**Abstract**

**Objective:** To assess coverage of the adolescent weekly iron-folic acid supplementation (WIFS) program in rural West Bengal, India.

**Design:** We conducted a population-based cross-sectional survey of intended WIFS program beneficiaries (in-school adolescent girls and boys and out-of-school adolescent girls).

**Setting:** Birbhum Health and Demographic Surveillance System.

**Participants:** A total of 4,448 adolescents 10-19 years of age participated in the study.

**Results:** The percentage of adolescents that reported taking four WIFS tablets during the last month as intended by the national program was 9.4% among in-school girls, 7.1% for in-school boys, and 2.3% for out-of-school girls. The low effective coverage was due to a combination of large deficits in WIFS provision and poor adherence. A large proportion of adolescents reported they were not provided any WIFS tablets in the last month: 61.7% of in-school girls, 73.3% of in-school boys, and 97.1% of out-of-school girls. In terms of adherence, only 41.6% of in-school girls, 38.1% of in-school boys and 47.4% of out-of-school girls reported they consumed all WIFS tablets they received. Teachers, administrators and school staff counselling was the primary reason adolescents reported taking WIFS tablets, whereas the major reasons for non-adherence were lack of perceived benefit, peer suggestion not to take WIFS and a reported history of side-effects.

**Conclusions:** Effective coverage of the WIFS program for in-school adolescents and out-of-school adolescent girls is low in rural Birbhum. Integrated supply- and demand-side strategies appear to be necessary to increase effective coverage and potential benefits of the WIFS program.

**Keywords:** adolescent, nutrition, anemia, iron

**Introduction**

Adolescents (10-19 years of age) are at high risk for iron deficiency and anemia due to increased iron requirements during this life stage, poor dietary intake of iron, the onset of menstruation, teenage pregnancy among girls, risk of helminth infections, and other factors(1, 2). Further, folate deficiency can cause megaloblastic anemia and increase the risk of neural tube defects for adolescents who become pregnant (3, 4). In India, the 2015-16 National Family Health Survey (NFHS-4) estimated that the prevalence of anemia among adult women and men 15-49 years was 53.1% and 22.7%, respectively; the NFHS-4 sample did not include the full 10-19 years age range of adolescents (5). Studies in India and other low- and middle-income countries have documented that adolescents with iron deficiency or anemia on average have lower IQ scores, poorer attention, and poorer productivity as compared to their non-anemic or iron deficient peers(6, 7).

In order to address the large burden and consequences of adolescent anemia in India, the Federal Ministry of Health and Family Welfare launched the national Weekly Iron and Folic Acid Supplementation (WIFS) program for in-school adolescents and out-of-school adolescent girls in 2012(8). The WIFS program currently targets over 100 million adolescents for once weekly iron-folic supplementation of 100 mg elemental iron and 500 mcg folic acid(9). Adolescents attending school in grades 6-12 are to receive WIFS tablets once weekly at school, while out-of-school adolescent girls receive community-based WIFS through Anganwadi centers(8). Anganwadi centers are a community-based, service-delivery component of the Indian public health care system that offer basic health care services(10). Anganwadi center activities primarily focus on women and children beneficiaries and services include contraceptive counselling, nutrition education and supplementation and early child development support. Early WIFS projects in India closely engaged communities, obtained high levels of supplementation coverage, and found marked reductions in adolescent anemia; however, when the WIFS program was implemented nationally there has been documented resistance in some communities and a few studies have documented low uptake among in-school adolescents(11, 12).

In order to address the need for population-based estimates of WIFS program coverage in India, we conducted a cross-sectional survey of in-school adolescents and out-of-school adolescent girls residing in the Birbhum Health & Demographic Surveillance System (HDSS) in rural West Bengal, India.

**Methods**

 We conducted a population-based cross-sectional household survey of adolescents residing in the Birbhum HDSS between December 2017 and March 2018. The Birbhum HDSS is located in the district of Birbhum in West Bengal, India, and is overseen by the Society for Health and Demographic Surveillance (SHDS). The HDSS is primarily rural with the majority of households partaking in agriculture. The Birbhum HDSS was established in 2008, and during its first survey in 2009, the 2001 census-sampling frame was used to select the HDSS study population using a simple stratified self-weighted random sample of 59,395 individuals from 13,053 household residing in 351 villages of four administrative blocks of Birbhum district. A full description of the Birbhum HDSS and population characteristics has been published elsewhere(13). According to the 2011 data, 29.5% of the population belong to the scheduled castes and 6.9% to the scheduled tribes. In 2012, the mean age of marriage for girls was 18.1 years and 16.2% of all pregnancies were adolescent girls below 19 years of age.(13)

 We conducted a population-based survey of potential WIFS program beneficiaries, which include adolescent boys and girls in 6th to 12th grade (middle and lower/higher secondary school) and out-of-school adolescent girls(8). During the study period, WIFS was exclusively provided to adolescents by the national program through the local District Health Authority. Data from the 2017-2018 HDSS survey round were used to identify all households with adolescents aged 10-19 years. The 2017-2018 Birbhum HDSS survey round included 12,255 households and 52,716 individuals; we selected all 6,693 individuals estimated to be 10-19 years old for potential participation in the WIFS survey. Study interviewers then visited the selected households, assessed eligibility of adolescents for participation in the survey and sought informed consent and assent for minors among those who were eligible. The inclusion criteria for the WIFS survey were male or female adolescents in Grades 6-12 and out-of-school adolescent females (10-19 years of age) based on the intended WIFS program beneficiaries. Exclusion criteria were out-of-school males (not intended beneficiaries of WIFS program) and adolescents for whom parental consent or adolescent assent were not obtained. Written informed consent was obtained from all participants. For minors, written informed consent was obtained from a parent/guardian and written assent was obtained from minors. Ethical approval to conduct the WIFS study was received from the Institutional Ethics Review Board of SHDS.

 In order to assess WIFS coverage, we asked all adolescent participants whether they received any WIFS tablets during the last month (30 days) and, if yes, the number of WIFS tablets they received. We then asked the number of WIFS tablets consumed among those who reported to have received tablets. We also asked adolescents for the primary reasons they decided to take the WIFS tablets as well as reasons for not consuming WIFS tablets among those who did not report consuming the tablets they had received. A demographic questionnaire was used to determine adolescent sex and grade level. Household wealth quintiles were constructed using a principal component analysis of adolescent reported household water source, toilet and household assets(14).

We assessed WIFS coverage by calculating the prevalence of consumption of four WIFS tablets during the last month for the full survey sample and by school status and sex. In order to assess provision of WIFS, we then calculated the prevalences of adolescents who reported receiving at least one WIFS tablet in the last month and those receiving four WIFS tablets in the last month. We also assessed adherence by calculating the percentage of adolescents who reported taking all WIFS tablets they received. We then examined predictors of reported receipt of at least one WIFS tablet in the last month and then consumption of all WIFS tablets received among in-school adolescents using log-binomial models to produce relative risk estimates(15). P-values for trend for categorical wealth quintiles were calculated by treating the median value of each category as a continuous variable. Missing indicators were used for missing data. Statistical analyses were performed using the SAS v9.4.

**Results**

 Of the 6,693 adolescents attempted to be contacted, we were not able to contact 934 (14.0%) of these individuals for participation. Among 5,759 adolescents contacted for participation, 359 in-school adolescents who were not in grades 6-12, and 952 out-of-school boys were excluded from participation since there were not eligible for the WIFS program. There were some differences in sex (contacted: 52.8% male; unable to be contacted: 47.1% male) and mean age (contacted: 14.8 ± 2.8 years; unable to be contacted 16.4 ± 2.8 years) between adolescents who were contacted as compared to those who were not able to be contacted. A total of 4,448 adolescents 10-19 years of age were determined to be eligible and participated in the WIFS survey. The sample included 1,903 (42.8%) in-school girls, 1,898 (42.7%) in-school boys, and 647 out-of-school girls (14.5%). Among in-school adolescents, 74.0% were in middle school, 16.0% were in lower secondary school and 10.0% were in higher secondary school.

 The percentage of adolescents that reported taking four WIFS tablets during the last month as intended by the national program was 9.4% (95% CI: 8.1-10.7%) for in-school girls, 7.1% (95% CI: 6.0-8.3%) for in-school boys, and 2.3% (95% CI: 1.7-4.1%) for out-of-school girls (Figure 1). The effective coverage of the WIFS program was low due to the combination of large gaps in provision of WIFS as well as poor adherence. Among in-school adolescent girls, 38.3% received at least one WIFS tablet during the last month and only 20.2% received four WIFS tablets as intended by the program. These percentages were slightly lower for in-school adolescent boys at 26.7% and 16.1%, respectively. In addition, there was low reported adherence to WIFS tablets. Among adolescents who received WIFS tablets during the last month, the percentage that took all tablets they received was 41.6% for in-school girls, 38.1% for in-school boys and 47.4% for out-of-school girls.

 We then examined factors associated with receipt of at least one WIFS tablet during the last month and consumption of all WIFS tablets received (Table 1). In multivariate analyses, in-school boys were 29% (95% CI: 20-37%) less likely to report they received at least one WIFS tablet during the last month as compared to in-school girls. Lower secondary school students (RR: 0.78; 95% CI: 0.65-0.94) and higher secondary students (RR: 0.16; 95% CI: 0.10-0.27) were less likely to report having received WIFS as compared to middle school students. In terms of reported consumption of tablets received, there was no difference by schooling level, sex, and age. However, there was some indication that lower wealth quintiles may be associated with increased adherence to WIFS (p-value for trend: 0.07).

 We also assessed the primary reasons in-school adolescents reported for adhering or not adhering to WIFS. Among in-school adolescents who consumed all WIFS tablets they received, 95.1% reported the primary reason they took the tablets was counselling from teachers, school principals, vice-principals, or other school staff. As for students who did not take the WIFS tablets they received, 47.7% reported they did not think WIFS was beneficial, 20.2% said their peers suggested they should not take the tablets, and 16.6% reported they had experienced side effects.

**Discussion**

Overall, the population-level coverage of the WIFS program in rural Birbhum, India was low. We found that lack of WIFS tablet supply was a major contributor to low coverage. We found that among in-school adolescents, boys and adolescents in higher secondary school were less likely to report having received WIFS tablets. Suboptimal adherence also contributed to low coverage as adolescents reported taking less than 50% of the WIFS tablets they received.

 The low coverage of the WIFS program in rural West Bengal is consistent with other reports that have noted suboptimal coverage(11). A recent mixed methods of in-school adolescents in North Kerala found ~25% coverage of WIFS and noted that fear of side-effects was a major contributor to low adherence in this setting(16). A study in Pondicherry also indicated lower than 50% coverage of WIFS and identified similar reasons for non-adherence, including fear of side effects, lack of perceived benefits, and irregular supply of WIFS(17). Nevertheless, there are some reports of relatively high coverage of WIFS in some settings, such as a school-based study conducted in a different part of Pondicherry that found 86% of adolescents reported taking four WIFS tablets in the last month; the authors noted that counselling from teachers appeared to be an important factor which is consistent with our findings(12). To the best of our knowledge, our study is the first to assess the WIFS program coverage among out-of-school adolescent girls and we determined that coverage in this group was very low and largely driven by a lack of provision of WIFS tablets.

In terms of potential interventions to increase coverage and adherence, studies have documented that important components of the successful WIFS pilot in India have not been fully translated and incorporated into the national WIFS program roll-out, including close engagement of stakeholders, timely and quality communication on program issues between stakeholders, availability of WIFS supplements, technical and supervisory support, and peer group advocacy(11). There is also evidence that adolescent girl-to-girl peer counselling has been shown to be very effective in increasing WIFS coverage and decrease anemia in Uttar Pradesh(18). As a result, it is likely a multi-component intervention will be needed to activate the complex enablers to high coverage of WIFS.

This study has a few limitations. Firstly, we assessed WIFS coverage using adolescent self-report and therefore we may have overestimated both provision and adherence due to social desirability bias. We also found that girls and older adolescents were more likely to not be reached for participation in the survey and therefore there is the potential for some degree of selection bias in our study. It is possible that these harder to reach adolescents could have decreased access to WIFS as compared to their peers who were able to be contacted for study participation. In addition, we did not assess hemoglobin concentrations and were therefore unable to link WIFS program coverage and tablet adherence to anemia prevalence. Future studies would benefit from assessing hemoglobin as well as iron biomarkers to assess the prevalence of iron deficiency anemia. In addition, we did not collect information on the WIFS supply chain and therefore were not able provide details on specific issues affecting supply at schools or Anganwadi centers. Lastly, provision of WIFS among out-of-school girls was too low to assess risk factors for provision and adherence as well as reasons for taking or not the tablets.

Population-level coverage of the WIFS program was low among in-school adolescents and out-of-school girls in rural Birbhum. Our findings and the literature suggest that integrated supply- and demand-side strategies that closely engage the adolescents, school staff and the community will be needed to increase effective coverage of WIFS. These strategies should take in account potential differences in the needs of in-school adolescents and out-of-school adolescent girls. Technical and supervisory support may increase WIFS supply and provision in schools and Aganwadi centers, while engagement of teachers, administrators and school staff as well as peer support groups for both in-school and out-of-school adolescents may improve adherence. Implementation research can inform and evaluate strategies and policies to fully realize the potential benefits of the WIFS program in India.

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Table 1. Association of school level, adolescent sex, and household wealth with receipt of at least one weekly iron-folic acid supplementation (WIFS) tablets in last month and reported consumption of all WIFS tablets received among in-school adolescents (n=4,160)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Reported receipt of at least one WIFS tablet in last monthn / N (%) | Multivariate relative risk for receipt of at least one WIFS tablet in last month (95% CI) | Reported consuming all WIFS tablets received in last month n/N (%) | Multivariate relative risk for consuming all WIFS tablets received (95% CI) |
| Overall | 1236 / 3801 (32.5%) | - | 489 / 1236 (39.6%) | - |
|  |  |  |  |  |
| *School level* |  |  |  |  |
| Middle school (Grade 6-8) | 1057 / 2814 (37.6%) | Ref.  | 417 / 1057 (39.5%) | Ref.  |
| Lower Secondary (Grade 9-10) | 162 / 608 (26.6%) | 0.78 (0.65-0.94) | 66 / 162 (40.7%) | 1.07 (0.80-1.44) |
| Higher Secondary(Grade 11-12) | 17 / 379 (4.5%) | 0.16 (0.10-0.27) | 6 / 17 (35.3%) | 0.93 (0.41-2.15) |
|  |  |  |  |  |
| *Adolescent sex* |  |  |  |  |
| Male | 507 / 1898 (26.7%) | 0.71 (0.63-0.80) | 211 / 507 (41.6%) | 1.09 (0.91-1.31) |
| Female | 729 / 1903 (38.2%) | Ref. | 278 / 729 (38.1%) | Ref.  |
|  |  |  |  |  |
| *Adolescent age* |  |  |  |  |
| 10-14 years | 658 / 1697 (38.8%) | Ref. | 266 / 658(40.4%) | Ref.  |
| 15-17 years | 533 / 1659 (32.1%) | 0.94 (0.83-1.07) | 204 / 533 (38.3%) | 0.93 (0.76-1.13) |
| 18-19 years | 45 / 445 (10.1%) | 0.61 (0.43-0.86) | 19 / 45 (42.2%) | 1.01 (0.60-1.69) |
|  |  |  |  |  |
| *Household Wealth Quintile\** |  |  |  |  |
| Q1 - Poorest | 223 / 669 (33.3%) | 0.94 (0.78-1.12) | 92 / 223 (41.3%) | 1.22 (0.92-1.64) |
| Q2 | 255 / 755 (33.8%) | 0.90 (0.76-1.08) | 112 / 255 (43.9%) | 1.26 (0.95-1.67) |
| Q3 | 224 / 676 (33.1%) | 1.03 (0.87-1.21) | 99 / 224 (44.2%) | 1.34 (1.02-1.76) |
| Q4 | 282 / 887 (31.8%) | 1.00 (0.85-1.19) | 103 / 282 (36.5%) | 1.05 (0.79-1.40) |
| Q5 - Richest | 252 / 814 (31.0%) | Ref. | 83 / 252 (32.9%) | Ref.  |

\*Calculated by water source, toilet and household assets among all adolescent households

**Figure Titles**

Figure 1. Effective coverage of WIFS for adolescents overall and stratified by schooling status and sex in rural Birbhum, India (n=4,448)