences (IIPS) and ICF. National Family Health Survey (NFHS-4), 2015-16: India. Mumbai: IIPS; 2017.

4. MOSPI. Millennium Development Goals India Country Report 2015. New Delhi: Social Statistics Division, Central Statistics Office, Ministry of Statistics and Programme Implementation; 2015.

5. Karvande S, Sonawane D, Chavan S, Mistry N. What does quality of care mean for maternal health providers from two vulnerable states of India? Case study of Bihar and Jharkhand. Journal of Health, Population and Nutrition. 2016;35(6):1-10.

6. Mohan P, Kishore B, Singh S, Bahl R, Puri A, Kumar R. Assessment of implementation of integrated management of neonatal and childhood illness in India. Journal of Health, Population and Nutrition. 2011;29(6):639-38.

7. Neogi SB, Sharma J, Chauhan M, Khanna R, Chokshi M, Srivastava, et al. Care of newborn in the community and at home. Journal of Perinatology. 2016;36(Suppl 3):s13-7.

8. CARE Family Health. Integrated Family Health Initiative: Catalysing change for healthy communities. 2013.

9. Blanc AK, Warren CE, McCarthy KJ, Kimani J, Ndwiga C, RamaRao S. Assessing the validity of indicators of the quality of maternal and newborn health care in Kenya. Journal of Global Health. 2016;6(1):1-11.

1	
2	
3	10 Eisele TP Rhoda DA Cutts FT Keating J Ren R Barros AJD et al Measuring
4	coverage in MNCH: Total survey error and the interpretation of intervention coverage
5	etimates from herest ald survey effort and the interpretation of intervention coverage
6	estimates from nousenoid surveys. PLoS Medicine. 2013,10(5).e1001380.
7	11. Anoke SC, Mwai P, Jeffery C, Valadez JJ, Pagano M. Comparing two survey
8	methods of measuring health-related indicators: Lot Quality Assurance Sampling and
9	Demographic Health Surveys, Tropical Medicine and International Health.
10	2015:20(12):1756-70
11	12 Valadaz II. Davikata D. Dradhan MM. Maharda D. Sanal CS. Dhariyyal A. at al
12	12. Valadez JJ, Devkola B, Pladhan Wivi, Menerda P, Sonal OS, Dhanwal A, et al.
13	Improving malaria treatment and prevention in India by aiding district managers to
14	manage their programmes with local information: a trial assessing the impact of Lot
15	Quality Assurance Sampling on programme outcomes. Trop Med Int Health. 2014.
16	13 Tourangeau R Remembering what happened. Memory errors and survey reports
17	In: Stone AA Johe IB Bachrach CA Cain VS Kurtzman HS editors The Science of
18	Calf and at a local for account of a matrice Maharah NIL Language Full and
19	Self-report : Implications for research and practice. Manwan, NJ: Lawrence Eribaum;
20	2000.
20	14. Bradburn NM. Temporal representation and event dating. In: Stone AA, Jobe JB,
21	Bachrach CA, Cain VS, Kurtzman HS, editors. The Science of Self-report : Implications
22	for research and practice Mahwah NJ: Lawrence Erlbaum: 2000
25	15 Tomeo CA Rich-Edwards IW Michels KB Berkey CS Hunter DI Frazier AL
25	15. Tomeo CA, Rich-Edwards 5 W, Wheners RD, Berkey CS, Hunter DJ, Hazler AL,
25	et al. Reproducibility and validity of maternal recall of pregnancy-related events.
20	Epidemiology. 1999;10(6):7/4-7.
27	16. Elkadry E, Kenton K, White P, Creech S, Brubaker L. Do mothers remember key
20	events during labor? American Journal of Obstetrics and Gynecology. 2003;189(1):195-
29	200
50 21	17 Li R Scanlon KS Serdula MK. The validity and reliability of maternal recall of
ו כ כח	herestfeeding mastice Nutrition Deviews 2005 (2/4):102-10
32	bleastieeding plactice. Nutrition Reviews. $2003,03(4).103-10$.
31	18. Miles M, Ryman TK, Dietz V, Zell E, Luman ET. Validity of vaccination cards
25	and parental recall to estimate vaccination coverage: A systematic review of the
<u> </u>	literature. Vaccine. 2013;31:1560-8.
20 27	19. Valadez JJ. Weld LH. Maternal recall error of child vaccination status in a
30	developing nation Am I Public Health 1992.82(1):120-2
20	20 Chan M. Kazatahking M. Loh Lowat I. Ohaid T. Schwaizer I. Sidiba M. at al
39 40	20. Chain W, Kazatchkine W, Loo-Levyt J, Obaiu T, Schweizer J, Shube W, et al.
40	Meeting the demand for results and accountability: a call for action on health data from
41	eight global health agencies. PLoS Med. 2010;7(1):e1000223.
42	21. Valadez JJ, Weiss W, Leburg C, Davis R. Assessing Community Health
45	Programs: A Trainer's Guide. Using LQAS for Baseline Surveys and Regular
44	Monitoring 2nd ed St Albans: Teaching-aids At Low Cost: 2007
45	22 Turner AG Magnani RI Shuaib M A not quite as quick but much cleaner
40 47	alternative to the Expanded Dreagramme on Immunization (EDI) Cluster Survey design
4/ 10	anemative to the Expanded Frogramme on minimumzation (EPI) Cluster Survey design.
40 40	International Journal of Epidemiology. 1996;25(4):198-203.
49	23. Davis RH, Valadez JJ. Improving the collection of knowledge, attitude and
50	practice data with community surveys: a comparison of two second-stage sampling
51	methods. Health Policy Planning. 2014:29(8):1054-60.
52	24 Dodge HF Romig HG Sampling inspection tables: single and double sampling
55	21. Douge III, Ronne IIO. Sumpring inspection autors. Single and double sampling.
54	2nu cu. mew York. John whey & Sons, 1939.
55	
56	
5/	
58	
59	For peer review only - http://hmiopen.hmi.com/site/shout/guidalines.yhtml
60	r or peer review only - http://binjopen.binj.com/site/about/guidelines.shtml

Robertson SE, Joseph J V. Global review of health care surveys using lot quality assurance sampling (LQAS), 1984–2004. Social Science & Medicine. 2006;63:1648-60.
Valadez JJ. Assessing child survival programmes in developing countries: testing

lot quality assurance sampling. Boston: Harvard University Press; 1991.

27. Mantel N. Chi-square tests with one degree of freedom: extensions of the Mantel-Haenszel procedure. J Am Stat Assoc. 1963;58(303):690-700.

28. Agresti A. An Introduction to Categorical Data Analysis. 2nd ed. Hoboken, New Jersey: Wiley-Interscience; John Wiley & Sons; 2007.

29. World Weather Online. Patna Monthly Climate Averages, Bihar, India 201<u>8.</u> [Available from: <u>https://www.worldweatheronline.com/patna-weather-</u> averages/bihar/in.aspx.

to beet eview only