

Appendix 1. Analytic Approach

1. Item Construction and Identifying Dimensions

1a. Exploratory data analysis: Item frequencies were calculated, and items were combined based on theory, practicality, understandability and item translation across study countries. Patterns of repeated events and co-occurring mistreatment incidents also were examined to determine the most appropriate scoring structure.

1b. To determine whether a psychometric approach was appropriate to develop the measures, a series of preliminary tests (examinations of principal components analysis (PCA), Bartlett's test of sphericity, the Kaiser-Meyer-Olin (KMO) measure of sampling adequacy) were performed on the dimensions separately and as a single composite measure to determine whether the items yielded a consistent factor structure (i.e., "factorability") (1, 2). To confirm this conclusion, PCA and exploratory factor analysis (EFA) were conducted on items from all dimensions, both separately by dimension and combined. *Results*: The final 7 scale items were satisfactory for factor analysis in all settings based on a significant p-value ≤ 0.05 on Bartlett's test of sphericity and Kaiser-Meyer-Olin (KMO) measures of sampling adequacy > 0.50 overall and for each item; the overall KMO was 0.75 in Nigeria, 0.61 in Ghana, and 0.76 in Guinea.

1c. Missing data: Completeness of the labor observation data was high for the mistreatment items at 98% (1,974/2,016). The pattern of missing data for the 42 women with incomplete or missing data collection forms was assessed within each country sample to determine if items were clustered by facility or by observer within a facility. While nearly two thirds of missing or incomplete data forms were in Guinea (27/42), no such clustering was observed. Women with missing data on the mistreatment items were not included in the analyses.

2. Interpersonal Abuse Scale Development: Psychometric Analysis

2a. Tetrachoric correlation matrices were examined during EFA to assess interrelatedness of the binary interpersonal abuse items in each country as well as to examine similarities and deviations in the factor structures across the three samples. Item uniqueness was assessed with the goal of minimizing uniqueness (using the benchmark of < 0.50 as "acceptable,"), though retaining items with high factor loading and theoretical importance to the construct were prioritized over low uniqueness (1). *Results*: While 3-4 items in each country had uniqueness values above the recommend value of 0.50, they were retained due to high factor loadings and theoretical importance of the items to the interpersonal abuse dimension.

2b. To assess reliability/internal consistency of the scale, a range of 0.15-0.50 corrected item-to-total and interitem correlations was used as evidence of internal consistency for new measures in early scale development (1-3). Scale reliability was also assessed via the Kuder-Richardson-20 (KR-20) coefficient (the corollary to Cronbach's alpha used for scales based on dichotomous items), where a coefficient of ≥ 0.70 is considered the benchmark for consistency in scale development (1, 2, 4, 5). *Results*: Tetrachoric correlations ranged between 0.22-0.62 in Nigeria, 0.24-0.58 in Ghana, and 0.18-0.57 in Guinea, with two exceptions: between threatened and insulted in Ghana and between physical abuse and negative comments in Guinea, both of which had pairwise correlations < 0.10 (**Appendix 1c**).

3. Index Development for Exams & Procedures and Unsupportive Birth Environment

3a. Consistent with the OECD approach for composite index development, item selection occurred using a theoretical framework (WHO typology of mistreatment), literature review, and expert opinion, and assessment of missing data and imputation during preliminary data analysis of the item pool (6).

3b. No normalization was required because all items were binary, defined as "0=no mistreatment" and "1=mistreatment."

4. Measure Validation and Reliability Assessment

4a. In assessing Spearman-Rank correlations between the three measures, correlations (<0.30 , $p>0.05$) across different measures provide evidence of construct validity and confirm that the measures should be assessed separately rather than as an overall composite measure.

4b. Predictive criterion validity (the extent to which measures are associated with theoretically related measures or outcomes in predictable ways) was assessed by regressing a global measure of satisfaction with care and intentions to delivery in the same facility in the future on ordinal mistreatment measure scores. These global satisfaction with care variables were obtained from linked data of women's responses on the WHO community survey tool. They have been used to assess construct validity in previous studies assessing mistreatment, RMC, and person-centered maternity care (7-12). We hypothesized that women with higher mistreatment scores would have: 1) higher odds of reporting overall dissatisfaction with care, and 2) lower odds of intending to deliver in the same facility for a future delivery. *Results:* Higher scale scores were positively associated with women's reports of dissatisfaction with their overall care experience in Ghana and Guinea, indicating predictive validity of the scale, though no association was observed in Nigeria. Evidence for predictive validity was limited for the Exams & Procedures Index and the Unsupportive Birth Environment Index (**Appendix 2b**).

4c. Reliability: Two additional tests of internal consistency were conducted on all three mistreatment measures to further determine the reliability of the Interpersonal Abuse Scale and to establish a degree of consistency in the two indexes. *To assess consistency of items within a measure:* the percent distributions of co-occurring mistreatment items were examined, whereby internally consistent measures would have higher proportions of items that occur with at least one or several other items in a measure (results available upon request). *To determine consistency of measure scores:* to determine if each item could distinguish between "high" and "low" scores of mistreatment, a binary variable was constructed where "high" scores included observations with scores higher than the country-specific mean, and "low" included those scoring at or below the country-specific mean (13, 14). The proportion of women experiencing a mistreatment item who had "high" and "low" scores was then calculated; if scores were internally consistent and distinguished between these two groups, we would expect to see a higher proportion of women in the "high" score group experiencing each item (14).

5. Performance of Measures

5a. Item frequencies, mean scores, and percent distributions of mistreatment scores were calculated separately by mistreatment measure and country.

5b. Other descriptive statistics were calculated to assess measure performance, including low and high scores and the range of item frequency (the number of items occurring in $<5\%$ and $>90\%$ of observations).

5c. Ceiling and floor effects were assessed through the percent distribution of observations with minimum and maximum scores, using 15% in either category as evidence of ceiling or floor effects; presence of these effects could indicate inadequate content validity (15, 16).

Selected statistics assessing full score distributions and overall measure performance are shown in **Appendix 4**.

6. Sensitivity Analyses

6a. Mistreatment items that included "don't know" or "not applicable" options that were originally coded as "0=no mistreatment" on the items to yield the most conservative estimates were recoded as "1=mistreatment" to yield the most inflated mistreatment estimates.

6b. Responses in the "don't know" or "not applicable" categories were also omitted to determine the impact of these structural changes on item inclusion in the final measures.

6c. Versions of the two indexes that included and omitted combinations of high and low frequency items were assessed for measure performance (based on criteria in Step 5).

6d. Measure score distributions and performance assessments and correlations between measures were calculated at the facility-level, rather than the country-level, to assess the level of heterogeneity in item and measure performance by facility.

References

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Appendix 2. Validation Analyses

Appendix 2a. Construct Validity Analysis: Tetrachoric Correlation Matrices of the 7-item Interpersonal Abuse Scale for Nigeria, Ghana, and Guinea

Tetrachoric correlation matrix:	Shouted	Insulted	Scolded	Mocked	Threatened	Negative comments	Physical abuse
NIGERIA (N=407)							
Shouted	1.00						
Insulted	0.44	1.00					
Scolded	0.59	0.62	1.00				
Mocked	0.43	0.61	0.41	1.00			
Threatened	0.47	0.39	0.36	0.54	1.00		
Negative comments	0.53	0.55	0.52	0.32	0.31	1.00	
Physical abuse	0.60	0.44	0.33	0.42	0.22	0.32	1.00
GHANA (N=912)							
Shouted	1.00						
Insulted	0.58	1.00					
Scolded	0.44	0.24	1.00				
Mocked	0.57	0.60	0.29	1.00			
Threatened	0.32	0.08	0.30	0.45	1.00		
Negative comments	0.57	0.49	0.34	0.43	0.46	1.00	
Physical abuse	0.58	0.58	0.33	0.29	0.30	0.37	1.00
GUINEA (N=655)							
Shouted	1.00						
Insulted	0.51	1.00					
Scolded	0.43	0.40	1.00				
Mocked	0.45	0.44	0.41	1.00			
Threatened	0.31	0.29	0.39	0.38	1.00		
Negative comments	0.23	0.37	0.24	0.57	0.33	1.00	
Physical abuse	0.48	0.54	0.26	0.39	0.18	0.07	1.00

Appendix 2b. Construct Validity Analysis: Spearman-Rank Correlations Between Mistreatment Measures by Country

Measurement	Interpersonal Abuse Scale	Exams & Procedures Index	Unsupportive Birth Environment Index
Nigeria (N=407)			
Interpersonal Abuse Scale	1.00		
Exams & Procedures Index	0.19	1.00	
Unsupportive Birth Environment Index	-0.06	-0.06	1.00
Ghana (N=912)			
Interpersonal Abuse Scale	1.00		
Exams & Procedures Index	0.13	1.00	
Unsupportive Birth Environment Index	0.002	0.10	1.00
Guinea (N=655)			
Interpersonal Abuse Scale	1.00		
Exams & Procedures Index	0.06	1.00	
Unsupportive Birth Environment Index	0.03	-0.08	1.00

*p<0.05

Appendix 2c. Criterion Validity Analysis: Bivariate Logistic Regressions of Measures of Satisfaction^a on mistreatment measure score by measure and country

	Interpersonal Abuse Scale OR (95% CI)			Exams & Procedures Index OR (95% CI)			Unsupportive Birth Environment Index OR (95% CI)		
	Nigeria (n=331)	Ghana (n=771)	Guinea (n=423)	Nigeria (n=331)	Ghana (n=771)	Guinea (n=423)	Nigeria (n=331)	Ghana (n=771)	Guinea (n=423)
Overall satisfaction with care									
Satisfied/neutral	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>
Dissatisfied	0.99 (0.81-1.21)	1.54* (1.20-1.99)	1.42* (1.08-1.85)	1.00 (0.85-1.18)	0.96 (0.52-1.75)	0.73 (0.33-1.60)	0.97 (0.62-1.54)	0.93 (0.68-1.27)	1.21 (0.88-1.68)
Would deliver in same facility in future									
No	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>
Yes	0.90 (0.56-1.44)	0.89 (0.74-1.06)	0.76* (0.60-0.96)	0.72 (0.32-1.58)	1.08 (0.79-1.47)	1.09 (0.63-1.86)	1.47 (0.98-2.23)	1.01 (0.85-1.21)	0.81 (0.2-1.05)

^a Based on women's reports from subset of linked labor observation and community survey data (Nigeria: N=331; Ghana: N=771; Guinea: N=423). Analyses adjusted for clustering within facilities.

* p<0.05

Appendix 3. Reliability/Internal Consistency: Distribution of Co-Occurring Mistreatment Items for Each Item by Measure

Appendix 3a. Distribution of Co-Occurring Mistreatment Items for Each Item by Measure, Nigeria (N=407, unless otherwise noted)*

Mistreatment Item	Number of Co-Occurring Items (%) ^a												Total (n)	n (%) without item ^b
	0	1	2	3	4	5	6	7	8	9	10	11		
<i>Interpersonal Abuse Scale (7 items)</i>														
Shouted	20.1	28.5	21.0	12.6	10.3	5.6	1.9	--	--	--	--	--	214	193 (47.4)
Insulted	7.3	13.4	14.6	20.7	24.4	14.6	4.9	--	--	--	--	--	82	325 (79.9)
Scolded	7.4	19.4	24.1	16.7	18.5	10.2	3.7	--	--	--	--	--	108	299 (73.5)
Mocked	3.5	20.7	25.3	16.1	17.2	12.6	4.6	--	--	--	--	--	87	320 (78.6)
Negative comments	2.1	17.0	25.5	17.0	17.0	12.8	8.5	--	--	--	--	--	47	360 (88.5)
Threatened	4.5	14.9	23.9	19.4	19.4	11.9	6.0	--	--	--	--	--	67	340 (83.5)
Physical abuse	12.7	22.7	20.9	13.6	15.5	10.9	3.6	--	--	--	--	--	110	297 (73.0)
Total Score (%) women with score of ≥ 1	--	28.2	28.2	19.4	9.9	8.4	4.4	1.5	--	--	--	--	273	134 (32.9)
<i>Exams & Procedures Index (3 items) (N=350)</i>														
Informed consent	18.2	32.4	49.5	--	--	--	--	--	--	--	--	--	275	75 (21.4)
Exposed	7.2	41.5	51.3	--	--	--	--	--	--	--	--	--	265	85 (24.5)
Confidential information	0.60	17.5	81.9	--	--	--	--	--	--	--	--	--	166	184 (52.3)
Total Score (%) women with score of ≥ 1	--	20.0	32.6	38.9	--	--	--	--	--	--	--	--	320	30 (8.6)
<i>Unsupportive Birth Environment Index (12 items)</i>														
Pain relief	--	0.3	9.3	47.9	38.1	3.7	0.8	--	--	--	--	--	378	29 (7.1)
No interpreter	--	--	--	--	33.3	33.3	33.3	--	--	--	--	--	3	404 (99.3)
No staff present at birth	--	--	9.7	29.0	22.6	32.3	6.5	--	--	--	--	--	31	376 (92.4)
Not offered labor companion	--	0.8	11.0	46.8	37.3	3.3	0.8	--	--	--	--	--	391	16 (3.9)
Neglect	--	--	--	--	50.0	33.3	16.7	--	--	--	--	--	6	401 (98.5)
Bribe	--	--	--	21.4	57.1	14.3	7.1	--	--	--	--	--	14	393 (96.6)
Clean up blood/fluids	--	--	--	16.7	33.3	33.3	16.7	--	--	--	--	--	6	401 (98.5)
Fluids	--	--	0.6	17.7	74.9	6.3	0.6	--	--	--	--	--	175	232 (57.0)
Mobilize	--	1.1	8.1	48.3	38.1	3.7	0.8	--	--	--	--	--	381	26 (6.4)
No curtains/partitions	--	1.1	8.3	46.6	39.4	3.6	0.8	--	--	--	--	--	360	47 (11.6)

Mistreatment Item	Number of Co-Occurring Items (%) ^a											Total (n)	n (%) without item ^b	
	0	1	2	3	4	5	6	7	8	9	10			11
No bed	--	--	20.0	--	--	20.0	40.0	20.0	--	--	--	--	5	402 (98.8)
Shared bed	--	--	--	--	--	100.0	--	--	--	--	--	--	1	406 (99.8)
Total Score (%) women with score of ≥ 1	--	--	1.5	11.8	46.7	35.8	3.4	0.7	--	--	--	--	407	n (%) scoring 0 0 (0.0)

Appendix 3a

* Table shows the percent distributions of co-occurring mistreatment items to evaluate internal consistency of items within each measure. Internally consistent measures have higher proportions of items that occur with at least one or several other items in a measure.

^a Proportions sum by row; ^b Proportions sum by column

Appendix 3b. Distribution of Co-Occurring Mistreatment Items for Each Item by Measure, Ghana (N=912, unless otherwise noted)*

Mistreatment Item	Number of Co-Occurring Items (%) ^a											Total (n)	n (%) without item ^b	
	0	1	2	3	4	5	6	7	8	9	10			11
<i>Interpersonal Abuse Scale (7 items)</i>														
Shouted	42.9	33.3	15.9	5.3	2.1	0.5	--	--	--	--	--	--	189	723 (79.3)
Insulted	15.4	11.5	42.3	23.1	3.9	3.9	--	--	--	--	--	--	26	886 (97.2)
Scolded	31.1	36.5	23.0	6.8	2.7	--	--	--	--	--	--	--	74	838 (91.9)
Mocked	9.1	31.8	31.8	9.1	13.6	4.6	--	--	--	--	--	--	22	890 (97.6)
Negative comments	32.7	36.7	14.3	8.2	6.1	2.0	--	--	--	--	--	--	49	863 (94.6)
Threatened	16.7	35.2	29.6	11.1	5.6	1.9	--	--	--	--	--	--	54	858 (94.1)
Physical abuse	27.0	33.8	23.0	9.5	5.4	1.4	--	--	--	--	--	--	74	838 (91.9)
Total Score (%) women with score of ≥ 1	--	54.2	28.5	12.0	3.5	1.4	0.4	--	--	--	--	--	284	n (%) scoring 0 628 (68.9)
<i>Exams & Procedures Index (3 items) (n=797)</i>														
Informed consent	90.8	6.2	2.9	--	--	--	--	--	--	--	--	--	578	219 (27.5)
Exposed	11.3	56.6	32.1	--	--	--	--	--	--	--	--	--	53	744 (93.4)
Confidential information	18.2	30.3	51.5	--	--	--	--	--	--	--	--	--	33	764 (95.9)
Total Score (%) women with score of ≥ 1	--	90.7	6.4	2.9	--	--	--	--	--	--	--	--	592	n (%) scoring 0 205 (25.7)
<i>Unsupportive Birth Environment Index (12 items)</i>														
Pain relief	0.4	15.9	35.4	39.1	8.7	0.5	--	--	--	--	--	--	785	127 (13.9)
No interpreter	--	--	25.0	33.3	33.3	8.3	--	--	--	--	--	--	12	900 (98.7)
No staff present at birth	--	--	17.7	11.8	58.8	11.8	--	--	--	--	--	--	17	895 (98.1)
Not offered labor companion	4.9	17.9	32.7	36.1	8.0	0.5	--	--	--	--	--	--	854	58 (6.4)
Neglect	--	--	50.0	50.0	--	--	--	--	--	--	--	--	2	910 (99.8)
Bribe	--	--	50.0	16.7	33.3	--	--	--	--	--	--	--	6	906 (99.3)
Clean up blood/fluids	--	--	--	--	--	--	--	--	--	--	--	--	0	912 (100)
Fluids	--	3.0	15.8	63.3	16.8	1.0	--	--	--	--	--	--	398	514 (56.4)
Mobilize	0.4	7.8	37.6	43.9	9.7	0.6	--	--	--	--	--	--	692	220 (24.1)
No curtains/partitions	--	5.1	15.9	43.5	34.1	1.5	--	--	--	--	--	--	138	774 (95.9)
No bed	--	12.5	25.0	50.0	12.5	--	--	--	--	--	--	--	8	904 (99.1)
Shared bed	--	--	--	63.6	18.2	18.2	--	--	--	--	--	--	11	901 (98.8)
														n (%) scoring 0

Mistreatment Item	Number of Co-Occurring Items (%) ^a											Total (n)	n (%) without item ^b	
	0	1	2	3	4	5	6	7	8	9	10			11
Total Score (%) women with score of ≥ 1	-	5.3	19.3	33.4	34.1	7.5	0.4	--	--	--	--	--	912	0 (0.0)

Appendix 3b

* Table shows the percent distributions of co-occurring mistreatment items to evaluate internal consistency of items within each measure. Internally consistent measures have higher proportions of items that occur with at least one or several other items in a measure.

^a Proportions sum by row; ^b Proportions sum by column

Appendix 3c. Distribution of Co-Occurring Mistreatment Items for Each Item by Measure, Guinea (N=655, unless otherwise noted)*

Mistreatment Item	Number of Co-Occurring Items (%) ^a											Total (n)	n (%) without item ^b	
	0	1	2	3	4	5	6	7	8	9	10			11
<i>Interpersonal Abuse Scale (7 items)</i>														
Shouted	40.3	34.5	14.4	7.2	2.9	--	0.7	--	--	--	--	--	139	516 (78.8)
Insulted	11.1	27.8	11.1	38.9	5.6	--	5.6	--	--	--	--	--	18	637 (97.3)
Scolded	38.5	30.8	11.5	12.8	5.1	--	1.3	--	--	--	--	--	78	577 (88.1)
Mocked	25.0	25.0	28.9	11.5	7.7	--	1.9	--	--	--	--	--	52	603 (92.1)
Negative comments	26.7	40.0	6.7	13.3	6.7	--	6.7	--	--	--	--	--	15	640 (97.7)
Threatened	40.9	18.2	9.1	18.2	9.1	--	4.6	--	--	--	--	--	22	633 (96.6)
Physical abuse	40.4	32.7	13.5	8.7	3.9	--	1.0	--	--	--	--	--	104	551 (84.1)
Total Score (%) women with score of ≥ 1	--	60.0	26.5	6.9	4.6	1.5	--	0.4	--	--	--	--	260	395 (60.3)
<i>Exams & Procedures Index (3 items) (n=391)</i>														
Informed consent	63.3	33.2	3.6	--	--	--	--	--	--	--	--	--	196	195 (49.9)
Exposed	32.7	61.1	6.2	--	--	--	--	--	--	--	--	--	113	278 (71.1)
Confidential information	55.3	26.3	18.4	--	--	--	--	--	--	--	--	--	38	353 (90.3)
Total Score (%) women with score of ≥ 1	--	69.7	27.6	2.7	--	--	--	--	--	--	--	--	261	130 (33.3)
<i>Unsupportive Birth Environment Index (11 items)</i>														
Pain relief	0.5	17.5	38.4	25.7	14.3	3.3	0.4	--	--	--	--	--	573	82 (12.5)
No interpreter	--	--	--	--	50.0	50.0	--	--	--	--	--	--	2	653 (99.7)

Mistreatment Item	Number of Co-Occurring Items (%) ^a											Total (n)	n (%) without item ^b	
	0	1	2	3	4	5	6	7	8	9	10			11
No staff present at birth	--	5.7	22.6	30.2	34.0	7.6	--	--	--	--	--	--	53	602 (91.9)
Not offered labor companion	2.3	18.0	37.7	24.4	13.6	3.3	0.4	--	--	--	--	--	579	76 (11.6)
Neglect	--	--	--	--	60.0	40.0	--	--	--	--	--	--	5	650 (99.2)
Bribe	--	--	9.5	23.8	52.4	11.9	2.4	--	--	--	--	--	42	613 (93.6)
Clean up blood/fluids	--	--	--	--	--	100.0	--	--	--	--	--	--	1	654 (99.9)
Fluids	0.5	4.0	23.8	34.7	27.2	8.9	1.0	--	--	--	--	--	202	453 (69.2)
Mobilize	--	1.6	16.8	40.0	31.2	8.8	1.6	--	--	--	--	--	125	530 (80.9)
No curtains/partitions	0.5	11.5	36.1	29.1	18.5	3.9	0.5	--	--	--	--	--	416	239 (36.5)
No bed	--	3.3	3.3	26.7	23.3	33.3	10.0	--	--	--	--	--	30	625 (95.4)
Shared bed	--	2.1	21.0	18.2	38.5	18.9	1.4	--	--	--	--	--	143	512 (78.2)
Total Score (%) women with score of ≥ 1	--	3.4	20.8	36.3	23.7	12.7	2.9	0.3	--	--	--	--	655	0 (0.0)

Appendix 3c

* Table shows the percent distributions of co-occurring mistreatment items to evaluate internal consistency of items within each measure. Internally consistent measures have higher proportions of items that occur with at least one or several other items in a measure.

^a Proportions sum by row; ^b Proportions sum by column

Appendix 4. Parallel Analysis Figures for 7-Item Interpersonal Abuse Scale from Principal Components Analysis in Nigeria, Ghana, and Guinea

