**TABLES AND FIGURES**



**Fig 1. Flow Chart of MICS 2012 data for the study population**



**Fig 2. Flow Chart of BDHS 2014 data for the study population**

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**Fig 3. Flow Chart of MICS 2019 data for the study population**

|  |  |  |
| --- | --- | --- |
|  |  |  |
| **Fig 4a. C-section delivery in MICS (2012)** | **Fig 4b. C-section delivery in BDHS (2014)** | **Fig 4c. C-section delivery in MICS (2019)** |

|  |  |  |
| --- | --- | --- |
|  |  |  |
| **Fig 5a. Count (diseases) variable in MICS (2012)** | **Fig 5b. Count (diseases) variable in BDHS (2014)** | **Fig 5c. Count (diseases) variable in MICS (2019)** |

**Table 1. Distribution of maternal and child characteristics including diseases count with the type of delivery**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sources** | **MICS 2012** | | | **BDHS 2014** | | | **MICS 2019** | | |
| **Type of Delivery** | | | **Type of Delivery** | | | **Type of Delivery** | | |
| **Caesarean**  **(n=1513)**  **N (%)** | **Normal (n=6408)**  **N (%)** | **p-value** | **Caesarean**  **(n=1062)**  **N (%)** | **Normal**  **(n=3495)**  **N (%)** | **p-value** | **Caesarean**  **(n=3306)**  **N (%)** | **Normal**  **(n=5877)**  **N (%)** | **p-value** |
| **Disease Count** | | | | | | | | | |
| 0 (No) | 20 (1.5) | 80 (1.2) | <0.001 | 518 (48.8) | 1813 (51.9) | <0.001 | 13 (0.4) | 39 (0.7) | <0.001 |
| 1 | 135 (10.1) | 981 (15.1) |  | 245 (23.1) | 607 (17.4) |  | 333 (10.1) | 583 (10.1) |
| 2 | 505 (37.6) | 2434 (37.5) |  | 162 (15.3) | 535 (15.3) |  | 823 (25.0) | 3486 (60.2) |
| 3 | 497 (37.0) | 2241 (34.5) |  | 122 (11.5) | 493 (14.1) |  | 1884 (57.3) | 1259 (21.7) |
| 4 | 137 (10.2) | 559 (8.6) |  | 15 (1.4) | 47 (1.3) |  | 220 (6.7) | 378 (6.5) |
| 5 | 49 (3.6) | 195 (3.0) |  | - | - |  | 16 (0.5) | 44 (0.8) |
| **Mother’s age group in years at birth** | | | | | | | | | |
| Mean (SD) | 25.4 (5.2) | 25.9 (6.0) | <0.001 | 24.9 (5.5) | 24.5 (5.8) | 0.038 | 25.4 (5.3) | 25.7 (5.7) | <0.009 |
| 15-19 | 171 (11.4) | 740 (11.6) | <0.001 | 191 (18.0) | 745 (21.3) | 0.402 | 427 (13.0) | 812 (14.0) | <0.001 |
| 20-34 | 1241(82.5) | 4952 (77.5) |  | 802 (75.5) | 2550 (73.0) |  | 2682 (81.5) | 4481 (77.4) |
| 35+ | 93 (6.1) | 700 (10.9) |  | 69 (6.5) | 200 (5.7) |  | 180 (5.5) | 497 (8.6) |
| **Religion** | | | | | | | | | |
| Islam | 1343 (88.9) | 5894 (92.2) | <0.001 | 961 (90.5) | 3236 (92.6) | 0.705 | 2955 (89.8) | 5373 (92.8) | <0.001 |
| Othersa | 167 (11.1) | 497 (7.8) |  | 101 (9.5) | 259 (7.4) |  | 334 (10.2) | 416 (7.2) |
| **Place of residence** | | | | | | | | | |
| Urban | 548 (36.3) | 1110 (17.4) | <0.001 | 532 (50.1) | 925 (26.5) | <0.001 | 952 (28.9) | 1029 (17.8) | <0.001 |
| Rural | 962 (63.7) | 5282 (82.6) |  | 530 (49.9) | 2570 (73.5) |  | 2337 (71.1) | 4760 (82.2) |
| **Geographical location** | | | | | | | | | |
| Barishal | 50 (3.3) | 428 (6.7) | <0.001 | 105 (9.9) | 435 (12.4) | <0.001 | 374 (6.5) | 134 (4.1) | <0.001 |
| Chattogram | 267 (17.7) | 1577 (24.7) |  | 169 (15.9) | 716 (20.5) |  | 1391 (24.0) | 589 (17.9) |
| Dhaka | 604 (40.0) | 1872 (29.3) |  | 262 (24.7) | 548 (15.7) |  | 1157 (20.0) | 1027 (31.2) |
| Khulna | 230 (15.2) | 524 (8.2) |  | 182 (17.1) | 346 (9.9) |  | 429 (7.4) | 480 (14.6) |
| Mymenshing | - | - |  | - | - |  | 543 (9.4) | 158 (4.8) |
| Rajshahi | 189 (12.5) | 656 (10.3) |  | 148 (13.9) | 406 (11.6) |  | 610 (10.5) | 429 (13.0) |
| Rangpur | 104 (6.9) | 788 (12.3) |  | 108 (10.2) | 440 (12.6) |  | 650 (11.2) | 319 (9.7) |
| Sylhet | 66 (4.4) | 547 (8.6) |  | 88 (8.3) | 604 (17.3) |  | 636 (11.0) | 153 (4.7) |
| **Mother’s education** | | | | | | | | | |
| None | 80 (5.3) | 1378 (21.6) | <0.001 | 43 (4.0) | 571 (16.4) | <0.001 | 102 (3.1) | 673 (11.6) | <0.001 |
| Primary incomplete | 78 (5.2) | 964 (15.1) |  | - | - |  |
| Primary | 142 (9.5) | 1096 (17.1) |  | 145 (13.7) | 1112 (31.8) |  | 419 (12.7) | 1646 (28.4) |
| Secondary incomplete | 660 (44.0) | 2360 (36.9) |  | 572 (53.9) | 1580 (45.2) |  | - | - |
| Secondary complete/ higher | 539 (36.0) | 594 (9.3) |  | 302 (28.4) | 232 (6.6) |  | 2768 (84.2) | 3471 (60.0) |
| **Wealth index** | | | | | | | | | |
| Richest | 735 (48.6) | 847 (13.3) | <0.001 | 471 (44.4) | 437 (12.5) | <0.001 | 1172 (35.6) | 1654 (28.6) | <0.001 |
| Richer | 351 (23.2) | 1046 (16.5) |  | 275 (25.9) | 673 (19.3) |  | 800 (24.3) | 1275 (22.0) |
| Middle | 192 (12.7) | 1308 (20.6) |  | 165 (15.5) | 709 (20.3) |  | 622 (18.9) | 1094 (18.9) |
| Poorer | 136 (9.0) | 1436 (22.6) |  | 99 (9.3) | 763 (21.8) |  | 438 (13.3) | 996 (17.2) |
| Poorest | 98 (6.5) | 1717 (27.0) |  | 52 (4.9) | 913 (26.1) |  | 257 (7.8) | 770 (13.3) |
| **Body mass index (mother)** | | | | | | | | | |
| Underweight | 50 (3.3) | 320 (5.0) | <0.001 | 153 (14.5) | 1005 (28.9) | <0.001 | 151 (4.6) | 309 (5.3) | <0.001 |
| Normal | 1034 (68.4) | 4934 (77.2) |  | 568 (53.7) | 2051 (58.9) |  | 2221 (67.5) | 4283 (74.0) |
| Overweight | 427 (28.3) | 1138 (17.8) |  | 336 (31.8) | 426 (12.2) |  | 917 (27.9) | 1197 (20.7) |
| **Breastfeeding status** | | | | | | | | | |
| Yes | 1483 (98.2) | 6208 (97.1) | 0.020 | 891 (83.9) | 3011 (86.1) | 0.018 | 3273 (99.5) | 5769 (99.6) | 0.374 |
| No | 27 (1.8) | 183 (2.9) |  | 171 (16.1) | 484 (13.9) |  | 16 (0.5) | 21 (0.4) |
| **Sex of the children** | | | | | | | | | |
| Male | 784 (51.9) | 3226 (50.5) | 0.331 | 575 (54.1) | 1768 (50.6) | 0.205 | 1758 (53.5) | 2914 (50.3) | 0.004 |
| Female | 727 (48.1) | 3166 (49.5) |  | 487 (45.9) | 1727 (49.4) |  | 1531 (46.5) | 2876 (49.7) |
| **Child’s age group in months** | | | | | | | | | |
| 0-11 | 766 (50.7) | 3138 (49.1) | 0.264 | 372 (35.0) | 1090 (31.2) | 0.168 | 1677 (51.0) | 2688 (46.4) | <0.001 |
| 12-23 | 744 (49.3) | 3254 (50.9) |  | 375 (35.3) | 1182 (33.8) |  | 1450 (44.1) | 2702 (46.7) |
| 24-35 | - | - |  | 315 (29.7) | 1223 (35.0) |  | 161 (4.9) | 400 (6.9) |
| **Size at birth** | | | | | | | | | |
| Very large | 5 (0.3) | 6 (0.1) | <0.001 | 23 (2.2) | 78 (2.2) | 0.009 | 60 (1.8) | 53 (0.9) | <0.001 |
| Larger than average | 326 (22.0) | 718 (12.2) |  | 154 (14.5) | 327 (9.4) |  | 435 (13.3) | 479 (8.4) |
| Average | 881 (59.4) | 3794 (64.6) |  | 710 (66.8) | 2379 (68.1) |  | 2188 (66.8) | 4089 (71.4) |
| Smaller than average | 228 (15.4) | 1134 (19.3) |  | 118 (11.1) | 480 (13.7) |  | 933 (16.3) | 933 (16.3) |
| Very small | 44 (3.0) | 222 (3.8) |  | 57 (5.4) | 230 (6.6) |  | 173 (3.0) | 173 (3.0) |
| **Weight at birth** | | | | | | | | | |
| Low | 306 (22.8) | 560 (37.0) | <0.001 | - | - | - | 2292 (73.2) | 1080 (66.6) | <0.001 |
| Normal | 1037 (77.2) | 952 (63.0) |  | - | - |  | 838 (26.8) | 541 (33.4) |

aOthers: Hinduism, Buddhism, Christianity

**Table 2. Model selection criteria for Poisson and NB model**

|  |  |  |  |
| --- | --- | --- | --- |
| **Data** | **Model** | **AICb** | **BICc** |
| **MICS (2012)** | Poisson | 24684.24 | 24698.17 |
| **NBa** | **24610.48** | **24621.38** |
| **BDHS (2014)** | Poisson | 13348.55 | 13361.40 |
| **NBa** | **12565.08** | **12584.35** |
| **MICS (2019)** | Poisson | 27400.02 | 27421.40 |
| **NBa** | **27165.02** | **27179.27** |

aNB: Negative Binomial,

bAIC: Akaike information criterion,

cBIC: Bayesian information criterion

**Table 3. Association between C-section (vs normal delivery) and common childhood diseases from the crude and adjusted NB models**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Model** | **Exposure** | **MICS 2012** | | **BDHS 2014** | | **MICS 2019** | |
| **RRa (95% CI)** | **p-value** | **RRa (95% CI)** | **p-value** | **RRa (95% CI)** | **p-value** |
| **Crude Model** | C-section vs.  normal delivery | 1.05  (1.02-1.08) | <0.001 | 1.08  (0.97-1.19) | 0.159 | 1.16  (1.14-1.18) | <0.001 |
| **Adjusted Modelb** | C-section vs.  normal delivery | 1.01  (0.97-1.04) | 0.071 | 1.15  (1.05 - 1.27) | 0.004 | 1.14  (1.11 - 1.17) | <0.001 |

aRR: Risk Ratio,

bModel adjusted for possible confounding factors

**Table 4. Association between C-section (vs normal delivery) and common childhood diseases from crude and adjusted PS models**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Model** | **Exposure** | **MICS 2012** | | **BDHS 2014** | | **MICS 2019** | |
| **ARR (95% CI)** | **p-value** | **ARR (95% CI)** | **p-value** | **ARR (95% CI)** | **p-value** |
| **Crude Model** | C-section vs.  Normal delivery | 1.12  (0.94-1.31) | 0.201 | 1.11  (1.01-1.23) | 0.042 | 1.02  (0.87-1.20) | 0.080 |
| **Adjusted Model** | C-section vs.  Normal delivery | 1.02  (0.90-1.14) | 0.082 | 1.17  (1.05-1.29) | 0.030 | 1.01  (0.98-1.03) | 0.075 |

**Supporting information**

**S1 Table. Unadjusted LR statistics for type 3 analysis**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Source** | **MICS 2012** | | **BDHS 2014** | | **MICS 2019** | |
| **Chi-Square** | **P-value** | **Chi-Square** | **P-value** | **Chi-Square** | **P-value** |
| **Type of Delivery** | 11.58 | <0.001 | 1.88 | 0.170 | 226.75 | <0.001 |

**S2 Table. Adjusted LR Statistics for Type 3 Analysis**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Covariates** | **MICS 2012** | | **BDHS 2014** | | **MICS 2019** | |
| **Chi-Square** | **P-value** | **Chi-Square** | **P-value** | **Chi-Square** | **P-value** |
| **Type of Delivery** | 0.08 | **0.071** | 8.24 | **0.004** | 106.25 | **<0.001** |
| **Mother Age** | 10.87 | **0.004** | 2.06 | 0.357 | 0.51 | 0.775 |
| **Religion** | 2.50 | 0.114 | 0.62 | 0.429 | 0.75 | 0.387 |
| **Place of residence** | 0.00 | 0.989 | 0.00 | 0.969 | 0.01 | 0.905 |
| **Geographical Location** | 60.13 | **<0.001** | 9.48 | 0.148 | 91.56 | **<0.001** |
| **Mother's education** | 8.95 | 0.062 | 3.76 | 0.288 | 0.05 | 0.973 |
| **Wealth Index** | 3.21 | 0.524 | 5.71 | 0.222 | 4.26 | 0.372 |
| **Body Mass Index** | 8.93 | **0.012** | 6.41 | **0.041** | 6.64 | **0.036** |
| **Breastfeed** | 0.99 | 0.321 | 2.63 | 0.105 | 2.54 | 0.111 |
| **Sex of the children** | 1.65 | 0.199 | 4.26 | **0.039** | 0.06 | 0.808 |
| **Child age** | 0.55 | 0.459 | 9.71 | **0.008** | 3.23 | 0.199 |
| **Size at birth** | 5.54 | **0.236** | 7.63 | 0.106 | 4.39 | 0.356 |
| **Weight at birth** | 4.02 | **0.045** | - | - | 0.10 | 0.750 |

**S3 Table. Influence of factors associated with childhood diseases (lower diseases and normal delivery vs. higher diseases due to C-section delivery)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sources** | **Adjusted Estimates** | | | | | | | | |
| **MICS 2012** | | | **BDHS 2014** | | | **MICS 2019** | | |
| **ARR\*** | **95% CI** | **p-value** | **ARR\*** | **95% CI** | **p-value** | **ARR\*** | **95% CI** | **p-value** |
| **Type of Delivery** | | | | | | | | | |
| C-section | 1.02 | 0.97-1.04 | 0.071 | 1.15 | 1.05 - 1.27 | 0.004 | 1.14 | 1.11-1.17 | <0.001 |
| Normal | 1 | - | - | 1 | - | - | 1 | - | - |
| **Mother’s age group in years at birth** | | | | | | | | | |
| 15-19 | 1.04 | 0.97-1.12 | 0.276 | 1.05 | 0.95-1.15 | 0.182 | 1.01 | 0.96-1.06 | 0.720 |
| 20-34 | 0.93 | 0.88-0.97 | 0.002 | 0.96 | 0.87-1.06 | 0.376 | 0.98 | 0.94-1.02 | 0.510 |
| 35+ | 1 | - | - | 1 | - | - | 1 | - | - |
| **Religion** | | | | | | | | | |
| Islam | 0.95 | 0.90-1.01 | 0.107 | 1.06 | 0.92-1.21 | 0.431 | 0.99 | 0.95-1.02 | 0.381 |
| Other religion (Hinduism, Buddhism, Christianity) | 1 | - | - | 1 | - | - | 1 | - | - |
| **Place of residence** | | | | | | | | | |
| Urban | 1.01 | 0.95-1.05 | 0.989 | 1.00 | 0.91-1.10 | 0.969 | 1.01 | 0.97-1.03 | 0.905 |
| Rural | 1 | - | - | 1 | - | - | 1 | - | - |
| **Geographical Location** | | | | | | | | | |
| Barishal | 0.94 | 0.82-1.08 | 0.486 | 1.00 | 0.85-1.17 | 0.981 | 0.94 | 0.90-0.99 | <0.001 |
| Chattogram | 0.90 | 0.81-0.99 | 0.037 | 1.07 | 0.94-1.22 | 0.319 | 0.88 | 0.84-0.92 | 0.017 |
| Dhaka | 0.90 | 0.82-0.99 | 0.029 | 0.94 | 0.82-1.07 | 0.339 | 0.95 | 0.90-1.01 | 0.420 |
| Khulna | 1.10 | 0.99-1.21 | 0.164 | 1.04 | 0.89-1.21 | 0.636 | 1.02 | 0.95-1.09 | 0.596 |
| Mymenshing | - | - | - | - | - | - | 0.99 | 0.94-1.04 | 0.719 |
| Rajshahi | 1.03 | 0.94-1.14 | 0.389 | 0.96 | 0.83-1.11 | 0.554 | 0.89 | 0.84-0.94 | 0.016 |
| Rangpur | 1.07 | 0.97-1.18 | 0.075 | 0.90 | 0.77-1.01 | 0.160 | 1.02 | 1.02-1.07 | <0.001 |
| Sylhet | 1 | - | - | 1 | - | - | 1 | - | - |
| **Educational level (mother)** | | | | | | | | | |
| None | 0.89 | 0.82-0.96 | 0.042 | 0.89 | 0.75-1.05 | 0.166 | 0.99 | 0.94-1.05 | 0.911 |
| Primary incomplete | 0.93 | 0.86-1.01 | 0.091 | 0.91 | 0.81-1.03 | 0.154 |
| Primary | 0.97 | 0.91-1.04 | 0.395 | 0.98 | 0.87-1.11 | 0.780 | 0.99 | 0.97-1.03 | 0.827 |
| Secondary incomplete | 0.98 | 0.92-1.03 | 0.336 | - | - | - | - | - | - |
| Secondary complete/higher | 1 | - | - | 1 | - | - | 1 | - | - |
| **Wealth Index** | | | | | | | | | |
| Richest | 1.04 | 0.99-1.10 | 0.259 | 1.17 | 1.03-1.34 | 0.191 | 1.03 | 0.98-1.07 | 0.574 |
| Richer | 1.03 | 0.98-1.09 | 0.150 | 1.10 | 0.95-1.28 | 0.119 | 1.02 | 0.97-1.05 | 0.555 |
| Middle | 1.02 | 0.96-1.09 | 0.494 | 1.11 | 0.96-1.28 | 0.148 | 1.01 | 0.96-1.02 | 0.249 |
| Poorer | 1.00 | 0.95-1.07 | 0.876 | 1.11 | 0.98-1.25 | 0.110 | 1.00 | 0.95-1.03 | 0.678 |
| Poorest | 1 | - | - | 1 | - | - | 1 | - | - |
| **Body Mass Index (mother)** | | | | | | | | | |
| Underweight | 1.11 | 1.04-1.19 | 0.002 | 1.13 | 1.01-1.26 | 0.025 | 1.05 | 1.01-1.09 | 0.027 |
| Overweight | 1.12 | 1.03-1.21 | 0.005 | 1.17 | 1.03-1.32 | 0.015 | 1.01 | 0.97-1.02 | 0.621 |
| Normal | 1 | - | - | 1 | - | - | 1 | - | - |
| **Breastfeeding status** | | | | | | | | | |
| Yes | 0.91 | 0.76-1.10 | 0.634 | 0.91 | 0.81-1.02 | 0.066 | 0.81 | 0.64-1.03 | 0.081 |
| No | 1 | - | - | 1 | - | - | 1 | - | - |
| **Sex of child** | | | | | | | | | |
| Male | 1.03 | 0.99-1.06 | 0.822 | 1.08 | 1.00-1.16 | 0.039 | 1.01 | 0.98-1.02 | 0.808 |
| Female | 1 | - | - | 1 | - | - | 1 | - | - |
| **Child’s age group in months** | | | | | | | | | |
| 0-11 | 1.02 | 0.98-1.06 | 0.459 | 1.15 | 1.04-1.27 | 0.006 | 1.03 | 0.98-1.08 | 0.199 |
| 12-23 | 1 | - | - | 1.14 | 1.04-1.26 | 0.005 | 1.02 | 0.97-1.07 | 0.521 |
| 24-35 | - | - | - | 1 | - | - | 1 | - | - |
| **Size at birth** | | | | | | | | | |
| Very large | 0.81 | 0.60-1.09 | 0.166 | 0.93 | 0.80-1.07 | 0.314 | 0.95 | 0.88-1.03 | 0.411 |
| Larger than average | 0.82 | 0.61-1.10 | 0.223 | 0.95 | 0.79-1.14 | 0.585 | 0.95 | 0.88-1.03 | 0.993 |
| Average | 0.83 | 0.62-1.12 | 0.223 | 0.96 | 0.73-1.27 | 0.795 | 0.93 | 0.86-1.00 | 0.951 |
| Smaller than average | 0.89 | 0.65-1.21 | 0.461 | 1.07 | 0.90-1.27 | 0.418 | 0.95 | 0.86-1.07 | 0.589 |
| Very small | 1 | - | - | 1 | - | - | 1 | - | - |
| **Weight at birth** | | | | | | | | | |
| Low | 0.96 | 0.92-1.00 | 0.042 | - | - | - | 0.99 | 0.97-1.02 | 0.750 |
| Normal | 1 | - | - | - | - | - | 1 | - | - |

*RR: Risk Ratio; CI: Confidence Interval; ARR: Adjusted risk ratio*

*\*Model adjusted with Propensity scores \*\*Model adjusted with confounding and/or covariates*