Original Article

Adolescent girls' infant and young child nutrition knowledge levels and sources differ among rural and urban samples in Bangladesh

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Abstract

In many low-income countries, girls marry early and have children very soon after marriage. Although conveying infant and young child nutrition (IYCN) knowledge to adolescent girls in time is important to ensure the well-being of their children, little is known about the best ways to convey these messages. This study examines the extent of, and sources from which adolescent girls derive IYCN knowledge in order to inform the design of programmes that convey such information. Data on adolescent girls aged 12–18 was collected in 2013 in 140 clusters of villages in rural areas ($n = 436$), and 70 clusters of slums in urban areas ($n = 345$) in Bangladesh. Data were analysed using multivariable Poisson regression models. In both the urban and rural samples, girls' schooling is positively and significantly associated with IYCN knowledge ($P < 0.01$ and $P < 0.10$, respectively). IYCN knowledge of adolescent girls' mothers is also associated with adolescents' IYCN knowledge in both urban and rural samples, but the magnitude of association in the urban sample is only half that of the rural sample ($P < 0.01$ and $P < 0.10$, respectively). In Bangladesh, efforts to improve knowledge regarding IYCN are typically focused on mothers of young children. Only some of this knowledge is passed onto adolescent girls living in the same household. As other messaging efforts directed towards mothers have only small, or no association with adolescent girls' knowledge of IYCN, improving adolescent girls' IYCN knowledge may require information and messaging specifically directed towards them. © 2016 John Wiley & Sons Ltd

Keywords: adolescent girls, child feeding knowledge, nutrition knowledge, Bangladesh.

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Introduction

Approximately 165 million children under the age of five are chronically undernourished (Black *et al.* 2013). Stunting, along with foetal growth restriction, suboptimum breastfeeding, wasting and Vitamin A and zinc deficiencies are estimated to account for 3.1 million annual deaths of children under five (Black *et al.* 2013). Chronic undernutrition leads to poorer schooling outcomes, lower economic productivity and a greater likelihood of being poor in adulthood (Hoddinott *et al.* 2013). Poor infant and young child nutrition (IYCN) practices contribute to poor pre-school nutrition outcomes (Black *et al.* 2013; World

Health Organization 2008; Avula *et al.* 2013; Ahmed *et al.* 2012) and where these have been improved, gains in length (Guldan *et al.* 2000; Bhandari *et al.* 2004) and weight (Zaman *et al.* 2008; Santos *et al.* 2001) have been observed. For this reason, in a number of countries where the burden of undernutrition is high, efforts are being made to improve IYCN practices. Where these efforts exist, they are nearly always directed towards already married women (Avula *et al.* 2013; Nguyen *et al.* 2014a; Baker *et al.* 2013).

In some countries, women marry at a relatively early age and soon afterwards become pregnant. For example, in Bangladesh, the 2011 Demographic and Health Survey (National Institute of Population Research

and Training 2013) showed that 44% of women aged 15–19 were already married or cohabitating. Among women aged 20–24, 64.9% were married by age 18; 54.1% of married women aged 15–19 already had one or more children. Median maternal age at time of first birth is 18.9 years for women currently aged 20–24 (National Institute of Population Research and Training 2013). For these women, the short duration between marriage and first birth allows little time to provide information on correct IYCN practices. IYCN knowledge is a strong determinant of IYCN practices (Stewart *et al.* 2013). What women know about IYCN in adolescence, therefore, may well play an important part in their IYCN practices. As such, female adolescence may be a window of opportunity for improving health outcomes among future children, and investing in adolescent girls' IYCN knowledge may be an effective strategy to promote improved infant feeding practices (Hackett *et al.* 2015). Yet, little is known about the extent of IYCN knowledge in adolescent girls. Focus group discussions and semi-structured interviews with 70 adolescent girls in rural Bangladesh found major gaps in knowledge and understanding of exclusive breastfeeding practices and the use of nutrient-rich complementary foods (Hackett *et al.* 2015a) with similar results also reported in Ethiopia (Hadley *et al.* 2008). Subsequent work in Bangladesh identified a lack of IYCF knowledge as a constraint to best practice (Hackett *et al.* 2015b). One study looks at the related issue of adolescent girls' knowledge of reproductive health issues in Bangladesh (Kabir *et al.*, 2015) and another documents low levels of adolescent girl's knowledge of the nutritional content of foods (Alam et al, 2010), but we are not aware of any study that documents the correlates of adolescent girls' knowledge of IYCN.

The objectives of this paper, therefore, are twofold. First, we document adolescent girls' knowledge of IYCN practices in both rural and urban settings of Bangladesh. Bangladesh is an appropriate setting for this work given the patterns of early marriage described above. Second, we examine the determinants of the knowledge of adolescent girls, assessing the extent to which this knowledge is associated with the characteristics of the adolescent girl herself, the characteristics of the household in which she lives and exposure to sources of information on IYCN within the household and from outside of it (from the media, health workers, schooling).

Materials and methods

Study context and sampling

Our data come from a baseline survey collected in September–November 2013 to evaluate three Department for International Development (DFID) funded programmes in Bangladesh, under the DFID Programme to Accelerate Improved Nutrition for the Extreme Poor in Bangladesh project (hereafter, DFID project). The three programmes are the Chars Livelihoods Programme (CLP) targeting extreme poor households in the rural northwest 'chars' (riverine islands); the Concern sub-project within the Economic Empowerment of the Poor (EEP, also known as Shiree) programme targeting extreme poor households in the rural flood-prone 'Haor' areas of Sunamgonj, Habigonj and Kishoregonj districts; and the Urban

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Key messages

- Because of early marriage and subsequent childbearing in some countries, targeting infant and young child nutrition (IYCN) messages to adolescents quickly is important, as IYCN knowledge improves child health.
- IYCN interventions typically focus on mothers of young children.
- This study documents the extent and sources of IYCN among adolescent girls in Bangladesh.
- While adolescent girls have IYCN knowledge, it is imperfect. Knowledge is passed on from mothers to adolescents, but imperfectly, and less so in urban areas than rural areas.
- Improving adolescents' IYCN knowledge may require messaging specifically directed towards them, and approaches should differ in rural and urban areas.

Partnerships for Poverty Reduction (UPPR) programme targeting extreme poor households in urban slums throughout 23 cities and towns. Although the impact evaluation aims to assess effects of adding direct nutrition components to these livelihoods programmes for randomly selected beneficiaries, at baseline, no direct nutrition components had yet been added.

For each programme, the sampling frame included beneficiary households with a child aged 0 to 24 months at the time of the baseline survey. Among these, attempts were made to randomly sample 2520 households per programme. The design of the sampling matched the cluster-randomisation of the direct nutrition components to be added after baseline—stratified at the level of *upazilas* (sub districts) and clustered at the level of 70 wards (a group of villages) for each of the two rural programmes, and stratified at the level of towns and clustered at the level of 70 programme-defined 'clusters' of slums for the urban UPPR programme.

In each sample household of the DFID project, a roster of all members was collected (i.e. the group of people who had lived together and shared meals together for most of the preceding 6 months, as well as new-born children and other new entrants who were expected to remain in the household long term). If there was any girl aged 11 to 19 years that was not the mother of the child aged 0–24 months, the oldest was classified as the 'adolescent girl,' to whom relevant survey modules were administered. The selection of the oldest adolescent girl was motivated by the DFID project's interest in the IYCN knowledge of adolescent girls nearing motherhood. If the adolescent girl had been chosen randomly from the adolescent girls present in the household, the sample would have included many adolescents further from the point of having their own children. These households (households containing both a child 0 to 24 months old, and a girl aged 11 to 19 years old) comprise a frequently observed household structure in Bangladesh because women move in with their in-laws upon marriage, so sisters-in-law tend to cohabit.

For our present analysis, we focus on a restricted subset of the adolescents for whom data were collected in the adolescent girls' modules under the DFID project: unmarried adolescent girls aged 12 to 18 years who had been household members for at least 5 years. The age restriction is motivated by average age of menarche in rural Bangladesh being 12.8 years (Rah *et al.* 2009), suggesting that age 12 may be approximately when girls perceive that they are approaching their own marriage and childbearing and see relevance in IYCN. The restriction to unmarried girls maintains some uniformity in the sample because married adolescents tend to live with in-laws and may also be more focused on issues related to childbearing. The restriction on years of being a household member for at least five years helps ensure that the adolescent girl had meaningful exposure to household characteristics that form the analysis. It is possible that some of the adolescent girls may currently be living with another family member or friend, or may have previously been living with another family member or friend, for example for the purposes of schooling.

Additionally in each sample household, the child aged 0 to 24 months (or one randomly chosen, if there were multiple) was designated as the 'index child.' This child's mother was the main respondent for the overall household survey. The index mother is always distinct from the adolescent girl. For this analysis, the index child's mother is of particular interest as she is likely to be an informed household member about IYCN, given that she has a child in relevant age range. We refer to her as the 'index mother.' In our restricted sample, the index mother is typically but not always the mother of the adolescent girl. In nearly all cases when the adolescent girl is not the daughter of the index mother, they are sisters-in-law. In all cases, the adolescent girl and index mother are relatives. It is possible that there are older women in the household who have had children and may also be a source of IYCN knowledge. However, our interest in the index mother is because she has most recently given birth to and has been rearing a young child. In addition, she is likely to be younger than the matriarch of the household, and so may be more informed on the most recent knowledge about IYCN practices.

The survey collected socioeconomic, demographic and nutrition-related information at both the household and individual levels, with a particular focus on the index child, the index mother and the adolescent

girl. The analysis in this paper focuses on the adolescent girl and the index mother within our restricted sample.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Internal Review Board (IRB) of the International Food Policy Research Institute (IFPRI). Verbal informed consent was obtained from all subjects, and verbal consent was witnessed and formally recorded.

Measures

Both adolescent girls and index mothers were asked 14 questions regarding IYCN knowledge—four on breastfeeding, three on complementary feeding and seven on other health and nutrition topics. There was not an existing validated knowledge scale available for use. The questions are based on the curriculum for the direct nutrition components of the larger study, which came from the large-scale Alive and Thrive nutrition programme in Bangladesh. The Alive and Thrive programme involves 4400 mothers and their children under five in 20 sub-districts, and the curriculum has been widely used (Nguyen *et al.* 2014b). These questions are listed in Table 1. From these questions, for each of the adolescent girl and the index mother, we construct a total IYCN knowledge score summing the number of questions answered correctly from 0 to

14, as well as sub scores by topic. If a question has multiple possible correct responses, the question is considered to be answered correctly if any of the correct responses is marked.

We construct variables for the adolescent girl's demographic characteristics and role in the household. Demographics include her age in years (ranging in our estimation sample from 12 to 18 years old) and her level of completed education. We classify educational attainment into three groups: no education (has never attended school), below primary (has attended school but did not complete primary) and primary and above (has completed primary school or higher). We hypothesise that IYCN knowledge may increase with girls' age (as they near their own anticipated marriage and childbirth) and with girls' education (if they are better informed in general) (Stewart *et al.* 2013). We also construct a measure of the adolescent girl's responsibility for childcare activities, hypothesising that close involvement in childcare may increase IYCN knowledge. For each of three activities—feeding young children, bathing young children and looking after young children—the survey asks index mothers who in the household is primarily responsible, as well as who is responsible in the absence of this person. If the adolescent girl is named as either of these for any of the three activities, we classify her as participating in childcare activities.

Table 1. Infant and young child nutrition knowledge questions

Breastfeeding	
1	How long after birth should a baby start breastfeeding?
2	What should a mother do with the 'first milk' or colostrum?
3	How often should a baby breastfeed?
4	If a mother thinks her baby is not getting enough breast milk, what should she do?
Complementary feeding	
5	Do you think that infants under 6 months of age should be given water if the weather is very hot?
6	At what age should a baby first start to receive liquids (including water) other than breast milk?
7	At what age should a baby first start to receive foods in addition to breast milk?
Other health and nutrition	
8	Name one thing that can happen to children if they do not get enough iron (either in their diet or via iron supplements);
9	What seasoning (food item) is often fortified with iodine (a nutrient important for brain development)?
10	For how many days do children need an extra meal per day after they have been sick?
11	What should you do when your child has diarrhea?
12	When should you wash your hands?
13	What are some of the things we can do to encourage young children to eat their food?
14	What foods does a young child (<24 months) need in order to grow and develop their brain?

Because an aim of our analysis is to explore how adolescent girls' IYCN knowledge relates to IYCN knowledge of the index mother—likely to be the best source of IYCN information within the household—we construct an indicator as well for whether the adolescent girl is the index mother's daughter. This indicator can be used as an interaction term in estimation to assess whether associations between their knowledge depend on their relationship. Such dependence is plausible if, for example, mothers are more likely to discuss IYCN with their own daughters than with other young women in the household such as sisters-in-law.

The age and education of the index mother are also measured, as they may help account for confounding factors. Because mothers have completed little education on average, we create a single dummy variable equal to one if the mother has never attended school.

We further construct measures that may be associated with exposure to external information related to IYCN. One important source of information for the adolescent girl is information that has been provided to the index mother through various sources. Index mothers are asked whether the household was visited by any health worker in the six months preceding the survey. This could include a health worker from one of the livelihoods programmes or another health worker. They are also asked whether they have watched any advertisement on television (in their own home or elsewhere) regarding breastfeeding or complementary feeding in the three months preceding the survey. They are additionally asked, after being asked the IYCN knowledge questions, if they have heard about the following six IYCN practices: (1) starting breastfeeding within 1 h after delivery; (2) exclusive breastfeeding for six months; (3) feeding adequate quantity of family foods in addition to breastfeeding from 7 to 24 months; (4) feeding animal source foods like fish, egg, liver, meat at least once a day to a child more than 6 months old; (5) how to feed a child who has poor appetite; and (6) how fathers can support mothers to give enough time to the child for proper feeding. A variable is created summing the number of these practices the index mother reports having heard about, to capture overall exposure to information on feeding practices.

Household characteristics are also constructed to help account for confounding factors. These include household size, the age of the household head, whether the household head is female and a consumer durables asset index. The consumer durables asset index is constructed using the first component estimated from principal components analysis over dummy variables for household ownership of a large set of consumer durables appropriate to Bangladesh. These include: trunk/suitcase, buckets/pots, stove/gas burner, metal cooking pots, beds, armoire/cabinet, table/chair, hukka, electric fan, electric iron, radio, audio cassette/CD player, wall clock/watch, television and jewellery. The index is constructed separately for each of the three programmes, allowing for differing profiles of asset ownership in the three programme contexts. The reason for this is that the three programmes operate in very different areas of Bangladesh with very different asset ownership profiles. The objective is to construct a variable that captures whether a household is 'poor', and if the index were created with all three programmes together, there is a risk that all of the 'poor' would be part of one programme and the variable would pick up programme, rather than poverty effects. The first component of the index explains 12.37%, 12.55% and 16.77% of the variation for CLP, Shiree and UPPR, respectively. Within each programme's sample, we split the index into quartiles and construct a dummy variable for the household falling in the bottom quartile, as a proxy for it being very poor.

The sets of maternal and household characteristics were selected based on a series of univariate regressions of adolescent knowledge on a single characteristic. Those with coefficients having *p*-values of 0.10 or smaller were considered for the main estimation.

Statistical analysis

We distinguish the rural sample (CLP and Shiree, pooled) from the urban sample (UPPR). This disaggregation is motivated by potentially different predictors of knowledge in the two settings, given different information environments.

We first present descriptive statistics on the knowledge scores and other key indicators, by rural or urban

setting using histograms as well as summaries of means and SDs. We then analyse associations between adolescent girls' knowledge scores and other key indicators using regression analysis. Separately for the rural and urban samples, we estimate multivariable Poisson regressions—which explicitly account for the knowledge scores taking only discrete values—and represent results as marginal effects. The *P*-values on Chi-squared goodness-of-fit tests indicate that Poisson regression is the correct specification (*P*-values for the Pearson goodness-of-fit test are 1.00 for both rural and urban samples). Clustering effects are modelled with fixed effects at the level of the ward in the rural sample, and the level of programme defined clusters in the urban sample. Standard errors in the regression estimates are adjusted for stratification (at the level of the sub-district in the rural sample, and at the town level in the urban sample) and are also adjusted for clustering according to the sample design. Standard errors in the rural sample are clustered at the ward level and in the urban sample are clustered at the level of programme defined clusters. Chi-squared tests are conducted to assess whether each set of regression coefficients is statistically different between the rural and urban samples (comparing all coefficients jointly in the rural model to all coefficients jointly in the urban model).

We conduct two additional sets (a set comprises the rural and urban samples) of Poisson regressions to assess whether the determinants of adolescent knowledge depend on the relationship between the index mother—plausibly the best source of IYCN information within the household—and the adolescent girl. In the first set, we include a term interacting the index mother's IYCN knowledge score with a dummy variable for whether the adolescent girl is her daughter; the coefficient estimate on this term tells us whether the correlation between the two scores depends on the relationship between the two household members. In the second set, we restrict the sample to only the subset of adolescent girls who are the daughters of the index mothers; this allows us to compare, for all characteristics, whether associations differ from those in the full sample. Throughout, we interpret *p*-values less than 0.10 as statistically significant. All estimation is conducted in Stata 13.

Effect sizes and levels of significance are consistent over two alternate specifications checked for robustness: (1) an Ordinary Least Squares (OLS) specification that implicitly treats the knowledge scores as continuous outcomes and (2) an OLS specification that includes fixed effects at the level of the primary sampling unit (ward for rural sample, 'cluster' of slums for urban sample).

Results

Characteristics of the study sample

A total of 7021 households met the criteria of the overall evaluation's baseline sampling frame and were successfully interviewed across the three programmes (2388 from CLP, 2122 from Shiree, 2511 from UPPR). Of these, 781 households include an unmarried adolescent girl aged 12 to 18 years who had been a household member for at least five years and thus meet the sample restrictions for this analysis. The rural sample contains 441 adolescent girls, and the urban sample contains 352 girls.

Table 2 provides a summary of the number of observations in the entire sample, in the rural sample and in the urban sample. The first row reports the number of adolescent girls between the ages of 11 and 19 years who were administered the modules pertaining to adolescent girls in the DFID programme survey. The second row reports the number of adolescent girls in the restricted sample in this paper: unmarried, between the ages of 12 and 18 years, and who have resided in their present household for five or more years. The third row reports the further restricted sample on which we conduct stratified analysis: unmarried, between the ages of 12 and 18 years, resided in their present household for five or more years and daughters of the index mother.

Table 3 presents characteristics of the sample of adolescent girls, index mothers and their households for both the urban and rural samples. Average scores of adolescent girls on IYCN questions remain similar across the two samples when aggregated across ages, although are slightly higher in the urban sample. Overall, adolescent girls correctly answer an average of about 8 out of all 14 questions, with correct responses

Table 2. Number of observations in the sample

Description of sample	Total	Rural	Urban
Adolescent girl between 11 and 19 years of age administered the modules pertaining to adolescent girls in the DFID programme survey.	940	521	419
HHs with complete data in the treatment groups with an unmarried adolescent girl between 12 and 18 years of age who has been present in the household for at least 5 years.	781	436	345
HHs with complete data in the treatment groups with an unmarried adolescent girl between 12 and 18 years of age who has been present in the household for at least 5 years and who is the daughter of the index mother.	492	319	173

Table 3. Characteristics of study samples in rural and urban areas [1]

Variable	Rural (*n* = 436)		Urban (*n* = 345)	
	Mean	SD	Mean	SD
Adolescent girl characteristics				
Number of correct answers to all IYCN questions (of 14)	8.13	2.61	8.77	2.19
Number of correct answers to breastfeeding questions (of 4)	2.03	1.14	2.20	1.10
Number of correct answers to complementary feeding questions (of 3)	1.47	1.09	1.63	1.01
Number of correct answers to other health and nutrition questions (of 7)	4.64	1.30	4.93	1.06
Age	13.59	1.66	14.23	1.80
Education level—No education	16.05%		4.92%	
Education level—Below Primary	53.67%		28.41%	
Education level—Primary and above	30.28%		66.67%	
Participates in childcare activities (feeding, bathing or looking after)	60.32%		42.90%	
Is the daughter of index mother	73.17%		50.14%	
Mother of index child characteristics				
Number of correct answers to all IYCN questions (of 14)	8.63	1.95	9.28	1.78
Age	31.89	7.07	27.89	7.00
Had no schooling	68.35%		26.09%	
Watched TV ad on breastfeeding or complementary feeding in past 3 months	6.65%		58.84%	
Number of nutrition practices heard of (of 6)	4.04	1.68	4.79	1.32
Household characteristics				
Visited by health worker in the previous six months	36.93%		29.57%	
Household size	6.77	1.55	6.89	1.99
Age of household head	43.56	9.34	45.03	11.55
Female headed household	7.11%		10.14%	
Consumer durables asset index—bottom quartile	25.00%		26.09%	
Chars Livelihoods Programme (CLP) beneficiary	39.91%			

[1]IYCN, infant and young child nutrition.

for slightly more than 2 of the 4 breastfeeding questions, about 1.5 of the 3 complementary feeding questions and slightly more than 4.5 of the 8 other health and nutrition questions. Relative to adolescent girls in the urban sample, girls in the rural sample are on average younger (13.6 years vs. 14.2 years), less educated (30.3% vs. 67% with completed primary school or above) and are more likely to participate in child care activities (60% vs. 42%). The share of adolescent girls who are daughters of the index mother

is higher in the rural sample than in the urban sample (73% vs. 50%).

Compared with index mothers in the urban sample, index mothers in the rural sample are on average older (32 years vs. 28 years), less educated (68% vs. 26% with no schooling) and score lower on IYCN knowledge (8.6 questions vs. 9.2 questions). In both samples, index mothers score on average slightly higher on these questions than adolescent girls. Exposure to nutrition messages on television is much less common among

the rural sample. While 59% of mothers in the urban sample report having seen a television advertisement on breastfeeding or on complementary feeding within the past 3 months, only 7% in the rural sample report the same.

It is important to note that only 19 of 781 index mothers (2%) are themselves adolescents between the ages of 15 and 19. The average number of children that index mothers have given birth to is 4 in rural areas and is 2.6 in urban areas.

Included household characteristics are similar across the urban and rural samples. However, visits from health workers are more common in the rural sample than in the urban sample (37% in rural areas vs. 30% in urban areas). Finally, 40% of the rural sample belongs to the CLP program.

Determinants of adolescent girls' IYCN knowledge

Table 4 presents Poisson regression results on the determinants of adolescent girls' IYCN knowledge.

Column (1) shows Poisson marginal effects coefficients for the rural sample, and column (2) shows these for the urban sample. We describe below variables with statistically significant coefficients ($P < 0.05$), and with statistically significant differences in coefficients between urban and rural samples based on Chi square tests.

In the rural sample, statistically significant determinants of the adolescent girl's knowledge score include the adolescent girl's own education level, the index mother's education level and the index mother's IYCN knowledge score. On average for girls in the rural sample, completion of primary school or higher is associated with correctly answering 1.3 more questions out of 14 ($P < 0.01$), while the index mother having no education is weakly associated with correctly answering about 0.5 more questions ($P < 0.1$). Each additional IYCN question that the index mother correctly answers out of 14 is associated with the adolescent girl correctly answering 0.46 more questions ($P < 0.01$). Associations with all other included covariates are not statistically significant.

Table 4. Association of individual, household, programme and media factors with adolescent girls' infant and young child nutrition (IYCN) knowledge, Poisson estimates of marginal effects[a]

	(1)	(2)
	Poisson marginal effects	
Dependent variable: number of all IYCN questions (of 14) answered correctly by the adolescent girl	**Rural**	**Urban**
Age of adolescent girl	0.05	0.20***
Education level of adolescent girl = Below primary	0.10	0.55
Education level of adolescent girl = Primary and above	1.34***	1.18*
Adolescent participates in any childcare activities (feeding, bathing, looking after)	0.32	−0.20
Adolescent girl is daughter of index mother[b]	−0.35	0.28
Index mother's number of correct answers to all IYCN questions	0.46***	0.14**
Index mother's age	0.03	0.00
Index mother had no schooling	0.48*	−0.25
Index mother watched TV ad on breastfeeding or complementary feeding in past 3 months	0.52	0.29
Number of nutrition practices index mother has heard of (of 6)	0.06	0.21**
Household visited by health worker in the previous six months	−0.33	0.32
Household size	0.14	0.01
Female headed household	−0.71	−0.07
Age of household head	0.01	0.00
Consumer durables asset index—bottom quartile	0.18	−0.30
Household is a Chars Livelihoods Programme (CLP) beneficiary	0.30	
Number of observations	436	345

IYCN, infant and young child nutrition. Coefficients were significantly different from zero: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. [a]Each column represents a separate regression. Estimates are marginal effects coefficients from a Poisson multivariable regression. Standard errors are adjusted for stratification and clustered at the level of primary sampling units. [b]'Index mother' refers to mother of a child age 0–24 months in the household.

In the urban sample, the adolescent girl's IYCN knowledge score is again significantly associated with her own education level and the index mother's knowledge score. However these relationships are smaller in magnitude and less statistically significant than in the rural sample. In urban areas, adolescent girls' completion of primary school or higher is weakly associated with correctly answering 1.2 more questions out of 14 ($P < 0.1$). Each additional IYCN question that the index mother correctly answers is associated with the adolescent girl correctly answering 0.14 more questions ($P < 0.05$); the difference between this coefficient in the urban sample and the coefficient estimate of 0.46 in the rural sample is statistically significant based on a Chi-squared test ($P < 0.01$). There are additional significant associations in the urban sample—namely, the adolescent girl's age and the number of nutrition

practices the index mother has heard of. For each additional year in age, the adolescent girl will on average correctly answer 0.2 more questions ($P < 0.01$). Each additional nutrition practice the index mother has heard of, out of 6, is associated with the adolescent girl correctly answering 0.21 more questions ($P < 0.05$). The remaining associations are not statistically significant.

We also regress the same variables on the three sub-indices of IYCN knowledge (breastfeeding, complementary feeding, and other health and nutrition topics). We find the same general pattern in associations, and so do not report the results. (These are available on request.)

Table 5 displays the results from two additional Poisson regression specifications. In columns (1) and (2) we include the same sample as in Table 3, as well

Table 5. Association of individual, household, programme and media factors with adolescent girls' IYCN knowledge in full sample and in subsample for which adolescent girl is the daughter of index mother [a]

Dependent variable: number of all IYCN questions (of 14) answered correctly by the adolescent girl	(1)	(2)	(3)	(4)
	Full sample [b]		Daughter of index mother [c]	
	Rural	Urban	Rural	Urban
Age of adolescent girl	0.05	0.20***	0.10	0.21**
Education level of adolescent girl = Below primary	0.10	0.53	0.34	1.34*
Education level of adolescent girl = Primary and above	1.33***	1.13	1.24***	1.71**
Adolescent participates in any childcare activities (feeding, bathing, looking after)	0.31	−0.19	0.14	0.17
Adolescent girl is daughter of index mother [d]	0.51	−1.87		
Index mother's number of correct answers to all IYCN questions	0.54***	0.03	0.44***	0.27***
Adolescent is daughter of index mother × index mother's number of correct answers to all IYCN questions	−0.10	0.23*		
Index mother's age	0.03	0.01	0.02	−0.01
Index mother had no schooling	0.48*	−0.23	0.39	−0.26
Mother watched TV ad on breastfeeding or complementary feeding in past 3 months	0.52	0.32	0.17	0.73**
Number of nutrition practices index mother has heard of (of 6)	0.06	0.21**	0.13	0.23*
Household visited by health worker in the previous six months	−0.33	0.28	−0.54*	0.26
Household size	0.13	0.03	0.21**	0.15
Female headed household	−0.72	−0.05	−0.94	−0.65
Age of household head	0.01	0.00	−0.01	0.00
Consumer durables asset index—bottom quartile	0.18	−0.35	0.06	−0.51
Household is Chars Livelihoods Programme (CLP) beneficiary	0.32		0.33	
Number of observations	436	345	319	173

IYCN, infant and young child nutrition. Coefficients were significantly different from zero: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. [a]Each column represents a separate regression. Estimates are marginal effects coefficients from a Poisson multivariable regression. Standard errors are adjusted for stratification and clustered at the level of primary sampling units. [b]'Full sample' includes adolescent girls who are between 12 and 18 years of age, are unmarried and have been a member of the household since 2008. [c]'Daughter of index mother' sample contains the subsample of adolescent girls who are the daughter of the index mother. [d]'Index mother' refers to mother of a child age 0–24 months in the household.

as the same regressors, and add a term interacting the number of questions answered correctly by the index mother and whether the adolescent girl is the index mother's daughter. Column (1) presents results for the rural sample, and column (2) for the urban sample. In columns (3) and (4) we again include the same regressors as in Table 3, and we restrict the sample to adolescent girls who are the daughter of the index mother. Column (3) presents results for the rural sample, and column (4) for the urban sample.

In columns (1) and (2), most coefficients remain consistent with those in Table 3. However, the pattern of coefficients on terms related to the index mother's IYCN knowledge differs between the rural sample in column (1) and urban sample in column (2). In the rural sample, the coefficient on mother's IYCN knowledge remains similar in magnitude and significance to that in Table 3, and the coefficient on the interaction term is statistically insignificant. In the urban sample, the coefficient on mother's IYCN knowledge falls to nearly 0 and becomes statistically insignificant, while the interaction term is positive and weakly significant ($P < 0.1$).

In columns (3) and (4), most coefficients for the restricted sample are comparable to those for the full sample in Table 3. In particular, across the rural restricted sample in column (3) and rural full sample in Table 3, associations between the index mother's characteristics and the adolescent girl's knowledge appear similar. Two household characteristics become significant in the restricted sample. The household having been visited by a health worker in the past six months is associated with 0.54 questions answered correctly ($P < 0.1$). Adolescent girls belonging to larger households answer 0.21 questions correctly ($P < 0.05$). In the restricted urban sample in column (4), the index mother's exposure to television advertisements on breastfeeding or complementary feeding in the preceding 3 months is now significantly correlated ($\beta = 0.73$, $P < 0.05$) with the adolescent girl's IYCN knowledge.

Discussion

Adolescent girls in our Bangladesh samples are aware of many IYCN practices. When asked a series of 14 questions regarding exclusive breastfeeding, complementary feeding and other health and nutrition topics, they answer about 59% correctly. We aim to assess the determinants of this knowledge.

In both rural and urban areas, the most salient and highly significant predictor of adolescent girls' knowledge is the knowledge of the index mother in the household. Based on the Poisson marginal effects estimates reported in Table 3, comparing an index mother with a score two standard deviations below the mean to one with a score two standard deviations above the mean (comparing a score of 4.73 to a score of 12.53 in rural areas, and comparing a score of 5.72 to a score of 12.84 in rural areas) implies a higher score for the adolescent girl of 3.6 questions in rural areas and of 1.0 question in urban areas (a difference of 7.8 points multiplied by the coefficient of 0.46 in rural areas, and a difference of 7.12 points multiplied by the coefficient of 0.14 in urban areas). Relative to adolescent girls' mean knowledge scores (of 8.13 and 8.77 questions correct in rural and urban areas, respectively), this represents an increase of 44% correct answers in rural areas and 11% in urban areas. Nonetheless, in both rural and urban areas, the coefficient on index mothers' knowledge is considerably smaller than one. If the strong association reflects that IYCN knowledge is passed from mothers of young children to adolescent girls in the same household, the transmission is not exhaustive. This is particularly true in urban areas where we observe a significant association between index mothers' and adolescents' knowledge only when the adolescent is the index mother's daughter. To the extent that the association reflects transmission of knowledge, the result implies that knowledge passed from index mothers to adolescent girls in the household differs between urban and rural areas; in urban areas, information is only transmitted if the adolescent girl is the index mother's daughter.

In urban areas, we find a stronger association than in rural areas with external messages to the household. In our urban sample, there is a significant association between the adolescent girl's knowledge and the number of nutrition practices that the index mother has heard of. When the adolescent is the index mother's daughter in the urban sample, there is also a significant association between the adolescent's IYCN knowledge and the index mother's exposure to television

advertisements regarding breastfeeding or complementary feeding. This likely reflects the greater availability of media in urban areas through which such messages can be received. However the magnitudes of these associations are small.

In the rural sample, that the coefficient on mother's IYCN knowledge remains similar in magnitude and significance when interacted with an indicator variable for whether the adolescent girl is the daughter of the index mother, and that the coefficient on the interaction term is not statistically significant indicates that the relationship between index mother and the adolescent girl does not meaningfully affect the association between their knowledge scores. In the urban sample, that the coefficient on mother's IYCN knowledge falls to nearly 0 and becomes statistically insignificant when the interaction term is included, while the interaction term is positive and weakly significant ($P < 0.1$), indicates that the association between adolescent and index mother primarily holds when the adolescent is the index mother's daughter. The results suggest that the association between the adolescent girl's IYCN knowledge and the index mother's knowledge or exposure to information may be stronger in the urban sample when the adolescent is the index mother's daughter but that this dynamic may be less pronounced in the rural sample. Taken together, these results indicate that efforts to improve adolescent girls' knowledge of IYCN indirectly—through mothers in the same household—will have modestly positive effects.

Adolescent girls' knowledge of IYCN is higher—by 1.3 questions or 16% in rural areas and 1.2 questions or 13% in urban areas—when they have completed primary school. These effect sizes suggest that primary schooling has only a limited direct effect on adolescent girls' knowledge, because five years of education only raises scores by 1.2 questions. Other covariates including the age and gender of the household head are very weakly associated with adolescent girls' knowledge. Effect sizes are small and statistically insignificant. The two statistically significant household characteristics in the restricted sample in rural areas can be explained as follows. Health workers may be more likely to visit poorer households, and poorer households are likely to have less IYCN knowledge, resulting in a negative association between visits to the household and adolescent girls' knowledge. Larger households may have more young children, or a more members who have had children, so there may be more experience to IYCN practices, resulting in higher knowledge among adolescent girls.

Our study has weaknesses. First, it is not a representative sample of adolescent girls in Bangladesh. Our rural sample is drawn from riverine islands or flood-prone localities, where households are displaced from their homes for part of the year. Our urban sample, while typical of urban settings throughout Bangladesh, excludes the capital city, Dhaka, which is wealthier than the secondary cities in which our urban sample is located. Second, our data allows us to assess associations but not causality. Although the IYCN knowledge of index mothers and adolescent girls are correlated, the mothers may not be the source; we do control for other sources of knowledge available to the household (including health worker visits and media), but these may not be all of the sources available and an unobservable source common to index mothers and adolescent girls may be responsible for the observed correlation. However, we believe we have captured the main factors that would comprise common sources of knowledge. Last, a limitation of the study is that data on exposure to nutrition messages from the media and on which IYCN practices had been heard of were collected from index mothers, but were not collected from adolescent girls. These data collected from adolescent girls would have been useful to the study; however, information provided to the index mother through various sources is also an important source of information for the adolescent girl.

Our study also has strengths. To our knowledge, it is the first study to quantify sources of IYCN knowledge of adolescent girls. We have a large sample that includes both urban and rural areas. We can assess the association between adolescent girls' knowledge and that of mothers of pre-school children residing in the same household. We can control for a wide range of confounding factors.

This paper assesses the extent and sources of the knowledge of adolescent girls in Bangladesh

regarding IYCN practices. Because of the early age of marriage and speed at which girls have children afterwards, it is important to target IYCN messages to them appropriately. This study shows, as has other work in Bangladesh (Hackett *et al.* 2015) and Ethiopia (Hadley *et al.* 2008), that while adolescent girls have knowledge of IYCN, this knowledge is imperfect, particularly with respect to exclusive breastfeeding. In Bangladesh and elsewhere, efforts to improve knowledge regarding IYCN are typically focused on mothers of young children. To our knowledge, our study is the first to suggest that some of this knowledge may be passed onto adolescent girls living in the same household, but that not all of it is passed on, and that in urban areas it is only passed on when the mother of the young child is also the mother of the adolescent girl. Other messaging efforts directed towards mothers have only small, or no association with adolescent girls' knowledge of IYCN. This suggests that improving adolescent girls' understanding of IYCN knowledge may require information and messaging specifically directed towards them, and that approaches may be different in rural and urban areas because different sources of knowledge are available. Further progress on this topic requires an improved understanding of how best to reach adolescent girls with this information and an assessment of whether such approaches are effective in increasing their knowledge and improving the health and nutritional status of their own children.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

JH contributed to the study design, coordinating data collection in Bangladesh, developing research questions, interpretation of data, drafting and revising the manuscript; NIK contributed to the study design, coordinating data collection in Bangladesh, interpretation of data, drafting and revising the manuscript; NAL contributed to the data setup and analysis; SR contributed to the study design, coordinating data collection in Bangladesh, developing research questions, interpretation of data, drafting and revising the manuscript. All authors read and approved the submitted manuscript.

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