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Sheela S. Sinharoy Date

Women's empowerment and women's dietary diversity in urban and rural Bangladesh

By

Sheela S. Sinharoy

Doctor of Philosophy

Nutrition and Health Sciences

_____	_____
Thomas F. Clasen, PhD JD MSc Advisor	Reynaldo Martorell, PhD Advisor
_____	_____
Aryeh D. Stein, MPH, PhD Committee Member	Amy Webb Girard, MPH, PhD Committee Member
_____	
Kathryn M. Yount, PhD Committee Member	

Accepted:

_____
Lisa A. Tedesco, PhD
Dean of the James T. Laney School of Graduate Studies

_____
Date

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By

Sheela S. Sinharoy

B.A., Pennsylvania State University, 1999

M.P.H., University of North Carolina, 2008

Advisor: Thomas F. Clasen, PhD JD MSc

Advisor: Reynaldo Martorell, PhD

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Abstract

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By Sheela S. Sinharoy

Background: Very little evidence exists documenting relationships between women's empowerment and women's nutrition. The objective of this dissertation is to quantify associations between domains of women's empowerment and women's nutrition. **Methods:** This dissertation uses a resources–agency–achievements framework and structural equation modeling (SEM) techniques to quantify associations between women's resources (schooling and/or income-earning), women's agency, and women's dietary diversity. Data collection took place between February 2015 and October 2016 at two sites in Bangladesh: a rural area in Habiganj district and poor urban neighborhoods of Dhaka. We used exploratory and confirmatory factor analysis to identify latent variables representing domains of women's agency in each study. We then used SEM to measure associations between women's resources, latent variables for agency, and dietary diversity. **Results:** In all studies, a majority of women consumed inadequately diverse diets (<5 of 10 food groups in the previous day). We observed strong positive associations between having any post-primary schooling and dietary diversity at the individual level. The standardized adjusted direct associations with dietary diversity were β=0.22 (p<.001), β=0.21 (p<.001), and β=0.22 (p<.001) in the rural, urban, and pooled samples, respectively. Schooling was positively associated with decision-making (β_{31}= 0.035, p=.018) and voice with husband (β_{41}=0.049, p=.010) in rural but not urban areas. In urban areas, income-earning was positively associated with decision-making (β_{31}=0.044, p=.002) but not associated with voice with husband. Relationships between women's agency and dietary diversity varied: we observed positive associations between voice with husband and dietary diversity in the rural sample (β_{54}=0.39, p=.002) but not in the urban sample. There was no association between decision-making and dietary diversity in the rural or urban models with schooling, but we noted a positive association in the urban model with income-earning (β_{53}=0.41, p=.038). We observed no associations between schooling, women's agency, or dietary diversity at the community level. **Conclusions:** We observed consistent positive associations between schooling and dietary diversity at the individual level. We also observed individual-level pathways from schooling through voice with husband to dietary diversity in a rural sample and from income-earning through decision-making to dietary diversity in an urban sample, but no community-level pathways.

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Chapter 1: Introduction

Women's empowerment is widely considered to be important for child nutrition (1, 2). However, pathways through which women's empowerment may lead to improvements in child nutritional status are not well understood. In the 2013 *Lancet* series on Maternal and Child Nutrition, Ruel and Alderman list women's empowerment as a nutrition-sensitive intervention but state that "few studies have measured specific aspects of women's empowerment as a pathway to improved nutrition, and results are mixed" (3). Similarly, Cunningham et al., in a 2014 review of women's empowerment and child nutrition in South Asia, found large gaps in the evidence base and concluded that "rigorous evaluation work should be conducted to establish the causal relationships between development programmes, women's empowerment and child nutrition" (4).

Even less is known about the relationship between women's empowerment and women's nutrition. Research on women's empowerment typically follows an instrumentalist approach, in which the research focuses on women's traditional roles as nurturers and caregivers and aims to measure whether they are performing these roles more effectively (as opposed to measuring empowerment for women's own benefit). Very little published literature exists in which the primary study objective was to measure the association between women's empowerment and women's own nutritional outcomes (5-8) . This dissertation aims to contribute toward filling that gap. The objective of this dissertation is to quantify associations between domains of women's empowerment and women's nutrition. The primary hypothesis is that women's empowerment is associated with nutrition of women in Bangladesh.

Research Aim 1

To assess the influence of enabling resources on the dietary diversity of women in the Food and Agricultural Approaches to Reducing Malnutrition (FAARM) target population and to quantify possible pathways through women's agency.

FAARM is a cluster-randomized controlled study implemented in Habiganj District in northeastern Bangladesh, led by the University of Heidelberg and carried out in collaboration with Helen Keller International (HKI). The objective of the study is to investigate the potential to improve child nutritional status through a food-based dietary diversification strategy that trains rural women's groups in gardening, nutrition and health. The primary outcome is stunting. Secondary outcomes are wasting and diarrhea prevalence in children and micronutrient status in women and children. Chapter 3 describes an analysis of relationships between women's resources, agency, and dietary diversity in the FAARM population, using data from the baseline survey.

Research Aim 2

To assess the influence of enabling resources on the dietary diversity of women in poor neighborhoods of Dhaka City Corporation and to quantify possible pathways through women's agency.

At the request of the Federal Ministry for Economic Cooperation and Development (Germany) and WorldFish, HKI/Bangladesh collected food consumption data from

750 urban households. The objective of the study was to generate knowledge on food consumption among households in poor neighborhoods of Dhaka. Outcomes of interest included household- and individual-level food consumption patterns, seasonal variation in household food consumption, and differences in food consumption by sex and age. Chapter 4 describes an analysis of relationships between women's resources, agency, and dietary diversity in this urban population.

Research Aim 3

To assess the influence of enabling resources on dietary diversity at the community level and to quantify possible pathways through community-level measures of women's agency in a pooled sample of rural and urban women in Bangladesh.

This analysis uses pooled the data from FAARM and the Bangladesh urban food consumption study. Chapter 5 describes an analysis of relationships between women's resources, agency, and dietary diversity at the community level in this pooled sample.

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Chapter 2: Background and Literature Review

Definitions

Gender

The United Nations defines sex as "the biological differences between men and women, which are universal and determined at birth" (1). They define gender in the following way:

> Gender refers to the roles and responsibilities of men and women that are created in our families, our societies and our cultures. The concept of gender also includes expectations held about the characteristics, aptitudes and likely behaviours of both women and men (femininity and masculinity). Gender roles and expectations are learned. They can change over time and they vary within and among cultures. Systems of social differentiation such as political status, class, ethnicity, age, physical and mental disability, and more all modify gender roles. The concept of gender is vital, because when applied to social analysis it reveals how women's subordination (or men's domination) is socially constructed. As such, the subordination can be changed or ended. It is not biologically predetermined nor is it fixed forever (1).

Women's empowerment

Women's empowerment, being an intangible construct, can be defined in many different ways. In a 2007 paper, Ibrahim and Alkire listed 29 different definitions for empowerment compiled from the literature (2). Ten years later, no clear consensus exists

on terminology or definitions. Perhaps the most commonly used definition is that of Kabeer, who described empowerment as "the expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them" (3). In this definition, empowerment is a process through which people increase their control over their lives over time (3).

There is also no consensus on the domains or dimensions of women's empowerment. Kabeer referred to three dimensions: resources, agency, and achievements (3). In her conceptualization, resources are the "pre-conditions … [that] enhance the ability to exercise choice," agency is the "ability to define one's goals and act upon them," and achievements are the "outcome" resulting from the exercise of agency (3). These dimensions are linked, as agency builds upon resources toward achievements. Malhotra and Schuler, in the book *Measuring Empowerment: Cross-Disciplinary Perspectives*, propose a framework of five dimensions of empowerment: psychological, social, economic, legal, and political (4). These, in contrast to Kabeer's dimensions, are not linked, and women may achieve empowerment in one dimension but not in the others. At the same time, other researchers continue to develop their own conceptualizations of empowerment. For example, Cunningham *et al.* refer to three domains: control of resources and autonomy, workload and time, and social support (5).

Along with empowerment, some researchers use the term "autonomy" to describe the same or similar concepts. Like empowerment, a number of definitions exist for autonomy. One recent systematic review defined autonomy as "a woman's ability to have control or influence over choices that affect herself and her family within her own particular context" (6). Some researchers include dimensions of autonomy in their

definitions, while others do not. Despite the similarities with empowerment, Jejeebhoy identifies an important distinction in that empowerment "is a more dynamic term, encompassing both process and the result of that process," whereas autonomy refers to "a given point in time" (7).

Measurement of women's empowerment

Due to its nature as an intangible construct, women's empowerment presents many measurement challenges. As Malhotra and Schuler note, "the process of empowerment is essentially qualitative in nature" (4). However, several quantitative tools and indicators exist at the international and national level to measure empowerment. One international indicator is the Gender Development Index, used by the United Nations, which is "a composite measure reflecting disparity in human development achievements between women and men in three dimensions—health, education and living standards" (8). Another index used by the United Nations is the Gender Inequality Index, which is also "a composite measure reflecting inequality in achievements between women and men in three dimensions: reproductive health, empowerment and the labour market" (9). Finally, the World Economic Forum uses the Global Gender Gap Index, which measures gaps in gender equality at the country level (10).

A number of other measures exist for use at the national and sub-national levels. The Demographic and Health Survey (DHS) woman's questionnaire includes questions on women's income control; land ownership; decision-making related to earnings, healthcare, major household purchases, and visits to relatives; and attitudes toward wife-beating in different situations (11). A newer measure being used in multiple countries is

the Women's Empowerment in Agriculture Index (WEAI), originally developed by the International Food Policy Research Institute for use in Feed the Future programs funded by the United States Agency for International Development (12). The WEAI measures five domains of empowerment: decisions about agricultural production, access to and decision-making power over resources, control over use of income, leadership in the community, and time use (12). Some of the WEAI questions are based on indicators originally proposed by Ibrahim and Alkire, focusing on decision-making in personal and household matters, autonomy with regard to actions in different areas of life, and agency in changing aspects of women's lives at the personal and community levels.

In addition to these measures, researchers often choose to develop and use their own indicators and scales that may or may not align with those used in other studies. In a discussion of dimensions of empowerment, Malhotra and Schuler propose a number of indicators for each dimension (4), a selection of which are listed in Table 1. However, validated modules do not currently exist to measure the majority of these indicators. Researchers use a variety of tools to measure their chosen dimensions of empowerment, and the lack of standardization across studies means that results are often not comparable. It also means that results cannot be entered into meta-analyses, so the evidence base around women's status in many cases remains scattered and disjointed. As stated in one recent review, "this field of study still lacks a coherent conceptual framework for measurement that can guide researchers in how to operationalize empowerment by aggregating indicators into meaningful dimensions" (13).

Table 1. Dimensions of empowerment and selected proposed indicators (4)

Dimension	Sample indicators
Economic	Control over income; ownership of assets and land; access to and control of family resources
Social	Freedom of movement; participation in domestic decision-making; control over sexual relations; control over spouse selection and marriage timing; freedom from violence
Legal	Knowledge of legal rights and mechanisms; familial support for exercising rights
Political	Knowledge of political system and means of access to it; familial support for political engagement; ability to exercise right to vote
Psychological	Self-esteem; self-efficacy; psychological well-being

Women's nutritional status

Malnutrition can include undernutrition, overnutrition, and micronutrient malnutrition. Undernutrition and overnutrition relate primarily to dietary energy intake, while micronutrient malnutrition relates to intake of individual micronutrients (14). Undernutrition can lead to a number of adverse health outcomes, including reduced immune function, increased susceptibility to infection, and increased inflammation (14). Overnutrition, particularly obesity, can increase the risks of chronic diseases including type 2 diabetes, coronary heart disease, high blood pressure, and some cancers (14). Micronutrient malnutrition can impair a range of body functions (14). Micronutrient deficiencies of particular relevance to women's health include iron deficiency as a cause of anemia, which can reduce women's energy, work capacity and earning potential; vitamin A deficiency, which is the leading global cause of preventable blindness; and vitamin D deficiency, which impairs calcium absorption and bone mineralization (15).

For women who become pregnant, malnutrition can have serious consequences for both mother and fetus. Maternal malnutrition can contribute to a number of pregnancy

complications: short maternal height (<145cm), which can result from chronic undernutrition, is associated with obstructed labor and a higher risk of small-for-gestational age (SGA) (16). Pregnant women with obesity have a higher risk of developing gestational diabetes mellitus and pre-eclampsia, and they are also at higher risk of labor complications including infection and hemorrhage (16). Similarly, studies have noted associations between individual micronutrient deficiencies and a range of adverse outcomes, such as between iron deficiency anemia and low birthweight, severe iodine deficiency and cretinism, and vitamin D deficiency and pre-eclampsia, preterm birth, and SGA (16, 17). Poor maternal nutrition increases the risks of fetal loss and maternal mortality and can indirectly contribute to neonatal and infant mortality (17-19). Finally, maternal nutritional status can also affect lactation performance, including both milk production and composition (20, 21).

Studies have also documented a positive association between mothers' dietary diversity and the dietary intake of their children in several low- and middle-income countries (22, 23). In Bangladesh, Ethiopia, and Vietnam, each additional food group consumed by a mother was associated with an increase of 0.29, 0.24, and 0.33 food groups consumed by the child, respectively (23). In Ghana, each additional food group in the mother's diet was associated with an additional 0.72 food groups consumed by the child (22). The World Health Organization defines minimum dietary diversity for children 6-23 months old as four or more out of seven food groups in one day (24). Especially in settings of limited resources, an increase in maternal dietary diversity can increase the likelihood of achievement of minimum dietary diversity for her young children. Thus, women's dietary diversity, in addition to being important for women's

own micronutrient status, can have an important influence on children's nutritional status throughout their early years.

Up-to-date global figures for women's nutrition are lacking. The most recent global analysis used data on women's body mass index (BMI) from 1980 to 2008. The results showed a trend toward a decrease in women's undernutrition alongside an increase in women's overnutrition (16). The prevalence of undernutrition, defined as BMI<18.5 kg/m^2, was highest in Africa and Asia, where it remained over 10% by 2008 (16). The prevalence of overweight, defined as BMI≥25 kg/m^2 and obesity, defined as BMI≥30 kg/m^2, increased in all regions, with the steepest increases in Oceania as well as the Americas and the Caribbean (16).

Relationships between women's empowerment and nutrition

As stated in Chapter 1, very little research exists on the relationship between women's empowerment and women's nutrition. The vast majority of research on women's empowerment has focused on child nutrition outcomes. The majority of research is also cross-sectional and often uses secondary analysis of large datasets such as the Demographic and Health Surveys. Very few studies have attempted to measure the longitudinal process of empowerment or to rigorously evaluate the impact of interventions on women's empowerment and nutrition outcomes using experimental study designs. The evidence base is therefore largely observational, making it difficult to draw definitive conclusions. Bearing in mind these limitations, this section will review the existing evidence related to women's empowerment and nutrition of women and children. Findings will be presented in categories relating to the domain (or proxy or correlate) of women's empowerment being measured.

Education

While education or schooling is not a domain of women's empowerment, researchers often use it as a proxy measure. A number of studies have linked women's education to nutrition outcomes, especially the nutrition of their children. In general, parental schooling is consistently associated with improved child nutrition outcomes (25). At the global level, Smith and Haddad examined data from 116 countries from 1970 to 2010 and found that women's education was the second most important factor contributing to reductions in child stunting, after access to safe water (26). Indeed, women's education was a more important factor than the food-related variables in their models such as per capita dietary energy supply (26).

Studies from individual countries also demonstrate the importance of women's education for child nutrition. A study from Norway found that following compulsory school reforms that began in 1960, each year of additional girls' education led to a decrease in the probability of low birth weight of about 0.01 (or one percentage point) (27). The authors conclude that over time, the reforms caused a 10% reduction in the prevalence of low birth weight (27). In another study from Mexico, children of mothers who had completed primary school had a higher height-for-age z-score than children of mothers who had less than a primary school education (28).

The pathway through which maternal schooling leads to improved child nutrition is not clear. Education may lead to increased health literacy and health knowledge, which would better equip mothers to make healthy decisions and practice healthy behaviors for the benefit of their children (29). These may include feeding behaviors but may also include more general health-promoting activities like vaccination, appropriate water

treatment, and handwashing, which also have benefits for children's nutrition. Mothers who have more education may have higher status and decision-making power in their households, allowing them to direct greater resources to child health and nutrition (29, 30). They may also have stronger social networks, through which they can receive information and assistance related to childcare (30). Finally, women with more years of education have a lower risk of depression (29); maternal antenatal depression has been associated with low birth weight and infant undernutrition at six months, especially in low socio-economic populations (31), and a meta-analysis of studies from 11 developing countries found an increased odds of child stunting associated with maternal depression (OR: 1.4; 95% CI: 1.2–1.7) (32).

Another way in which education may lead to better child nutrition outcomes is through delayed marriage. A report from the World Bank states that "[i]n all regions, women with more education … tend to marry later and have fewer children" (33). Given that marriage is a proximate determinant of fertility, later marriage leads to later childbearing. Early childbearing is associated with numerous adverse outcomes for children, including preterm birth, SGA, and infant mortality (34). According to the same report, "Girls with little or no education are far more likely to be married as children, suffer domestic violence, live in poverty, and lack a say over household spending or their own health care than better-educated peers, which harms them, their children, and communities" (33).

Decision-making

The importance of decision-making relates to household dynamics. In the field of family economics, an early model of household functioning was the unitary model, which held

that everyone within the household has the same preferences and will pool their resources (35). Under this model, women's decision-making would hold little importance, because the head of household, usually a man, would have the same preferences as the woman and would make decisions accordingly. This model has since been replaced by the bargaining model, in which individuals with more decision-making power in the household will receive a larger share of the benefits from household resources, including nutritious food (35). This model can be broken down further into cooperative and non-cooperative models of the household (35). However, in all cases, women's decision-making plays an important role in the well-being of women and their children.

As implied by its name, the bargaining model takes into consideration more than simple binary decisions. For example, a woman may not be able to simply decide that she will consume the best quality food, but she may be able to bargain around the allocation of food among household members (36). For this, she requires bargaining power. Studies that use the bargaining framework aim to measure whether individuals' bargaining power in the household allows them to achieve their "preferred outcomes" (35). In these studies, decision-making may act as a proxy for bargaining power; other proxies include employment, income earning, and asset control. The results of these studies indicate that women's bargaining power is positively associated with spending on food and health, among other categories (35).

The difference between men's and women's preferences is documented in the literature. For example, when women earn an income, they tend to make different decisions than men about how to spend their earnings, and they spend substantially larger proportions of their earnings on their families (37). Studies from countries such as Brazil,

Guatemala, and Cote d'Ivoire have noted a positive association between mothers' income share and child nutrition (38-40). The same applies to non-cash assets, as studies in several countries have observed that increasing women's assets increases the household budget allocation for food (41). Similarly, in Nepal, control over both income and agricultural decisions is positively correlated with higher height-for-age z-score (HAZ) for children (41). Women's decision-making is especially important in settings with limited resources: across Sub-Saharan Africa, Asia, and Latin America, women's decision-making is more strongly associated with child nutrition in poor households than in rich households (42).

Several studies have examined women's decision-making and women's dietary diversity. In Ghana, researchers analyzed DHS data and observed that women's decision-making concerning household purchases was positively associated with their dietary diversity (43). Similarly, in Ethiopia, results from a study that used the WEAI to measure empowerment indicate that women's participation in decisions concerning credit was positively associated with their dietary diversity (44). In Bangladesh, another study using the WEAI suggested that "household diet diversity and calorie availability increase if the primary female decisionmaker is more empowered" (45). These studies begin to fill the gap in knowledge around women's decision-making and diet, but much more research is necessary.

In addition to directing their income and assets toward their children, as noted by Desai and Johnson, women may use their decision-making power to carry out "health enhancing behaviors" (46). For example, women must choose how to allocate their time between paid and unpaid tasks, caring for themselves and their children, and leisure

activities. In a study in Ethiopia, women's time allocation was associated with both their own and their children's dietary diversity (44). Following guidelines for optimal infant and young child feeding (e.g. exclusive breastfeeding to six months of age, continued breastfeeding to two years and beyond, providing the correct amount and frequency of complementary foods, and practicing responsive feeding) can require a substantial investment of time and energy on the part of a caregiver. Mothers who lack the power to make decisions about their time may not be able to follow these guidelines. Similarly, the World Bank reports that a "[l]ack of agency can prevent women and girls from accessing a range of [health] services" (33).

An important area of decision-making that relates closely to Kabeer's definition of empowerment as "strategic life choices" are decisions around marriage. In developing countries, one-third of girls are married before age 18 (47). Girls living in poor households, in rural areas, and with less education are the most likely to be married before age 18 (48). Early age at marriage, in turn, increases risks of poor health outcomes including intimate partner violence, obstetric fistula, and maternal mortality (33, 49). The latter two outcomes result partly from girls becoming pregnant while their bodies are still maturing and partly from the fact that girls who marry before age 18 are less likely to receive prenatal and obstetric care (50). Early marriage also increases the risks of poverty and lower educational attainment (48) and, according to an analysis of DHS data from 58 countries, is associated with reduced freedom of movement and reduced sexual autonomy (51).

Closely linked to marriage are decisions around childbearing. Early childbearing, which is defined differently by different researchers, can have adverse outcomes for the

nutrition of both women and children. One review found that early age at first pregnancy (<16 years) is associated with higher odds of maternal anemia (OR: 1.36, 95% CI: 1.24,1.49) (52). A meta-analysis found that early age at first childbirth (<18 years) is associated with higher odds of small for gestational age (aOR: 1.80, 95% CI: 1.62,2.01); preterm birth (aOR: 1.52 , 95% CI: 1.40,1.66); neonatal mortality (aOR: 2.07 , 95% CI: 1.69,2.54); and infant mortality (aOR: 1.49 , 95% CI: 1.13,1.97) (34). In Bangladesh, a study observed that early age at first pregnancy (<19 years) was associated with arrested linear growth and decreases in body mass index, mid-upper arm circumference, and percent body fat among girls (53). Thus, the decision about when to marry and have children can have serious and long-term implications for both mother and child.

Freedom of movement

Freedom of movement is perhaps the most context-dependent domain of women's empowerment. Broadly, it is considered to be a more sensitive indicator of empowerment in Asian and Middle Eastern contexts than in many African contexts (13). However, even within the same country, women in some areas may have more liberty to move freely and carry out daily tasks than in others (54). The concept of freedom of movement is therefore difficult to define and measure in a uniform way. Only one study, to my knowledge, has measured the relationship between freedom of movement and nutrition: using cross-sectional data from two communities in South India, Sethuraman *et al.* observed that mothers' freedom of movement was positively associated with children's weight-for-age (54). Freedom of movement can also facilitate social connections and group membership, and it has been theorized that maternal social support may influence childcare practices and, in turn, child nutrition (38). Studies using the WEAI module on

group membership have observed positive associations between women's group membership and calorie availability and dietary diversity at the household level in Bangladesh, and also with women's and children's dietary diversity in Ethiopia (44, 55).

In addition, freedom of movement may be closely linked to women's bargaining and decision-making power, as it may provide women with greater exit options, changing their fallback position in the bargaining model (49, 56). Women with greater freedom of movement may have a greater ability to acquire skills, for example through participating in NGO programs, and greater income-earning potential, which would improve their bargaining position (36). Also, as noted by Katz, "women with relatively little outside contact or whose reference group is made up of similarly secluded neighbors and family members, are not likely to be fully aware of all their options, even if some of these options would enhance their bargaining power in the household" (56). She goes on to write that this "potentially creates an incentive for the … husband to actively seclude his wife … [as] keeping women home reduces their employability and therefore their bargaining power…" (56). On the other hand, the causal relationship may function in the opposite direction such that women's bargaining power may affect their freedom of movement, for example if greater bargaining power gives women the ability to choose to participate in the labor market (35).

Political participation

Little evidence exists on the relationship between women's political participation and nutrition outcomes. One multilevel analysis using country-level data on political participation and individual-level DHS data observed that women's political representation is inversely associated with infant mortality (30). Another review

examined 45 social determinants of life expectancy across 54 low-income countries and found that the proportion of seats held by women in national parliaments had the second-largest association with life expectancy at birth (57). Neither these nor any other studies, to my knowledge, have examined associations with nutrition. However, it has been theorized that women's political participation would benefit child health and nutrition more generally because women are more likely to support policies that promote child well-being (30). It should be noted that women's political representation is predicated on their freedom of movement, as women must be able to safely leave their homes in order to participate in civic life (33).

Intimate partner violence

The experience of intimate partner violence (IPV) is an indicator of deep *dis*empowerment, with potential implications for nutrition. IPV may influence nutritional outcomes through a number of pathways, as outlined by Yount *et al* (58). These include a direct pathway, through which exposure to violence may lead to increased psychological stress in children, including in utero, and associated adverse outcomes (58). They also include several indirect pathways, perhaps the most well-documented of which is the negative impact of IPV on maternal physical and mental health and thereby on mothers' caregiving abilities, resulting in adverse outcomes for children (58). IPV also increases the risk of child abuse, which directly and negatively impacts children's health (58). Finally, IPV may result in unintended pregnancy and lower health service utilization, both of which could impact the health and well-being of children (58).

Studies have attempted to quantify these relationships in various ways. A systematic review and meta-analysis found increased odds of low birth weight (aOR 1.53,

95% CI 1.28-1.82) and preterm births (aOR 1.46, 95% CI 1.27-1.67) among women exposed to domestic violence (59). However, several cross-national analyses of DHS data have documented mixed results when examining associations between various forms of IPV and nutrition outcomes. In one such study, physical abuse was associated with higher odds of child stunting in Kenya but not in Egypt, Honduras, Malawi or Rwanda (60). In another analysis of DHS data from 8 countries in Africa, researchers observed mixed associations between IPV and breastfeeding practices (61). A third study of data from Burkina Faso, Cameroon and Zimbabwe noted mixed associations between IPV and stunting (62).

At the national and sub-national level, several studies have examined similar relationships. An analysis of DHS data from Liberia indicated that maternal exposure to sexual IPV was associated with child HAZ (63). Analyses of DHS data from India suggest that IPV is associated with higher child mortality rates (64) and lower odds of exclusive breastfeeding (65). Another study from South India observed an inverse association between women's experience of psychological abuse and their own weight and BMI, but no association between IPV and child nutrition outcomes (54). A study of DHS data in Bangladesh observed that IPV was associated with higher odds of child stunting (66), while a different study from Bangladesh noted that any lifetime exposure to family violence was associated with an increased risk of fetal and early childhood growth impairment as well as of diarrheal and respiratory tract infections during infancy (67). Studies in Brazil observed that physical abuse was associated with lower gestational weight gain (68) and an increased risk of severe acute malnutrition (69). Finally, a study

from Nicaragua suggested that as in India, IPV is associated with higher child mortality rates (70).

Women's empowerment in Bangladesh

Several sources exist that provide data on women's empowerment in Bangladesh. The United Nations Development Programme's Human Development Report for 2014 ranked Bangladesh at 109 of 161 countries in the Gender Development Index and 111 of 155 countries in the Gender Inequality Index (8, 9). On the Global Gender Gap Index, Bangladesh was ranked 72 of 144 countries (10). Based on the WEAI, only 25% of women in Bangladesh met the minimum requirements to be considered empowered (71). Of the five WEAI domains, community leadership contributed most to women's disempowerment, followed by access to productive resources (71). The WEAI survey results indicated that men were better off than women in all indicators except workload, where men and women were roughly equal (71).

According to the Bangladesh DHS 2014, 31% of currently married women age 15-49 had been employed in the previous 12 months and received cash earnings (72). Of these women, 32% were primarily responsible for deciding how those earnings would be used; another 54% made decisions jointly with their husbands (72). The survey also asked whether women could go alone or with just their children to a health center or hospital; 19% of women said they could not (72). For decision-making, the DHS asked about four types of decisions. For each individual type of decision, over 60% of women said that they were usually involved in making the decision, either alone or jointly with their husbands (72). Altogether, 44% of women said they were usually involved in all

four types of decisions (72). Finally, a minority of women (28%) agreed with at least one reason for wife-beating (72). Of the five reasons, the largest proportion of women (19.9%) agreed that a husband is justified in hitting or beating his wife if she argues with him (72).

Women's nutrition in Bangladesh

In Bangladesh, the most recent DHS results indicate that among ever-married women ages 15-49, 18.6% were undernourished, 23.8% were overweight, and 4.4% were obese using the same BMI cut-offs listed above (72). Reflecting global trends, the proportion of women who were undernourished decreased by 15 percentage points over ten years, from 34% in 2004, while the proportion of women who were overweight increased in parallel by 15 percentage points in the same time period, from 9% in 2004 (72). As in many countries, the proportion of women who are overweight now exceeds the proportion who are undernourished. While little is known about the micronutrient status of women in Bangladesh, the Food Security and Nutritional Surveillance Project documented that 54% of women aged 10-49 years consumed inadequately diverse diets, defined as ≤4 of 9 food groups in the prior 24 hours (73). Given the positive association between dietary diversity and micronutrient intake (74), it is likely that a substantial proportion of women in Bangladesh are failing to meet micronutrient requirements.

Measures of empowerment included in this research

This dissertation uses Kabeer's resources – agency – achievement construct as an analytic framework (3). Throughout, we operationalize "resources" as schooling and/or income-

earning. We operationalize "agency" in a number of ways. Within Malhotra and Schuler's five dimensions of empowerment, our measurement of agency would fall within the social dimension, as we aim to measure women's decision-making, voice with husband, social solidarity, and freedom of movement (4). We chose these as being the most feasible and the most directly relevant to our "achievement" of interest, women's dietary diversity.

We measured decision-making because it is the most common proxy for agency (3). We chose voice with husband as a proxy for intra-household communication or bargaining, which, as described above, is closely related to decision-making. We measured social solidarity only in the rural population; we theorized that this was important because many programs, including ours, organize women's groups as an implementation strategy, and we were interested in examining whether these groups might serve to increase women's agency. Finally, we included freedom of movement because the social and religious practice of *purdah*, or seclusion, is common in Bangladesh. Women's movement, especially in rural areas, is extremely constrained, and we sought to determine whether this has any association with their diet.

The remaining dimensions listed by Malhotra and Schuler may be of future interest but were deemed to be either not feasible or not appropriate for this project. For example, women's economic empowerment may be important for their dietary diversity, but this dimension is less feasible to measure in Bangladesh, especially rural Bangladesh, where women's income earning and control is rare. Similarly, psychological empowerment may be important for nutrition, but concepts such as self-efficacy are more complex and require longer questionnaires than, for example, decision-making or

freedom of movement. The other two dimensions, political and legal empowerment, are more distal determinants of nutrition outcomes and so were not included in our measurements.

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Chapter 3: Women's dietary diversity in rural Bangladesh: pathways through women's empowerment

Manuscript Authors: Sheela S. Sinharoy, Jillian L. Waid, Regine Haardörfer, Amanda Wendt, Sabine Gabrysch, Kathryn M. Yount

Introduction

In Bangladesh, 54% of women aged 10-49 years consume inadequately diverse diets, defined as ≤4 of 9 food groups in the prior 24 hours (1). Dietary diversity has a consistent positive relationship with micronutrient adequacy cross-nationally and within Bangladesh (2, 3). A majority of women of reproductive age in Bangladesh are, therefore, likely to be consuming inadequate amounts of micronutrients, putting them at risk of deficiency and associated adverse health outcomes.

Gender-based inequities in the intra-household allocation of food have long been documented in Bangladesh (4, 5). However, few studies have examined whether women's empowerment influences their dietary intake. One study in Bangladesh noted a positive relationship between women's empowerment and household dietary diversity, but it did not examine dietary diversity at the individual level (6). Few other studies exist on domains of women's empowerment and women's nutrition.

Women's nutritional status, in addition to being important for health and well-being, can be considered a measure of women's broader capabilities. Amartya Sen defined a person's capabilities as "what he or she can *do* or can *be*" and noted that nutrition is an objective parameter for measuring this potential (7). Martha Nussbaum built on Sen's work, writing, "[W]e ask: Is the person capable of this, or not? And we ask

not just about the resources that are sitting around, but about how those do or do not go to work, enabling [her] to function in a fully human way" (8).

We aimed to address the research gap around women's empowerment and nutrition in Bangladesh, by examining how women's resources may contribute to their capabilities. We used Naila Kabeer's resources – agency – achievements framework to guide our analysis (9). Kabeer defines resources as the "pre-conditions … [that] enhance the ability to exercise choice," agency as the "ability to define one's goals and act upon them," and achievements as the "outcome" resulting from the exercise of agency (9). Resources include material, human and social resources (9). They serve as the foundation for agency, which can include the active exercise of power, such as through decision-making and negotiation, but can also include an individual's self-concept and attitudes (9).

The aim of our study was to assess the influence of enabling resources on dietary diversity among women in a rural area of Bangladesh and to quantify possible pathways through women's agency. We hypothesized that women who had more enabling resources would have higher agency and, in turn, higher dietary diversity.

Methods

Participants

The data for this study come from a baseline survey for a cluster-randomized controlled trial called "Food and Agricultural Approaches to Reducing Malnutrition" (FAARM), conducted in Habiganj District, northeastern Bangladesh. FAARM aims to evaluate the impact of an enhanced homestead food production intervention on

nutritional status in women and their young children. The target population is young married women under age 30 and their children under age 3. The trial covers 96 rural settlements, defined as a group of households that are geographically close and usually corresponding to a village. The number of households per settlement ranges from 9 to 59, with a median of 26.

The baseline survey took place from March to May 2015. All 96 settlements were visited, and all eligible women were targeted for inclusion in the study. A total of 2,623 women consented to participate in the study and were enrolled. Trained data collectors administered a structured survey covering household demographic and socioeconomic characteristics; food security and dietary diversity; women's agency; women's and children's health; and infant and young child feeding practices. A total of 2,599 women completed the household and women's sections of the survey.

Variables

The "achievement" or outcome of interest was women's dietary diversity, measured by asking the woman about her consumption in the previous day through a combination of open recall and prompted response methods. When women reported consuming a food item, data collectors asked whether she had consumed more or less than a spoonful, in order to assess whether she had consumed at least 15 g of the food. We then aggregated the responses into a score derived from a standard 10-Food Group Indicator (FGI-10R) (10). FGI-10R captured starches (e.g. grains and white roots or tubers), pulses, nuts and seeds, dairy, flesh foods (e.g. meat, poultry, fish, including organ meats), eggs, dark green leafy vegetables, vitamin A-rich fruits and vegetables, other fruits, and other vegetables if these items were consumed in a quantity greater than 15

grams. Among women of reproductive age, consumption of 5 or more of the 10 food groups is associated with a higher likelihood of achieving micronutrient adequacy (11).

We defined resources as grades of schooling, dichotomized to represent 0-5 completed years of primary schooling compared to any completed post-primary years. The dichotomization corresponds to a theoretically important threshold. A cross-country analysis of Demographic and Health Survey (DHS) data from 58 countries found that schooling was an important determinant of women's agency and noted that secondary schooling was of particular importance in Bangladesh (12). A study in Bangladesh found having any secondary schooling to be inversely associated with early marriage (13), while another observed that schooling was positively associated with women's decision-making (14). Thus, schooling is considered an important resource for agency in this context.

We used 22 items to capture four domains of agency: freedom of movement, women's social solidarity, decision-making, and voice with husband (Supplemental Table 1). To measure freedom of movement, we asked respondents whether they had left their homestead in the last month and, if so, whether they had visited seven types of places alone or with only their children. Women's social solidarity was measured by asking respondents whether they usually meet with other women in their community to discuss five types of issues. For decision-making, we used five questions that were taken from or modeled on the DHS standard woman's questionnaire and expanded the response options to allow listing by name all individuals in the household who made the decision. Voice has been defined as "the right and ability to enter into the household bargaining process" (15) and "the ability to articulate practical needs and strategic interests" (16).

We measured this concept by asking respondents how often they talked with their husband about five topics. With the exception of the questions on decision-making, the questions were taken from previous Helen Keller International project evaluations, in which they had been used but not validated. We re-coded variables to ensure that a higher value indicated higher agency. The Cronbach's alpha coefficient in our sample for the set of variables representing each domain was 0.21, 0.77, 0.69, and 0.70 for freedom of movement, social solidarity, decision-making, and voice with husband, respectively.

To control for potential confounding by socio-economic status, we created a household asset index using standard DHS techniques (17). We applied principal component analysis to measures for the ownership of 23 assets, including household goods, livestock, and land, as well as seven attributes of the housing structure, such as latrine type, water source, house size, and materials used in house construction. Other covariates were household structure (joint vs nuclear, with nuclear defined as a household with no more than one ever-married woman and no more than one ever-married man) and the woman's height and years of marriage. Woman's height was included as a potential proxy for deprivation, as adult height below 145 cm may result from chronic undernutrition and could therefore represent a long-term lack of resources (18). Years of marriage was included because longer duration of marriage may contribute to greater agency in traditional patriarchal households (14).

Statistical Analyses

We calculated descriptive statistics, as well as tetrachoric and polychoric correlations for dichotomous and ordinal variables, respectively.

Of the 22 items used to measure women's agency, several had not been extensively studied, nor had the full set of items been analyzed together. Therefore, we used exploratory factor analysis (EFA) to explore the structure of the constructs being measured (19). We ran sequential two- to six-factor EFA models on a random split-half sample (n=1300) using means and variance adjusted weighted least squares estimators, which are appropriate for categorical variables (20). We interpreted the results after geomin rotation. This rotation produces oblique factors, which allow correlation between dimensions of the construct under study (19). After each estimation, we removed items one at a time based on low pattern coefficients, high multidimensionality (i.e. cross-loadings (>|0.300|) on at least one second factor), or significant negative pattern coefficients. We also dropped items that loaded on factors for which only one or two items had significant pattern coefficients, because factors with fewer than three loading items are considered weak (21). After removing an item, we re-ran the analysis with the remaining variables until a satisfactory factor structure was achieved. We interpreted model fit based on the following indices: Root Mean Squared Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Squared Residual (SRMR). RMSEA<.08, CFI>.95, TLI>.95, and SRMR<.08 were considered good fit (22).

We followed a standard two-phase structural equation modeling (SEM) approach, with a measurement model followed by a structural model. To establish the measurement model, we used confirmatory factor analysis (CFA) on the remaining random split-half sample to test the structure that was identified in the EFA. We used the same fit indices and criteria as described above to assess model fit.

We added the final measurement model identified in the EFA and confirmed using CFA to a structural model with schooling modeled as an observed exogenous (independent) variable, women's social solidarity, decision-making, and voice with husband modeled as latent endogenous (mediator) variables, and dietary diversity score as an observed endogenous (outcome) variable. We identified confounders based on bivariable analyses, defining a confounder as any variable that was associated with both the outcome and the exposure variables and not on the causal path between the exposure and the outcome. Based on these analyses, the path from schooling to decision-making was adjusted for woman's height; the path from decision-making to dietary diversity was adjusted for years of marriage, household structure, and household wealth; and the path from voice with husband to dietary diversity was adjusted for household structure and household wealth. The structural model was also adjusted for clustering, with cluster defined as settlement. We report standardized results for the structural model.

We used MPlus version 7.2 for the EFA and CFA and Stata version 14.0 for the descriptive statistics and structural model. Missing data were minimal (n=25) and were handled using listwise deletion.

Ethics

This secondary analysis was conducted as part of a cluster-randomized trial, FAARM, for which the protocol was reviewed and approved by the ethics committees of the Bangladesh Medical Research Council, the James P Grant School of Public Health at BRAC University in Bangladesh, and Heidelberg University in Germany. FAARM is registered with ClinicalTrials.gov (NCT02505711). The analysis presented here used de-identified secondary data, and additional human subjects review was not required.

Results

Descriptive statistics

Table 1 shows descriptive statistics for women in the study. Women consumed a mean of 3.9 (robust SE=0.045) of 10 possible food groups in the 24-hour period prior to the survey. The dietary diversity score was approximately normally distributed, with a range of 0 to 9 and a median of 4. A majority of women (69%) had inadequately diverse diets, defined as <5 of the 10 food groups. High percentages of women reported consuming starches (100%), flesh foods (82%), and other vegetables (69%). The high percentage of women consuming flesh foods was primarily due to high fish consumption (80%, data not shown). For the other seven food groups, percentages were below 30% (data not shown).

[Table 1]

A minority (39%) of women had any post-primary schooling. With respect to women's freedom of movement, 69% of women said that they had not left their homestead in the previous 30 days. For those women who reported that they had left their homestead, the father's and relative's house were the most frequently reported destinations (15% and 8%, respectively).

The items on women's social solidarity had the smallest range (5% – 10%), with most women reporting that they did not typically meet with women in their community to discuss any of the listed topics. Of the five topics, the largest percentage of respondents (10%) reported that they met with other women to discuss problems of women.

With respect to decision-making, with the exception of daily food preparation, a minority of women reported being involved in the decisions. The percent of women who said that they could make the decision either alone or jointly ranged from 15% (for visits to their family or relatives) to 66% (for daily food preparation). For all questions except the item on daily food preparation, a majority of women said that they usually were not involved in making the decisions.

Responses to the questions about voice with husband indicated that a majority of women talked with their husbands about all five topics at least monthly, if not weekly. The percentage of women who said that they talked about a given subject with their husband on a weekly basis ranged from 18% (for what happens in your community/area) to 59% (for your work/agricultural activities).

Factor analyses

We dropped all items for freedom of movement from the EFA due to low pattern coefficients, high multidimensionality, significant negative pattern coefficients, and/or ≤2 items loading onto one factor. All five items relating to voice with husband loaded onto one factor, with pattern coefficients ranging from 0.60-0.75. The first three items for women's social solidarity (discussing problems of the community, education, and health) loaded onto one factor, with pattern coefficients ranging from 0.82-0.94. The first three items for decision-making (daily food preparation, major household purchases, and daily household purchases) loaded onto a third factor, with pattern coefficients ranging from 0.78-0.94. Pattern coefficients for the three factors were similarly high in the CFA (0.82-1.00, 0.96-1.00, and 0.99-1.00, respectively). Fit was acceptable for the final EFA model

(RMSEA=0.074, CFI=0.98, TLI=0.95, SRMR=0.034) and exceeded minimum thresholds for the final CFA model (RMSEA=0.057, CFI=0.97, TLI=0.96).

Latent-variable structural equation models

Figure 1 shows the measurement and structural models together in unadjusted and adjusted mediation models. Both models had good fit (unadjusted: RMSEA=0.042, CFI=0.95, TLI=0.93, SRMR=0.041; adjusted: RMSEA=0.040). Post-primary schooling showed a strong direct association with dietary diversity both in the unadjusted (β_{51}= 0.44, p<.001) and the adjusted model (β_{51}= 0.22, p<.001).

In the unadjusted model, strong inverse relationships exist between schooling and decision-making and between decision-making and dietary diversity. After adjusting for woman's height, years of marriage, household structure, household wealth, and clustering, we observed an association between schooling and decision-making (β_{31}= 0.035, p=.018) but not between decision-making and dietary diversity (β_{53}= 0.026, p=.89).

Schooling was also positively associated with voice with husband (β_{41}=0.049, p=.010) in the adjusted model, but not with the latent variable for women's social solidarity (β_{21}=-0.0022, p=.41). Voice with husband was positively associated with dietary diversity (β_{54}=0.39, p=.002). Women's social solidarity was not associated with dietary diversity (β_{52}=-0.25, p=.41).

Thus, we observed a positive direct association between schooling and dietary diversity as well as an indirect association, mediated by voice with husband. Neither decision-making nor social solidarity were important mediators of the relationship between schooling and dietary diversity. In examining our hypothesis that women with

higher agency would have higher dietary diversity, we rejected the null hypothesis of no association for one domain of women's agency (voice with husband) and failed to reject the null hypothesis for the other two domains (decision-making and women's social solidarity).

Discussion

This is the first study to use the resources – agency – achievement framework to examine women's nutrition outcomes in Bangladesh. We observed that having any completed years of post-primary schooling was positively associated with dietary diversity, both directly and indirectly through voice with husband: schooling was positively associated with voice with husband, which was positively associated with dietary diversity.

Women in our study population had low dietary diversity scores (mean=3.9). This is in line with earlier findings, which concluded that micronutrient inadequacy due to low dietary diversity is widespread among women in rural Bangladesh (3). Women's nutrition can affect their infants and young children through pregnancy and breastfeeding and also through the strong association between maternal and child diets (23, 24). Low dietary diversity and micronutrient inadequacy among women thus has implications not only for their own health but also for the health and nutrition of their children. Women's dietary diversity also has broader implications beyond health as a proxy for women's functioning and capabilities.

The positive direct and indirect associations of women's post-primary schooling with dietary diversity may represent several mechanisms of effect. More schooling may

equip women with higher literacy, including health and nutrition literacy, and a concurrent ability to understand and act upon health information (25). This may translate into improved dietary behaviors leading to higher dietary diversity. Especially in larger families, women with post-primary schooling may also have higher status in their households, which may entitle them to better food, thereby directly affecting their dietary diversity.

Having post-primary schooling may also lead to greater bargaining power in the household, indirectly leading to greater dietary diversity by enabling women to negotiate improved diets for themselves. In the field of family economics, both cooperative and non-cooperative models of the household acknowledge the importance of the relative bargaining power of each household member (26-28). Voice with husband acted as a proxy in our study for women's relative bargaining power. In this context, social norms about the value of education may contribute to increased bargaining power for women with post-primary schooling, making these women better able to pursue their desired outcome of improved diets. Women with more schooling also may be more articulate and better able to bargain for themselves (25). We carried out sensitivity analyses using schooling as a continuous variable and obtained similar results, reinforcing the importance of schooling as a resource.

We observed an association between schooling and decision-making, controlling for years of marriage, household structure, household wealth, and clustering, but not between decision-making and dietary diversity. Decision-making is considered an important domain of women's agency as well as a potentially important contributor to household nutrition in South Asia (29, 30). The lack of an association between decision-

making and dietary diversity in our sample suggests a need for additional research on the role of decision-making in this context.

Schooling was not associated with women's social solidarity. Little evidence exists of relationships between women's social solidarity and schooling or any health and nutrition outcomes globally. In our study, the lack of an association between social solidarity and dietary diversity may have several explanations. First, the sensitivity of our measures of women's agency is unknown, so it may be that our measures did not adequately capture social solidarity. Second, the scope for women to engage in any form of solidarity or activism is limited in our study setting, given that a minority of women reported leaving their homestead in the previous 30 days. Third, it may be that social solidarity is not related to dietary diversity because, as has been noted, women's agency in public spheres "does not necessarily spill over to agency in other domains such as the household" (16). In one study in Bangladesh, Kabeer noted that while women may have been vocal about injustice in the public sphere, they were more acquiescent in the private sphere (31). Thus, it may be that social solidarity is important for other types of achievements, but not for women's nutrition.

The questions on freedom of movement were dropped from the EFA. This was not surprising given their Cronbach's alpha coefficient of 0.21, suggesting that the items are not highly correlated and that a scale comprised of these items would have poor reliability. EFA analyzes the shared variance across variables (19), and the relative lack of variability in responses to these questions may further explain their failure to load together. Additional research is needed to examine the utility of including women's freedom of movement as a domain of agency in this population.

Few other studies have examined women's empowerment and women's nutrition in Bangladesh. The Bangladesh Integrated Household Survey (BIHS) examined women's empowerment and household dietary diversity, using the Women's Empowerment in Agriculture Index (WEAI) tool to measure empowerment (6). Results from the BIHS indicated that household dietary diversity was most strongly associated with women's ownership and rights over productive capital (6). We expected that most women in our target population would not be involved in agricultural production at baseline; therefore we chose questions that measured domains of agency that were not tied to agriculture. The BIHS also measured household dietary diversity using a seven-day recall, with foods grouped into 12 categories (6), as compared to our individual-level dietary diversity measure using one day and ten food groups. As a result of these differences, our findings are not comparable to those of the BIHS.

As Kabeer notes, achievements have to be "materially possible" and then have to be "*conceived* to be within the realms of possibility" before becoming reality (9). In rural Bangladesh, the achievement of an adequately diverse diet may not be materially possible for many women. Bangladesh produces only 22% of the fruits and vegetables necessary for the population to meet dietary guidelines (32), and economic constraints may prevent women from accessing certain foods. In a situation of limited availability of nutritious foods, the idea of prioritizing women's nutrition may not be something that women themselves would conceive to be in the realm of possibility, as this would be contrary to the traditional patriarchal norms underlying most Bangladeshi households. They may also choose to prioritize children over themselves, or they may have self-serving reasons for favoring others in the household, given their dependence on family members (26).

Projects aiming to improve women's dietary diversity may consider strengthening agricultural production of micronutrient-rich foods while also addressing women's agency based on the resources-agency-achievement framework. Projects may also seek out opportunities for intersectoral work to increase girls' school attainment, and those working with married women may aim to work with the women and their husbands to strengthen their bargaining and negotiation skills. Finally, non-governmental organizations implementing projects in rural Bangladesh should conduct formative and evaluation research to examine intra-household bargaining and other possible pathways to improved dietary diversity, including through other dimensions of women's agency.

Our study has several limitations. Our measure of dietary diversity was based on self-reported consumption in the previous day, which may not accurately reflect usual intake, thus adding measurement error. Certain measures of women's resources and agency that could be important for women's dietary diversity were not included in this analysis, such as women's asset ownership, women's employment, NGO membership, and the quality of family relationships (14, 16, 27, 33, 34). Additionally, several items measuring women's agency were dropped from the EFA and subsequently excluded from the mediation models, including all items on freedom of movement. Finally, our survey was implemented in the lean season, and results for women's dietary diversity may differ at other times of year.

Conclusion

In our study population of young women in Bangladesh, having any post-primary schooling was positively associated with achieving minimum dietary diversity. The link

was both direct and indirect through women's agency, mediated by women's voice with husband, but not by women's social solidarity or decision-making. Research is needed to examine intra-household communication and other possible pathways to improve dietary diversity, including through other domains of women's agency.

Author contributions

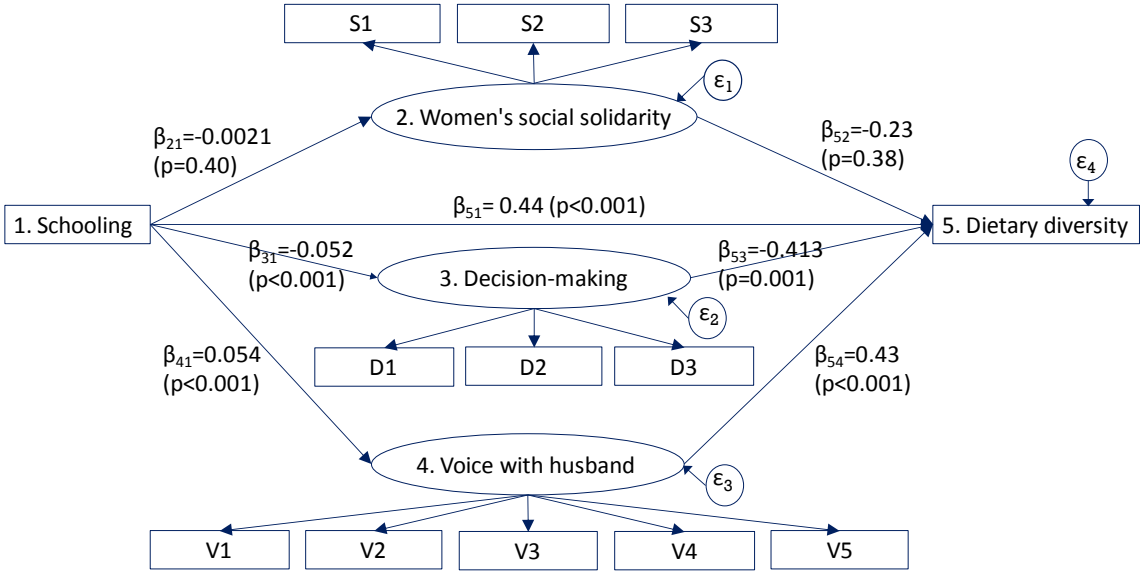
SS, RH and KMY conceptualized the research question and analysis plan. SG, JLW, and AW conceptualized and manage the FAARM study. SG, AW and JLW designed the questionnaires, with contributions from SS, and led data collection. JLW was responsible for data management, with involvement of SG, AW and SS. SS, RH, and KMY were responsible for statistical analysis. All authors contributed to interpretation of results. SS wrote the first and subsequent drafts of the article. All authors contributed to critically revising the article and gave final approval of the version to be published.

Table 1. Descriptive statistics of participant women in FAARM study, Habiganj district, Bangladesh

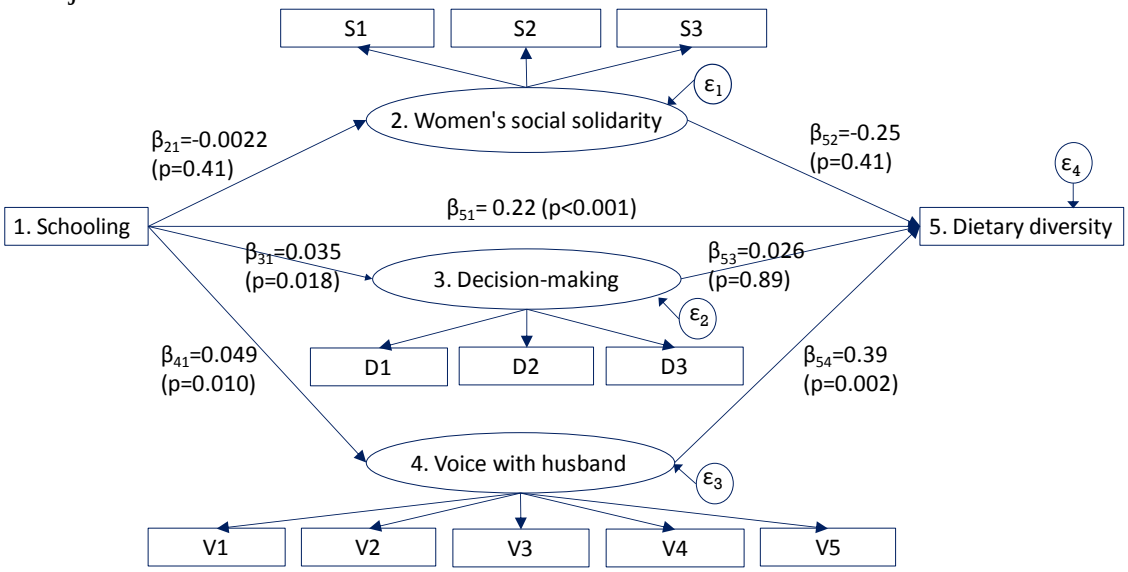
Characteristic	**Percent or mean (SE) (N=2,561)**		
Dietary diversity score, mean (Robust SE)	3.87 (0.045)		
Inadequate dietary diversity (<5 food groups in previous day)	69.5		
Any completed years of post-primary schooling	39.2		
Woman's height, mean in cm (Robust SE)	150.5 (0.15)		
Nuclear household structure	32.2		
Years since marriage, mean in years (Robust SE)	6.60 (0.12)		
Freedom of Movement			
In the last month, what are all of the places you have been to alone or just with your children outside the homestead?			
1. Market	2.9		
2. Health facility	7.3		
3. Community meeting	1.2		
4. Father's house	15.1		
5. Relative's house	7.9		
6. Friend's house	0.6		
7. Other	4.1		
Women's Social Solidarity			
Do you usually meet with other women in your community to discuss the following issues?			
1. Problems of the community	5.0		
2. Education problems	7.2		
3. Health problems	7.6		
4. Problems of women	9.8		
5. To receive information on health and nutrition	8.7		
Decision-Making			Woman is
Who usually makes decisions about…			involved in the decision
1. What food is prepared every day?			66.4
2. Making major household purchases?			22.3
3. Making purchases for daily household needs?			44.7
4. Your visits to your family or relatives?			14.8
5. Health care for yourself?			20.5
Voice with Husband			
How frequently do you talk with your husband about the following subjects:	Weekly	Monthly	Never
1. Your work activities/agricultural activities?	59.0	33.0	8.0
2. What happens at home?	43.9	46.5	9.6
3. Your expenditures?	48.7	43.9	7.5
4. What happens in your community/area?	17.9	58.1	24.0
5. Your own health?	57.0	38.8	4.3

Figure 1. Mediation of the relation between schooling and dietary diversity through Women's Social Solidarity and Voice with Husband

a. Unadjusted



b. Adjusted



Note: β_{31} is adjusted for women's height; β_{53} is adjusted for years of marriage and household structure; β_{54} is adjusted for household structure; all are adjusted for household wealth and clustering

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Supplemental Table 1: Women's agency: Elements of construction and internal validity

Component	Questions included	Response codes	Cronbach's alpha
Women's social solidarity	Do you usually meet with other women in your community to discuss the following issues? 1. Problems of the community 2. Education problems 3. Health problems 4. Problems specific to women 5. Receive information on health and nutrition	no=0; yes=1	0.77
Voice with husband	How frequently do you talk to your spouse about… 1. Your work/agricultural activities? 2. What happens at home? 3. Your expenditures? 4. What happens in your community or area? 5. Your health?	never=0; sometimes=1; often= 2	0.70
Purchasing decisions	Who usually makes decisions about… 1. What food is prepared every day? 2. Making major household purchases? 3. Making purchases for daily household needs? 4. Your visits to family or relatives? 5. Health care for yourself?	woman does not participate in decision=0; woman participates in decision=1	0.69
Freedom of movement	In the last month, what are all of the places you have been to alone or just with your children outside the homestead? 1. Market 2. Health facility 3. Community meeting 4. Father's house 5. Relative's house 6. Friend's house 7. Other	no=0; yes=1	0.21

Chapter 4: Women's dietary diversity in urban Bangladesh: pathways through women's empowerment

Manuscript Authors: Sheela S. Sinharoy, Jillian L. Waid, Masum Ali, Kathryn M. Yount, Shakuntala H. Thilsted, Amy Webb Girard

Introduction

The United Nations estimates that by the year 2050, 66% of the world's population will live in cities (1). In Bangladesh, up to 45% of the population of Bangladesh was living in urban areas as of 2010 (2). Dhaka, Bangladesh is one of six megacities – defined as a city with a population of at least ten million – in South Asia (2). According to the 2011 Bangladesh census, the official population of the Dhaka Statistical Metropolitan Area was listed at 14,543,124 (3), and Dhaka district was estimated to have a growth rate of 3.4 percent per year (2). However, population estimates range widely, and a World Bank report suggests that official figures may be underestimated (2). For Bangladesh as a whole, the estimated prevalence of urban poverty is approximately 20%, and approximately 60% of the urban population lives in slums (2); to our knowledge, similar estimates specific to Dhaka do not exist. Very little is known about the food security and diets of the urban poor in Bangladesh, at either the household or the individual level.

To date, studies of the determinants of food security and diets have focused on factors such as poverty, food systems, and price shocks. Women's empowerment is one potential determinant of dietary intake that remains under-studied. In the context of global nutrition programs, interventions that promote women's empowerment are

considered nutrition-sensitive (4, 5). However, little research exists to quantify the pathways through which different domains of women's empowerment may influence diet at the household or individual (woman) level (6). In recent years, the results of research using the Women's Empowerment in Agriculture Index (WEAI) have suggested that some domains of empowerment are positively associated with dietary diversity at the household and individual level in Bangladesh, Ethiopia, and Nepal (7-9). However, as the name suggests, the WEAI was designed for women in primarily rural agricultural households. Analogous research on women's livelihoods and empowerment in urban areas remains lacking.

Our objective was to address this gap in knowledge by examining food security and diets, and their determinants, at the household and individual (woman) level in poor neighborhoods of Dhaka City Corporation. We used the resources–agency–achievements framework by Naila Kabeer to conceptualize women's empowerment in the urban context and then to quantify associations between two measures of women's enabling resources (schooling, income-earning), two dimensions of women's agency (voice with husband and household/family decision-making), and food security and diet at the household and individual level (10). This analysis enabled us to assess the extent to which aspects of women's empowerment were important in the pathway to improved food security of the household and to improved nutritional status through women's diets.

Methods

Study Design

The data for this study come from a seasonal panel survey undertaken in Dhaka, Bangladesh, which was implemented to capture variation in food intakes across one year.

The survey aimed to visit each household three times in the observation year to collect data on household members' food consumption and food security status. The first round of data collection took place from February to May 2015, the second from June to November 2015, and the third from November 2015 to February 2016. Data collected during the month of Ramadan were excluded from this analysis.

Participants

The target population for the survey was non-transient households, which we defined as households that had lived in the area for at least six months prior to the survey and reported an intention to stay in the area for at least one year following enrollment, in poor neighborhoods in Dhaka. To select a sample, we first ranked census areas in Dhaka City Corporation by relative wealth, categorizing them into deciles using principal components analysis (PCA). The PCA used six neighborhood-level variables from the 2011 national census: proportion of permanent dwellings; school attendance rate of children 6 to 10 years of age; adult literacy rate; proportion of households with a water sealed toilet facility; proportion of households with tap water as their drinking source; and proportion of households with electricity. After categorization, we retained only the census areas in the lowest three deciles of wealth. We then split these areas into 1880 units of roughly 300 households, which we call "neighborhoods". We used probability proportionate to size to randomly select 10 neighborhoods from each decile, for a sample of 30 neighborhoods. We carried out a rapid census of each of the selected neighborhoods to establish a household sampling frame. From this list, we randomly selected 25 non-transient households from each neighborhood, for an initial target of 750 households across 30 neighborhoods.

For this analysis, we used listwise deletion to exclude any main respondents who were male (N=27), who lacked complete dietary data from all three survey rounds (N=69), or who had missing data from the women's empowerment module (N=47) for a final sample size of 598 women.

Procedures

In each of the three rounds, we collected two types of food consumption data. First, trained data collectors implemented quantitative 24-hour recall methods for all household members (11). In each household, the main survey respondent was the person primarily responsible for cooking and for the distribution of food to household members. This respondent was usually, but not always, female. Data collectors asked the main respondent to list all dishes cooked or eaten in the households the previous day and night, with ingredients, including the raw weight of the ingredients, for each dish. Data collectors then asked about the distribution of food among household members and the amount of food consumed by each household member. Next, they asked the respondent about the consumption of individual food items and snacks such as fruits, milk, and milk products, including those purchased and/or consumed outside the household, for each household member. In some instances, data collectors required more information from household members who were not available during the interview; they requested mobile phone numbers for those individuals and attempted to collect the information by phone. To estimate more accurately the amount of food consumed from outside vendors, data collectors visited the local market and weighed prepared foods that were available for consumption. Finally, in addition to the 24-hour recall data, we collected frequency data

on household food consumption over the prior seven days using a standard food consumption score module for Bangladesh (12, 13).

Outcome variable

For our main outcome variable, women's dietary diversity, we used the quantitative 24-hour recall data from the main respondent. Based on the respondent's self-reported food consumption in the previous day and night, we categorized foods into ten food groups according to the Minimum Dietary Diversity for Women (MDDW)-10 scale (14). The ten food groups are: starches; pulses; nuts and seeds; dairy; flesh foods (e.g. fish, poultry, meat, including organ meats); eggs; dark green leafy vegetables; vitamin A-rich fruit and vegetables; other fruit; and other vegetables. We summed the number of food groups the respondent reported having consumed in the previous day and night to obtain a dietary diversity score. We averaged each individual's dietary diversity score across the three survey rounds, to capture usual intake over one year, accounting for seasonal and other variation. Women's dietary diversity is of interest due to its association with micronutrient intake (15). This variable also can be used as a proxy for the food quality component of individual food access and therefore can be considered a measure of food security (16).

Independent and mediator variables

Our independent variable was enabling resources, which we defined in two ways, based on previous research that identified contemporary resources for women's empowerment in Bangladesh (17). The first was completed grades of schooling, dichotomized to represent less than or equal to five grades (primary or less) versus more than five grades

(any post-primary) schooling. The second was income-earning, which we defined by asking respondents about their main income-earning occupation, if any, during the first round of the survey. Responses were dichotomized into either no income or any income.

Women's agency, which we conceptualized as a mediator, was measured through a series of questions in the third round of data collection. We adapted and compiled 16 items to capture three relevant domains of agency: freedom of movement, decision-making, and voice with husband (Supplemental Table 1). To measure freedom of movement, we asked respondents whether they had left their home alone or with only their children in the last month and, if so, asked them to list the places where they had gone. We categorized their responses and created dichotomous dummy variables to represent seven types of places: market, health facility, community meeting, father's house, relative's house, friend's house, and other. The Cronbach's alpha coefficient in our sample for the set of variables representing freedom of movement was 0.30.

For decision-making, we used four questions that were taken from or modeled on the Demographic and Health Survey (DHS) standard woman's questionnaire (18). These questions focus on decisions related to major and minor household purchases, daily food preparation, and women's own health care. Women could list any number of people who were involved in making the decisions. We dichotomized their responses as either uninvolved in the decision if they did not include themselves in this list or involved if they did include themselves in this list. The Cronbach's alpha coefficient in our sample for the set of variables representing decision-making was 0.68.

Voice has been defined as "the right and ability to enter into the household bargaining process" (19) and "the ability to articulate practical needs and strategic

interests" (20). We measured this concept by asking respondents how often they talked with their husband about five topics. These questions have been used by Helen Keller International in previous program evaluations (21). The topics related mainly to domestic affairs such as women's work and expenditures, but they also include one topic on what happens in the local community/area. The response options were never, monthly, or weekly. The Cronbach's alpha coefficient in our sample for the set of variables representing voice with husband was 0.75. For all variables measuring domains of women's agency, we re-coded women's responses to ensure that a higher value indicated higher agency.

We created a mediator variable for household diets using the data from the food consumption score survey module. This module measures household food access, which is one component of food security, and captures the diversity and frequency of food group intakes (16, 22, 23). It includes nine food groups: starches; vegetables; dal, beans, or nuts; oily food or butter; meat, chicken, or eggs; milk or other dairy; fruit; fish; and sugar or molasses. Weights can be added to the food groups based on their relative nutrient density, which results in the Food Consumption Score (FCS) (13). We added weights to the values for each round and averaged the values from the three survey rounds to obtain a value for the usual FCS. We then used the Bangladesh-specific "high-acceptable" threshold score of 52 as a cut-off to dichotomize the FCS into acceptable or below acceptable household diet reflecting the food quality component of food access (12).

Control variables

The data also include demographic and socio-economic characteristics of women and households, including women's age in years, household assets, water and sanitation. We constructed a wealth index using standard techniques by applying principal component analysis to measures for the ownership of thirteen commonly owned assets and indicators of quality of housing, water provision, and latrine type.

Statistical analyses

We calculated descriptive statistics and tested bivariate relationships between variables of interest to identify confounders. We defined a confounder as any variable that was associated with both the independent variable and the outcome variable and not on the causal path between the independent variable and the outcome (24).

Given that our items for women's agency had not been extensively studied or analyzed together, we identified a need for exploratory factor analysis to explore the structure of the constructs being measured (25). We ran sequential one- to five-factor EFA models on a random split-half sample (n=362) using means and variance adjusted weighted least squares estimators, which are appropriate for categorical variables (26). We interpreted the results after geomin rotation. This rotation produces oblique factors, which allow correlation between dimensions of the construct under study (25). After each estimation, we removed items, one at a time, based on low pattern coefficients, high multidimensionality (i.e. cross-loadings (>|0.300|) on at least one second factor), or significant negative pattern coefficients. We also dropped items that loaded on factors for which only one or two items had significant pattern coefficients, because factors with fewer than three loading items are considered weak (27). After removing an item, we re-

ran the analysis with the remaining variables until a satisfactory factor structure was achieved. We interpreted model fit based on the following indices: Root Mean Squared Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Squared Residual (SRMR). RMSEA<.08, CFI>.95, TLI>.95, and SRMR<.08 were considered good fit (28).

We followed a standard two-phase structural equation modeling (SEM) approach, with a measurement model followed by a structural model (26). To establish the measurement model, we used confirmatory factor analysis (CFA) on the remaining random split-half sample to test the structure that we had identified in the EFA. We used the same fit indices and criteria as described above to assess model fit.

We added the final measurement model identified in the EFA and confirmed using CFA to two separate structural models, with either schooling or income-earning modeled as an observed independent variable, women's decision-making and voice with husband modeled as latent mediator variables, household diet as an observed mediator variable, and women's mean dietary diversity score as an observed outcome variable. We controlled for household wealth and women's age by adding them as observed covariates. In the model with income-earning as an independent variable, we also added women's schooling as an observed covariate. We adjusted the structural models for clustering, with cluster defined as survey neighborhoods. We report standardized results for the structural models.

We used MPlus version 7.2 for the EFA and CFA and Stata version 14.0 for the descriptive statistics and structural model.

Ethics

The protocol for this study was reviewed and approved by the Institutional Review Board of the James P Grant School of Public Health, BRAC University, Bangladesh. The analysis presented here used de-identified secondary data, and additional human subjects review was not required.

Role of the funding source

The study was funded by the Federal Ministry for Economic Cooperation and Development, Germany.

Results

Table 1 shows descriptive statistics for households and women in the study. Approximately 89% of households had adequate diets over the course of the year, as defined by the "adequate-high" threshold for FCS. On average, women consumed 4.3 (robust SE=0.05) of 10 possible food groups in the day prior to the surveys. A minority (23%) had adequately diverse diets, defined as at least 5 of the 10 food groups. On average, a majority of women reported consuming starches (100%), other vegetables (97%), flesh foods (79%), and legumes (51%). The high consumption of flesh foods was driven largely by fish rather than by meat, poultry, or organs (data not shown). For the other seven food groups, the average percentage of women consuming eggs was 31% while all other percentages were below 30% (data not shown).

[Table 1]

With respect to the variables used to measure women's resources and agency, a minority (39%) of women had any completed grades of post-primary schooling, and 27%

of women earned an income. More than 98% of women said that they had left their home alone or with just their children in the previous 30 days. Among these women, the market (37%), a relative's house (67%), and the health facility (67%) were the most frequently reported destinations. With respect to decision-making, a majority of women reported being involved in decisions about daily food preparations, purchases for daily household needs, and health care for themselves. About half (48%) of women reported being involved with decisions about major household purchases. Responses to the questions about voice with husband indicated that majorities of women talked with their husbands about their work/agricultural activities (67%), what happens at home (62%), their expenditures (63%), what happens in their community/area (55%), and their own health (73%) on a weekly basis.

We carried out separate bivariate analyses with household wealth, categorized in quintiles, as a dependent variable and schooling, income-earning, or age as an independent variable. The results indicated that schooling is positively associated with household wealth ($\beta=0.83$, $p<.001$), as is age ($\beta=0.02$, $p=.009$), while income-earning is negatively associated with household wealth ($\beta=-0.75$, $p<.001$).

Factor analyses

We dropped all items for freedom of movement from the EFA due to low pattern coefficients, high multidimensionality, significant negative pattern coefficients, and/or ≤ 2 items loading onto one factor. Four out of five items relating to voice with husband loaded onto one factor, with pattern coefficients ranging from 0.86-0.93. All four items for decision-making loaded onto a second factor, with pattern coefficients ranging from 0.68-0.92. Pattern coefficients for the three factors were similarly high in the CFA (0.90-

1.00 and 0.85-1.00 respectively). Fit was acceptable for the final EFA model (RMSEA=0.046, CFI=0.99, TLI=0.99, SRMR=0.027) and exceeded minimum thresholds for the final CFA model (RMSEA=0.049, CFI=0.99, TLI=0.99, WRMR=1.01).

Latent-variable structural equation models

Figure 1 shows the measurement and structural models together in a mediation model adjusted for women's age, household wealth, and clustering. This model quantifies the associations between women's schooling, latent variables for voice with husband and decision-making, household diet, and women's dietary diversity. Having any completed grades of post-primary schooling had a positive direct association with women's dietary diversity (β_{51}= 0.23, p<.001) but no association with household diet. Having an adequate household diet had a strong positive direct association with women's dietary diversity (β_{54}= 0.49, p<.001). Schooling was not associated with voice with husband or with decision-making. Neither voice with husband nor decision-making were associated with household diet or with women's dietary diversity. Schooling had positive total effects on both women's dietary diversity (β=0.24, p<.001) and household diet (β=0.050, p=.040) (data not shown). Neither household diet nor either of the latent variables for women's agency mediated the relationship between schooling and dietary diversity.

[Figure 1]

The model in Figure 2 is the same as the model in Figure 1, but with income-earning as the enabling resource and adjusted for women's schooling, household wealth, and clustering. In this model, women's income-earning had no direct association with women's dietary diversity. Income-earning had a negative direct association with household diet (β_{41}= -0.093, p<.001), which in turn had a larger and positive direct

association with women's dietary diversity (β_{54}= 0.46, p<.001). Income-earning was not associated with voice with husband but was positively associated with decision-making (β_{31}= 0.044, p=.002). Neither voice with husband nor decision-making were associated with household diet. Voice with husband also was not associated with women's dietary diversity, whereas decision-making had a positive association with women's dietary diversity (β_{53}= 0.41, p=.038). Although a pathway exists from income-earning to women's dietary diversity through decision-making, the total effect of income-earning on women's dietary diversity indicates no association (data not shown). There is a negative total effect of income on household diet (β=-0.096, p<.001) (data not shown).

Thus, for the second model, we observed a negative direct association between income-earning and household diet and no association between income-earning and women's dietary diversity. Income-earning also had no association with voice with husband. However, income-earning had a positive association with decision-making, and decision-making had a positive association with women's dietary diversity. Neither voice with husband nor decision-making was associated with household diet.

[Figure 2]

Discussion

In our sample of households in poor neighborhoods of Dhaka, we observed that over the course of one year, a majority of households were food secure as measured by FCS, but a majority of women had poor diets as measured by MDDW. Using the "high-adequate" threshold to categorize FCS, and after averaging the three rounds of data, 90% of households had an acceptable diet. If we had used the lower global threshold, all but one household in the sample, or 99.8% of the sample, would have had an acceptable diet.

At the same time, women in our sample had a mean dietary diversity score of 4.3, which is below the threshold for an adequately diverse diet, and only 23% of women had adequately diverse diets.

The FCS and MDDW tools both measure food security, specifically food access. However, previous research has suggested that FCS primarily measures the food quantity component while MDDW primarily measures the food quality component of food access (16, 29). Our results were in line with these findings and suggested that the FCS does not adequately capture diet quality in this population: in our models, although household food access was strongly and positively associated with women's dietary diversity, adequate household diets were not sufficient for women to achieve adequate food quality.

This is the first study to use the resources – agency – achievement framework to examine households' and women's food security in urban Bangladesh. In our sample of women living in poor, urban neighborhoods, we found that having any completed grades of post-primary schooling had positive total effects on household food access and women's dietary diversity, as measured by FCS and MDDW respectively. In contrast, income-earning had a negative total effect on household food access and no association with women's dietary diversity. Measures of women's agency did not fully mediate any of these relationships.

There are several potential explanations for the positive total effects of post-primary schooling on household diet and women's dietary diversity. First, a higher level of schooling may increase women's ability to marry into more socioeconomically advantaged households, which would be likely to have higher food security. It may also influence women's status in their household (i.e., their perceived value from the

perspective of other household members), which may directly affect their ability to obtain better diets (30, 31). In addition, women with more schooling may have better health literacy, health knowledge, and/or better access to information, which may lead to healthier behaviors, including around household and individual diets (31).

The reasons for the negative association between income-earning and household diet, and the lack of an association between income-earning and women's dietary diversity, are less clear. Bangladesh is a classic patriarchal society where the social and religious practice of *purdah*, or women's seclusion, remains common. Given the negative association between income-earning and household wealth, it appears that income-earning may be a function of poverty, with the poorest women choosing to work out of necessity. In this case, an inverse association with food security, even after controlling for household wealth quintile, makes sense. Employment-related constraints could lead to more meals being consumed outside the home, which could adversely affect the quantity component of household food access (32). Employed women may also have less time available for food shopping and food production (e.g. poultry rearing, which is not uncommon even in urban areas) (32). The lack of association with women's dietary diversity could be due to the fact that, unlike schooling, there are few mechanisms beyond economics or agency through which income would operate on individual diets.

Using Kabeer's framework, we observed that income-earning can be considered a resource for one domain of agency, women's decision-making. The positive association between income-earning and decision-making is in line with other research from urban Bangladesh, which noted that increased wage-earning opportunities can contribute to women's empowerment (33). Income-earning was not associated with the other domain

of agency, voice with husband. Neither voice with husband nor decision-making were associated with household diet, nor was voice with husband associated with women's dietary diversity in either model. Decision-making, on the other hand, was not associated with women's dietary diversity in the first model but was positively associated with women's dietary diversity in the second model. Thus, in the second model, we observed a pathway as conceptualized in Kabeer's framework, between income-earning, decision-making, and women's dietary diversity.

The lack of association between decision-making and household diet suggested that, in this urban poor setting, women may have had limited roles vis-à-vis household food security. At the same time, the positive association between decision-making and women's dietary diversity suggested that their agency may have increased their likelihood of obtaining better diets when such were available in the household, though decision-making alone was not sufficient for most women to achieve adequate dietary diversity. Our survey did not ask directly about decision-making for dietary diversity. However, the association between decision-making and dietary diversity suggested that the ability to make decisions in other areas of one's life may have transferred to women's decision-making about their own food consumption. Although few studies have examined women's decision-making for their own nutrition, some evidence from South Asia suggests that women's decision-making has a positive association with the nutritional status of their young children (34).

Questions remain about other factors that may influence women's diets in this setting. Although women's schooling and household diet were positively associated with women's dietary diversity in our sample, voice with husband and decision-making did

not mediate this relationship. The lack of mediation suggests that the positive direct association between women's schooling and dietary diversity operates through other mechanisms beyond those modeled in our analysis. Results from a study using data that were nationally representative of rural Bangladesh indicated that women's group membership and control over assets were positively associated with per capita energy availability, a proxy for food security (8). Given that we did not measure these domains of agency in our study, additional research is needed to assess whether these associations may exist in urban areas and whether other domains of women's agency, such as women's self-efficacy, may also be important.

Very few other studies have examined women's diets in urban Bangladesh. One study of middle-class women and men in Mohammedpur, a district within Dhaka, used food frequency questionnaires to examine dietary intake (35). The results showed that women consumed more fruits and vegetables and fewer fried foods and sweets than men, but that women had a higher prevalence of obesity than men (31% compared to 13%) (35). Factors associated with these differences were not examined. Another study of high-income urban women and low-income rural women found that the urban women had greater energy intake and dietary diversity than the rural women (36). Both studies were cross-sectional and observational. Our study, by examining factors associated with women's diets over a one-year period, adds more rigorous evidence to the literature on this topic. However, additional research remains necessary to better understand the food security and diets of urban women in Bangladesh.

Our analysis has some limitations, including the possibility of measurement error in the data on household food consumption for all members, which we used to calculate

FCS. However, for the calculation of the main outcome, dietary diversity score, we used only the information provided by the main respondent. Another limitation relates to the timing of the data collection for the variables measuring women's agency. We collected these data in the third survey round (November 2015 to February 2016). Conceptually, women's resources, agency, and achievements should all build on one another, so should follow one another temporally. In our study, we measured women's resources in the first survey round, but we were not able to establish women's agency prior to the measurement of their achievements. In order to address this limitation, we conducted a sensitivity analysis, using the same analytic models but using only the data from the third round. The results were the same as for the analysis of the pooled data from all three rounds.

Our findings have implications for programs working to improve food and nutrition security of households and women in poor, urban areas. First, given the positive association between household diet and women's dietary diversity, improving household-level access to food, especially quality food, is likely to improve women's diets. Second, given that decision-making was positively associated with women's dietary diversity in one model, interventions that improve women's decision-making power in the household may accrue nutrition benefits for women. Third, the pathway from women's income-earning to women's dietary diversity through decision-making suggests that, at least in some cases, income-earning may have potential to be an important resource for women's agency and diets. In our sample, income-earning appears to be a function of poverty; a minimum threshold of wealth may be required to translate women's income-earning into

improved diets for households and women. More rigorous research is needed to explore these relationships in an urban setting.

Conclusion

In our study population of women living in poor neighborhoods in Dhaka, Bangladesh, having any post-primary schooling was positively associated with both household food security and women's dietary diversity. Income-earning was negatively associated with household food security and not associated with women's dietary diversity. The negative association between income-earning and household diets may be due to the fact that, in our sample, women's income-earning appears to be a function of poverty. Voice with husband and decision-making did not mediate these relationships, but decision-making was positively associated with dietary diversity in one model. Further research is needed to better understand these relationships as well as other factors, including other domains of agency, which may influence household and individual diets in this context.

Author contributions

SS, JLW, KY and AWG conceptualized the research question and analysis plan. JLW, MA, and SHT conceptualized the urban food consumption study. JLW and MA designed the data collection instruments and led data collection. JLW and MA were responsible for data management. SS and JLW were responsible for statistical analysis. All authors contributed to interpretation of results. SS wrote the first and subsequent drafts of the article. All authors contributed to critically revising the article and gave final approval of the version to be published.

Table 1. Descriptive statistics of women in poor neighborhoods of Dhaka City Corporation, Bangladesh

Characteristic			**Percent (N=598)**
Household food group frequency score, mean (Robust SE)			32.6 (0.32)
Dietary diversity score, mean (Robust SE)			4.3 (0.05)
Adequate dietary diversity (≥5 food groups in previous day)			22.5
Any income-earning			26.9
Any completed grades of post-primary schooling			38.7
Freedom of Movement			
In the last month, what are all of the places you have gone alone or just with your children outside the homestead?			
1. Market			72.9
2. Health facility			66.6
3. Community meeting			25.3
4. Father's house			27.1
5. Relative's house			67.2
6. Friend's house			20.9
7. Other			44.3
Decision-Making			Woman is involved in
Who usually makes decisions about…			the decision
1. What food is prepared every day?			88.0
2. Making major household purchases?			47.5
3. Making purchases for daily household needs?			68.4
4. Health care for yourself?			60.9
Voice with Husband	Weekly	Monthly	Never
How frequently do you talk with your husband about the following subjects:			
1. Your work/agricultural activities?	66.6	32.8	0.7
2. What happens at home?	61.5	37.3	1.2
3. Your expenditures?	62.7	32.6	4.7
4. What happens in your community/area?	55.4	42.1	2.5
5. Your own health?	73.4	26.1	0.5

Figure 1. Mediation model showing pathways between schooling and dietary diversity, through voice with husband, decision-making, and household diet, adjusted for women's age in years, household wealth, and clustering

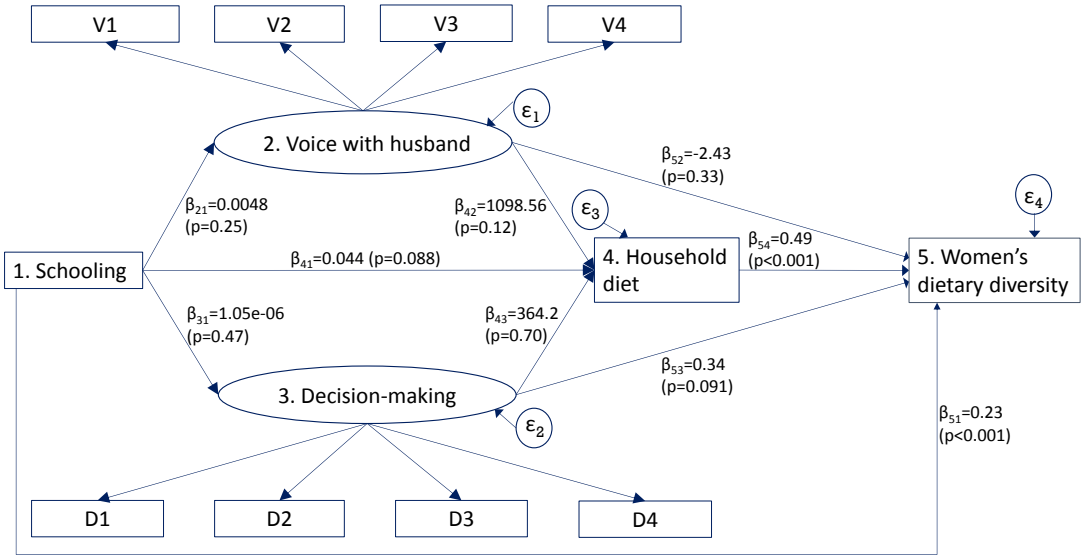
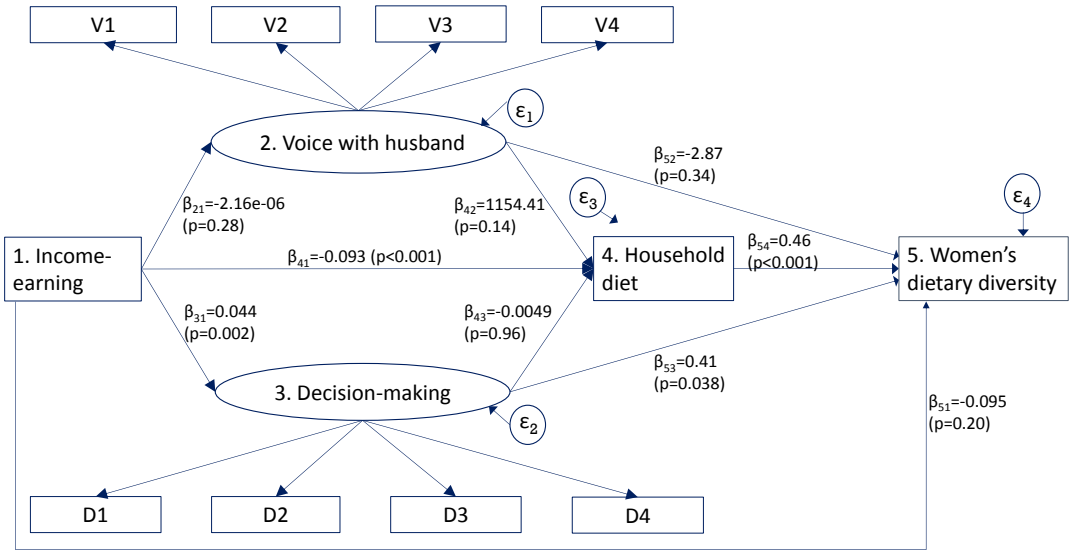


Figure 2. Mediation model showing pathways between income-earning and dietary diversity, through voice with husband, decision-making, and household diet, adjusted for women's schooling, age in years, household wealth, and clustering



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Supplemental Table 1: Women's agency: Elements of construction and internal validity

Component	Questions included	Response codes	Cronbach's alpha
Freedom of movement	In the last month, what are all of the places you have been to alone or just with your children outside the homestead? 1. Market 2. Health facility 3. Community meeting 4. Father's house 5. Relative's house 6. Friend's house 7. Other	no=0; yes=1	0.30
Purchasing decisions	Who usually makes decisions about… 1. What food is prepared every day? 2. Making major household purchases? 3. Making purchases for daily household needs? 4. Your visits to family or relatives? 5. Health care for yourself?	woman does not participate in decision=0; woman participates in decision=1	0.68
Voice with husband	How frequently do you talk to your spouse about… 1. Your work/agricultural activities? 2. What happens at home? 3. Your expenditures? 4. What happens in your community or area? 5. Your health?	never=0; sometimes=1; often= 2	0.75

Chapter 5: Women's dietary diversity in Bangladesh: pathways through women's empowerment at the community level

Manuscript authors: Sheela S. Sinharoy, Jillian L. Waid, Sabine Gabrysch, Shakuntala H. Thilsted, Kathryn M. Yount, Regine Haardörfer

Introduction

Women in Bangladesh face multiple forms of malnutrition. Almost one-fifth (19%) of women are underweight, defined as having a body mass index (BMI) <18.5 (1). Another one-quarter (24%) are overweight, defined as having a BMI≥25 (1). A majority (54%) consume inadequately diverse diets, putting them at risk of micronutrient malnutrition (2). Women's empowerment is widely considered to be important for child nutrition (3), but despite the challenges to women's nutrition, few studies have explored the relationship between women's empowerment and women's nutrition.

We chose to explore relationships between women's empowerment and dietary diversity at the community level. Several researchers have theorized that such relationships may be important. For example, Malhotra and Schuler argued that "aggregate-level, contextual factors may be considerably more important in defining certain aspects of women's empowerment than women's individual characteristics or circumstances" (4). Similarly, Pratley, in a recent systematic review, noted that "decision making and motivation to achieve goals do not happen in a vacuum and women's empowerment is context dependent" (5). Despite recognition of the need to examine context, very few studies have attempted to quantify these aggregate-level factors or their relationships with nutrition outcomes.

Naila Kabeer conceptualized empowerment as having three dimensions: resources, agency, and achievements. Our prior work in urban and rural Bangladesh has used Kabeer's resources – agency – achievement framework to examine relationships between women's schooling, agency, and dietary diversity (6). We observed a consistent strong positive association between women's completion of any post-primary grades of schooling and their individual dietary diversity. We have also observed a positive association at the individual level between women's agency and dietary diversity. In the current study, we aimed to use the same resources – agency – achievements framework to assess whether community-level measures of women's agency mediated the relationship between schooling and dietary diversity. Specifically, we hypothesized that community-level variability in women's agency mediates the relationship between the community-level components of women's schooling and dietary diversity.

Methods

Participants

Data in our study come from two separate studies within Bangladesh, one rural and one urban. The rural sample consists of women enrolled in a cluster-randomized controlled trial called Food and Agricultural Approaches to Reducing Malnutrition (FAARM). FAARM aims to evaluate the impact of an enhanced homestead food production intervention on nutritional status in women and their young children. The target population is young married women under age 30 and their children under age 3 in 96 rural settlements of Habiganj District, northeastern Bangladesh. Our sample uses data from the 48 control villages, to avoid any potential intervention effects.

The urban sample comes from a study of food consumption in poor neighborhoods of Dhaka, Bangladesh. The study collected food consumption data from all household members in 25 randomly selected households in each of 30 randomly selected neighborhoods in the poorest three deciles of neighborhoods in Dhaka. We used data from the main survey respondent, who was primarily responsible for cooking and food distribution in the household. Of this sample, we dropped any main respondents who were male (N=27) and any women over age 35 (N=176) to make the sample more similar to the rural sample.

Procedures

We collected data at multiple time points in both the urban and rural studies. The urban study aimed to visit all households three times in one year: the first round of data collection took place from February to May 2015, the second from June to November 2015, and the third from November 2015 to February 2016.

The rural study implemented a baseline survey from March to May 2015, in which we collected data from all women enrolled in the study (N=2,599). Then, in September 2015, we began collecting dietary diversity data in bi-monthly rounds from approximately one-third of all non-pregnant enrolled women, who were randomly sampled without replacement from all study participants. Data collection continued on a rolling basis, so the one-third of women visited in September-October 2015 were visited again in March-April 2016. The next one-third of women were visited in November-December 2015 and then again in May-June 2016. We have dropped these women from our sample because the visit dates overlap with the Muslim holy month of Ramadan, when dietary intake differs from usual patterns. The final one-third of women were

visited in January-February 2016 and again in September-October 2016. Thus, all non-pregnant enrolled women have data from three time points: baseline plus two of the bi-monthly visits. After dropping all women from intervention villages and women whose data collection round overlapped with Ramadan, we had a sample of 707 non-pregnant women.

The dietary diversity data was collected through different mechanisms in the two studies. Study procedures are described in detail elsewhere [CITE: Papers 1 and 2]. Briefly, the FAARM baseline and follow-up surveys asked women to report on their consumption in the previous day using a combination of open recall and prompted responses, while the urban surveys used quantitative 24-hour recalls. In both cases, we asked women whether they had consumed an amount greater or less than one spoonful, with the aim of capturing amounts of at least 15g. We categorized these responses into ten food groups according to the Minimum Dietary Diversity for Women (MDDW)-10 scale (WDDS). The food groups are: starches; pulses; nuts and seeds; dairy; flesh foods (e.g. meat, poultry, fish, including organ meats); eggs; dark green leafy vegetables; vitamin A-rich fruits and vegetables; other fruits; and other vegetables.

Variables

The outcome of interest was women's mean dietary diversity score, which represents the number of food groups (out of 10 groups) that a woman consumed in the previous day. We calculated this by averaging women's dietary diversity score across all three time points, as a measure of usual intake over the data collection period. We also calculated the proportion of women whose mean dietary diversity score was less than five, as this is considered to be inadequate (7).

We defined resources as grades of schooling, dichotomized to represent less than secondary versus any secondary schooling. For women's agency, we used 20 questions to measure three domains: freedom of movement, decision-making, and voice with husband. For freedom of movement, we asked whether women had visited a market, health facility, community meeting, their father's house, a relative's house, a friend's house, or other alone or with just their children. For decision-making, we asked who usually makes decisions about daily food preparation, major household purchases, daily household purchases, and health care for themselves. Respondents could list any number of individuals; we re-coded their answers into dichotomous variables indicating whether the index woman was usually involved in the decision or not. For voice with husband, we asked how frequently women talk with their husbands about their work or agricultural activities, what happens at home, their expenditures, what happens in their community or area, and their own health. The response options for these questions were never, monthly, or weekly.

The data also include demographic and socio-economic characteristics of the household, including assets, water and sanitation. In the rural and urban studies, we constructed wealth indices by applying principal component analysis to measures for the ownership of 23 and 13 assets, respectively, including housing type, water source, and type of sanitation facility.

Statistical Analyses

We calculated descriptive statistics at the individual level, then tested for differences by residence using Wald tests that were adjusted for clustering. We calculated cluster-level averages and descriptive statistics, testing for difference by residence using Wald tests.

We carried out exploratory factor analysis (EFA) to explore the structure of the constructs being measured (8). We ran sequential one- to three-factor EFA models on a random split-half sample (N=574) using means and variance adjusted weighted least squares estimators, which are appropriate for categorical variables (9). We interpreted the results after geomin rotation. This rotation produces oblique factors, which allow correlation between dimensions of the construct under study (8). After each estimation, we removed items one at a time based on low pattern coefficients, high multidimensionality (i.e. cross-loadings (>|0.300|) on at least one second factor), or significant negative pattern coefficients. After removing an item, we re-ran the analysis with the remaining variables until a satisfactory factor structure was achieved. We then used confirmatory factor analysis (CFA) on the remaining random split-half sample to test the structure that was identified in the EFA. We interpreted model fit based on the following indices: Root Mean Squared Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Squared Residual (SRMR). RMSEA<.08, CFI>.95, TLI>.95, and SRMR<.08 were considered good fit (10).

Prior to finalizing the measurement model, we tested for measurement bias in the form of differential item functioning (DIF). DIF has been defined as occurring when "an item yields a different mean response for the members of different groups with the same value of the underlying attribute" (11). We sought to determine whether observed heterogeneity in women's agency items was due to actual differences between urban and rural areas or whether it was due to DIF. Due to the lack of prior studies examining urban/rural differences in the measurement of women's agency, we did not have a pre-

determined theory as to how the items would function. Therefore, we chose an exploratory approach: we used multiple indicators, multiple causes (MIMIC) modeling on the full sample to test for invariance of factor means across urban and rural populations (11).

Using the CFA model, we added the dichotomous urban/rural covariate and estimated its effect on each latent variable for women's agency. We fixed all direct effects between the covariate and the indicators of the latent variables to zero, then inspected modification indices to determine whether important direct effects may exist in the data. We took an iterative approach: for the indicator with the highest modification index value, we allowed the parameter to be freely estimated and re-ran the model. We continued this process until no modification indices remained over 4.00 for the relationships between the urban/rural covariate and any indicators. All indicators that had been released from the parameter constraints and freely estimated were considered to have shown DIF by residence.

We used a multilevel structural equation modeling approach to assess our hypothesis that women's agency mediates the relationship between women's schooling and dietary diversity at the community level (12). We modeled education, dietary diversity, and the three latent factors (for voice with husband, decision-making, and freedom of movement) on both the individual and community levels. This allowed for decomposition of the variables at each level, such that we could examine relationships between only their individual-level or community-level components. We built a multilevel model with random intercepts and fixed slopes, using full information maximum likelihood estimation with robust standard errors. At the individual level, the

model included a direct effect of schooling on dietary diversity. At the community level, the model included direct effects of schooling on dietary diversity and indirect effects through each of the three latent variables for women's agency. Figure 1 shows the model with direct and indirect paths.

We included wealth, modeled only on the individual level, and urban/rural residence, modeled only on the community level, as covariates. We adjusted for DIF at the community level by regressing the urban/rural covariate on each item that had shown DIF in the MIMIC model. We used Stata version 14.0 for the descriptive statistics and MPlus version 7.2 for all other analyses.

Ethics

This secondary analysis uses data from two studies. The protocol for FAARM was reviewed and approved by the ethics committees of the Bangladesh Medical Research Council, the James P Grant School of Public Health at BRAC University in Bangladesh, and Heidelberg University in Germany. FAARM is registered with ClinicalTrials.gov (NCT02505711). The protocol for the urban food consumption study was reviewed and approved by the ethics committee of the James P Grant School of Public Health at BRAC University. The analysis presented here used de-identified secondary data, and additional human subjects review was not required.

Results

Descriptive statistics

Table 1 shows descriptive statistics for women in the study by rural and urban residence. We observed significant differences by residence for all variables except

schooling. Women in urban areas consumed a mean of 4.3 (robust SE=0.041) of 10 possible food groups in the 24-hour period prior to the survey, while women in rural areas consumed a mean of 4.0 (robust SE=0.064, p=.001). In both urban and rural areas, a majority of women had inadequate diets, meaning that they consumed fewer than five food groups in the previous day, but this proportion was lower in urban (79%) than in rural areas (85%, p=.046). In urban areas, a slightly larger proportion of women had any completed years of post-primary schooling (45%) than in rural areas (39%, p=.15).

For the questions relating to women's freedom of movement, significantly larger proportions of women in urban areas had visited each of the seven locations. Similarly, a higher proportion of women in urban areas reported being involved in each of the four types of decisions. For voice with husband, a larger proportion of women in urban areas reported talking with their husbands on a weekly basis about each of the five topics.

Table 2 shows descriptive statistics for the same variables, aggregated to the cluster level. The mean dietary diversity score for clusters in urban areas was 4.3 (range: 3.8-4.7) and for clusters in rural areas was 4.0 (range: 3.2-5.0). The intraclass correlation coefficient (ICC) across all clusters for dietary diversity was 0.16. The mean proportion of women who had completed any post-primary grades of schooling in urban areas was 0.45 (range: 0.15-0.83) and in rural areas was 0.39 (range: 0.00-0.82). The ICC for schooling was 0.075.

We observed significant differences between urban and rural clusters for all variables except minimum dietary diversity. Although the urban clusters had higher average dietary diversity scores than rural clusters, all clusters in both urban and rural areas had an average dietary diversity score of less than five; thus all clusters had

inadequate dietary diversity. The urban clusters had a larger mean proportion of women who had any completed years of post-primary schooling. As with the individual-level variables, urban clusters also had higher mean scores on all items for women's agency.

Factor Analyses

All four items for decision-making loaded onto one factor, with pattern coefficients ranging from 0.66-0.89. All five items relating to voice with husband loaded onto a second factor, with pattern coefficients ranging from 0.71-0.87. We dropped three items for freedom of movement (visiting the market, father's house, and other) from the EFA due to low pattern coefficients, high multidimensionality, and/or significant negative pattern coefficients. The remaining four items loaded onto a third factor, with pattern coefficients ranging from 0.61-0.91. Pattern coefficients for the three factors were similarly high in the CFA (0.86-1.00, 0.70-1.09, and 0.99-1.04 respectively). Fit was acceptable for both the final EFA model (RMSEA=0.042, CFI=0.98, TLI=0.97, SRMR=0.036) and the final CFA model (RMSEA=0.057, CFI=0.95, TLI=0.94, WRMR=1.43). Using the MIMIC model, we observed DIF for four items: decisions on daily food preparation, decisions on women's own health care, frequency of talking with husbands about community events, and freedom of movement to the health facility.

Latent variable structural equation models

Table 3 shows results for the full model as shown in Figure 1. We observed a strong positive association between schooling and dietary diversity at the individual level (β=0.22, $p<0.001$) but no association at the community level (p=0.57). At the community level, schooling was not associated with the latent variables for decision-making, voice

with husband, and freedom of movement (p=0.44, 0.90, and 0.22, respectively). The latent variables for decision-making, voice with husband, and freedom of movement were not associated with dietary diversity (p=0.093, 0.40, and 0.057, respectively). Thus, the results did not support our hypothesis of women's agency as a mediator of a relationship between women's schooling and dietary diversity at the community level.

Four items had shown differential item functioning in the MIMIC model: decisions on daily food preparation, decisions on women's own health care, frequency of talking with husbands about community events, and freedom of movement to the health facility. All four remained associated with the urban/rural covariate in the larger model (p=0.022, p<0.001, p<0.001, and p=0.001, respectively).

Discussion

Our study is the first to use multilevel structural equation modeling to examine the relationship between women's schooling, agency, and dietary diversity at the community level. We observed a positive association between schooling and dietary diversity at the individual level but no associations among any of our variables at the community level. There was no association between schooling and dietary diversity or between schooling and any of the latent variables for decision-making, voice with husband, and freedom of movement. The latent variables also were not associated with dietary diversity. These results suggest that while these variables may have important associations at the individual level, they do not operate at the community level in our sample.

In both our urban and rural samples, women's diets had poor diversity. The importance of diet is well known: dietary diversity is positively associated with micronutrient adequacy (7) and has been established as an important factor in the global burden of disease (13). Still, very little research exists on determinants of women's diets or strategies to improve women's nutrition in low-income countries like Bangladesh. We sought to identify whether women's agency at the community level plays an important role in their dietary diversity. Our results suggest that, for the domains under examination, community-level context may be less important than individual-level agency.

In our study, the items for decisions on daily food preparation, decisions on women's own health care, frequency of talking with husbands about community events, and freedom of movement to the health facility showed DIF and had significant associations with the urban/rural covariate in our structural model. This suggests that women in urban and rural areas may interpret or respond to these items differently. It is not clear why this may be the case for the item on daily food preparation. For the items relating to women's health care, distance to a health facility may be a factor. If women in rural areas have to travel farther to access health care, then financial and opportunity costs related to transportation may affect their decision-making and freedom of movement. With respect to frequency of talking with husbands about community events, women in urban and rural areas may conceptualize their community differently so may interpret this item in different ways. These findings reinforce the importance of testing for validity of measures by examining heterogeneity in the data (14).

Very few studies have explored the influence of community-level gender norms on health outcomes. Malhotra and Schuler, in the book *Measuring Empowerment: Cross-Disciplinary Perspectives*, note that "there is theoretical interest but less empirical attention to aggregations … at the community level" (4). They assert that community-level gender norms are critical for women's empowerment because "it is often precisely at these intermediate levels that normative changes occur, and programmatic or policy interventions operate" (4). Mason and Herbert studied women's autonomy and intra-couple communication at the community level and found these to be inversely associated with husbands' preferences for discussion of fertility and other issues (15). Gabrysch *et al.* used Demographic and Health Survey data and noted that women's autonomy in relation to both health care and their relationship with their spouse was positively associated with facility delivery for childbirth (16). To our knowledge, similar studies do not exist using diet or nutritional status as an outcome.

Although our analysis focused on relationships at the community level, we measured each item at the individual (woman) level. Our latent variables for women's agency therefore represent community-level means of individual-level variables. For example, our latent variable for voice with husband can be considered a proxy for intra-household bargaining. When aggregated to the community level, it remains a measure of individual bargaining, which we assessed between groups; it cannot be considered a measure of collective bargaining. Further research is necessary to investigate whether true community-level variables, such as social cohesion measured using experimental games, may be important for women's nutrition.

Bangladesh is a classic patriarchal setting where women face many challenges to empowerment (17). The United Nations ranks Bangladesh 109 of 161 countries and 111 of 155 countries in their Gender Development Index and Gender Inequality Index, respectively (18, 19). However, we observed significant heterogeneity in women's agency between rural and urban areas. Our results indicate that women in poor neighborhoods of Dhaka have greater agency in the domains of decision-making, voice with husband, and freedom of movement than women in our rural sample. This is in line with research from urban Bangladesh, where increased wage-earning opportunities can contribute to women's empowerment (20). The juxtaposition may be especially stark in our sample because our rural sample comes from Sylhet Division, which is considered to be the most conservative region of Bangladesh.

Our study has a number of strengths. One important strength is the use of multilevel structural equation modeling, which avoids specification errors by accounting for structural relationships at both the individual and community levels. Another is that we use repeated measurements for women's dietary intake, averaged over time, which allows the approximation of usual intake. Single measurements can be prone to bias, as they may not reflect individuals' usual intake. Though participants in the FAARM study were enrolled in a trial promoting agriculture for improved nutrition, we only used data from women in control arms of the trial, thereby eliminating any potential intervention effect on dietary diversity. Finally, identifying DIF allowed us to adjust for measurement bias in our final model.

Our study also has several limitations. Our urban sample focused on neighborhoods ranked in the poorest three quintiles of Dhaka City Corporation. Research

from Bangladesh has shown that household dietary diversity is positively associated with household expenditures, suggesting that dietary diversity may be higher in wealthier areas (21). However, we cannot generalize results to those wealthier neighborhoods. Additionally, our study included three domains of women's agency, but other domains may play an important role as well.

Conclusion

Our research breaks new ground through its use of multilevel structural equation modeling to examine relationships between women's schooling, agency, and dietary diversity at the community level. We did not observe any associations between variables at the community level. This indicated that the proportion of women with post-primary schooling in the community was not associated with the average dietary diversity of women in that community. It also meant that a woman without any post-primary schooling would not benefit, at least in terms of her dietary diversity, from living in a community where a large proportion of women had post-primary schooling. Additional research is needed to explore additional contextual factors, including other domains of women's agency.

Author contributions

SS, KMY, and RH conceptualized the research question and analysis plan. SG and JLW conceptualized and manage the FAARM study. JLW, MA, and SHT conceptualized and managed the urban food consumption study. JLW and MA were responsible for data management, with involvement of SG and SS. SS and RH were responsible for statistical

analysis. All authors contributed to interpretation of results. SS wrote the first and subsequent drafts of the article. All authors contributed to critically revising the article and gave final approval of the version to be published.

Table 1. Descriptive statistics of women in samples from Habiganj district and Dhaka, Bangladesh

Individual Level	Urban (N=422)	Rural (N=698)	P-value
Dietary diversity score, mean (Robust SE)	4.30 (0.041)	3.98 (0.064)	0.0001
Inadequate dietary diversity (<5 food groups)	79.4	85.4	0.046
Any completed years of post-primary schooling	44.8	38.5	0.15
Freedom of Movement			
In the last month, what are all of the places you have been to alone or just with your children outside the homestead?			
1. Market	74.2	3.3	<0.001
2. Health facility	69.0	6.7	<0.001
3. Community meeting	23.7	1.6	<0.001
4. Father's house	30.3	16.1	<0.001
5. Relative's house	67.1	8.6	<0.001
6. Friend's house	19.7	0.3	<0.001
7. Other	50.2	3.2	<0.001
Decision-Making			
Who usually makes decisions about…			
1. What food is prepared every day?	86.3	66.8	<0.001
2. Making major household purchases?	45.7	22.6	<0.001
3. Making purchases for daily household needs?	67.8	46.1	<0.001
4. Health care for yourself?	59.7	19.2	<0.001
Voice with Husband			
How frequently do you talk with your husband about the following subjects:			
1. Your work activities/agricultural activities?			0.004
Monthly	32.7	33.4	
Weekly	66.4	59.0	
2. What happens at home?			<0.001
Monthly	35.8	46.0	
Weekly	62.8	43.7	
3. Your expenditures?			<0.001
Monthly	32.5	45.1	
Weekly	63.3	46.7	
4. What happens in your community/area?			<0.001
Monthly	39.6	57.3	
Weekly	57.4	16.5	
5. Your own health?			<0.001
Monthly	26.1	40.1	
Weekly	73.5	55.9	

Table 2. Descriptive community-level statistics from Habiganj district and Dhaka, Bangladesh

	Urban (N=30)	Rural (N=48)	P-value
Dietary diversity score, mean (SD)	4.30 (0.21)	3.97 (0.41)	<0.001
Inadequate dietary diversity (<5 food groups)	100.0	100.0	
Any completed years of post-primary schooling	44.7	38.5	<0.001
Freedom of Movement			
In the last month, what are all of the places you have been to alone or just with your children outside the homestead?			
1. Market	74.8	3.3	<0.001
2. Health facility	67.7	6.7	<0.001
3. Community meeting	23.4	1.6	<0.001
4. Father's house	29.5	16.1	<0.001
5. Relative's house	66.3	8.5	<0.001
6. Friend's house	19.7	0.3	<0.001
7. Other	50.7	3.1	<0.001
Decision-Making			
Proportion of households where woman is involved in making decisions about…			
1. What food is prepared every day?	84.6	66.8	<0.001
2. Making major household purchases?	45.2	22.8	<0.001
3. Making purchases for daily household needs?	66.8	46.4	<0.001
4. Health care for yourself?	59.2	19.4	<0.001
Voice with Husband			
How frequently do you talk with your husband about the following subjects:			
1. Your work activities/agricultural activities?	1.7	1.5	<0.001
2. What happens at home?	1.6	1.3	<0.001
3. Your expenditures?	1.6	1.4	<0.001
4. What happens in your community/area?	1.5	0.9	<0.001
5. Your own health?	1.7	1.5	<0.001

Figure 1. Diagram of multilevel structural equation model examining resources – agency – achievements

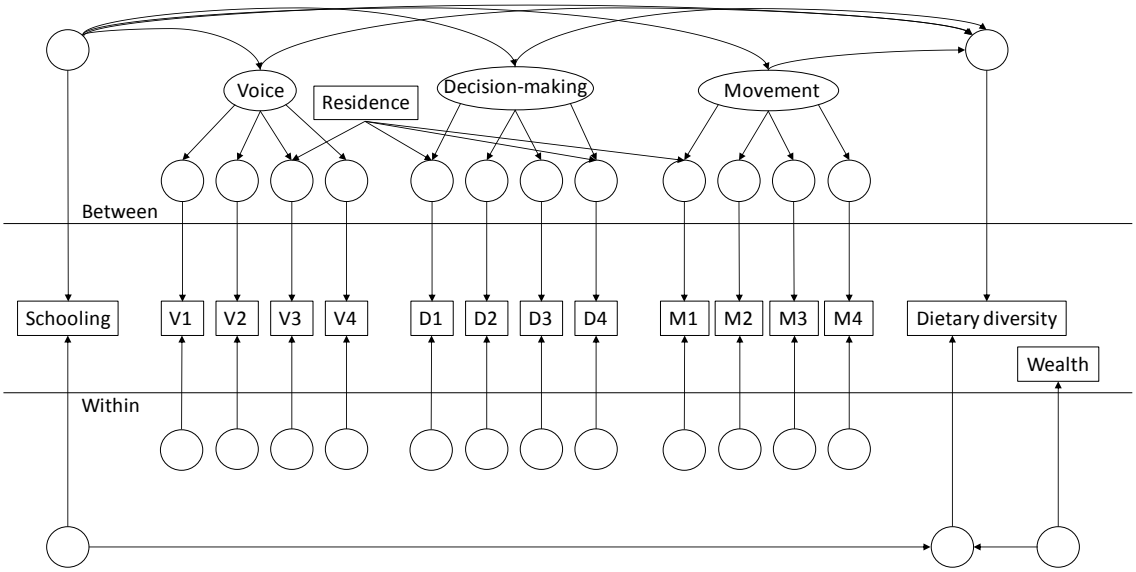

Table 3. Results of multilevel structural equation model

	Estimate	P-value
Individual Level		
Dietary diversity on		
Schooling	0.22	<0.001
Community Level		
Dietary diversity on		
Decision-making	-0.15	0.093
Voice with husband	-0.051	0.40
Freedom of movement	0.22	0.057
Schooling	0.13	0.57
Decision-making on		
Schooling	0.33	0.44
Voice with husband on		
Schooling	0.055	0.90
Freedom of movement on		
Schooling	0.67	0.22

Note: Model adjusted for household wealth (see Fig. 1)

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Chapter 6: Summary and Conclusions

Summary of findings

Women's empowerment

The primary objective of this research was to quantify associations between domains of women's empowerment and women's nutrition. The factors influencing women's nutrition are under-studied. Relationships between women's empowerment and women's nutrition are especially neglected. This could be due in part to the challenges involved in measuring women's empowerment: many definitions and conceptualizations of women's empowerment exist, and there are few validated tools and little consensus around measurement strategies. Even if validated tools exist for one setting, they may not be applicable to other settings, because women's empowerment is widely acknowledged to be context-dependent. Empowerment means different things to women in different places; thus researchers must continually test their measures of empowerment for validity in each new setting.

We aimed to fill this gap in knowledge by developing measures of different domains of empowerment. We used exploratory factor analysis and confirmatory factor analysis to assess the utility of the measures in capturing the intended domains. In the sample of women in rural Habiganj, we identified items that became indicators in factors for women's decision-making, voice with husband, and social solidarity. In the sample of women in poor neighborhoods of Dhaka, we did not use the items for social solidarity, but we identified items that became indicators in factors for women's decision-making and voice with husband. When examining the rural and urban samples separately, the

items that we had used to measure freedom of movement did not load together onto one factor, so did not seem to represent a coherent domain of empowerment. However, when we pooled the data from rural and urban areas together, the items on freedom of movement loaded together.

The results from testing questions on women's empowerment suggest that items on the following three aspects of decision-making may be useful across both rural and urban contexts in Bangladesh: daily food preparation, major household purchases, and daily household purchases. A fourth question on making decisions for women's own health care did not load onto a decision-making factor in the rural sample and subsequently showed differential item functioning between rural and urban areas in the pooled sample. This item may be useful in urban areas but cannot be recommended for use as part of a decision-making module in rural areas. It may, however, still be used as a stand-alone question to better understand barriers or facilitators to women's health care seeking behaviors in rural areas.

Similarly, the results suggest that the following four items on voice with husband were useful across both the rural and urban samples: how often women talk with their husbands about what happens at home, the women's own expenditures, what happens in their community/area, and the women's own health. The item on women's own work/agricultural activities loaded onto the voice with husband factor in the rural sample but not in the urban sample. However, it loaded with the other items in the pooled sample. In contrast, in the pooled sample, the item on what happens in the community/area showed differential item functioning by rural/urban residence. Thus, the

three items on what happens at home, women's own expenditures, and women's own health may be useful in rural and/or urban samples in Bangladesh.

In the rural sample, three items for women's social solidarity, relating to whether women usually meet with other women to discuss problems of the community, education problems, and health problems, loaded onto one factor. We did not test these questions in urban areas because we theorized that social solidarity would mean different things and take different forms in rural and urban areas. We recommend these three questions for use in rural samples, but we cannot draw any conclusions about their usefulness in an urban setting.

Although our results point to the utility of these modules in rural and/or urban settings within Bangladesh, we cannot yet state that they have been validated. Validation is a multi-step process and typically includes a quantitative assessment to determine whether the items being validated are associated with other variables that are known to measure the same construct (1, 2). In our studies, this would require us to assess whether our items are associated with other variables known to measure women's empowerment. Given that such variables do not exist, we cannot carry out this function. An alternative approach is to assess whether the items in question are associated with other variables, such as sociodemographic characteristics, that are known to be associated with the construct in question (1, 2). Again, so little is known about women's empowerment and its association with other measures that we do not find this to be a viable option. Therefore, we are not able to determine the validity of our constructs. However, in building on these findings, it will be important for researchers to carry out additional validation work when possible, to strengthen the evidence around these modules.

Women's nutrition

We used women's dietary diversity as the primary outcome in all three studies. In the rural baseline survey sample, the mean dietary diversity score in the previous day was 3.87, and 69.5% of women consumed inadequately diverse diets (defined as <5 food groups in the previous day). When additional data were added and dietary diversity scores were averaged across a period from February 2015 to October 2016, the mean dietary diversity score was 4.30 and 79.4% of women consumed inadequately diverse diets. We hypothesize that the difference between the two estimates is due to the fact that we implemented the baseline survey during the lean season, when dietary diversity is lower. In the urban sample, the mean dietary diversity score averaged across three rounds of data collection in one year was 4.32, and 77.5% of women consumed inadequately diverse diets. Overall, women's diets in our samples are poor, regardless of the location or time of year.

Relationships between women's resources, agency and nutrition

We observed strong positive associations between having any post-primary schooling and dietary diversity at the individual level in the rural, urban, and pooled samples. In the rural sample, the standardized adjusted direct association with dietary diversity was β=0.22 ($p<.001$). In the urban sample, the standardized adjusted direct association with dietary diversity was β= 0.23 ($p<.001$). In the pooled sample, the standardized adjusted direct association with dietary diversity was β=0.22 ($p<.001$). The nearly identical estimates in the rural and urban samples offers reinforcement of the findings that post-primary schooling is an important factor in women's dietary diversity.

In Kabeer's conceptualization of women's empowerment, resources serve as the building blocks for women's agency. We measured several, but by no means all, domains of women's agency. Our results indicated that in our rural sample, having any post-primary schooling was positively associated with women's decision-making (β_{31}= 0.035, p=.018) and with voice with husband (β_{41}=0.049, p=.010), but not with women's social solidarity (p=.41). We did not observe the same relationships in our urban sample. Post-primary schooling was not associated with decision-making or voice with husband (p=.47 and p=.25, respectively). This suggests that schooling may be an important resource for women's agency in rural areas but not in poor urban areas. In our urban sample, income-earning was positively associated with decision-making (β_{31}=0.044, p=.002) but not with voice with husband (p=.28).

In the next component of Kabeer's framework, women exercise their agency in pursuit of their goals, leading to achievements. We found this to be partially reflected in our data. Of the domains of agency measured in the rural sample, voice with husband was strongly and positively associated with dietary diversity (β_{54}=0.39, p=.002) but no association existed between either women's social solidarity or decision-making and dietary diversity (p=.41 and p=.89, respectively). In the urban sample, voice with husband was not associated with dietary diversity in the models with either schooling or income-earning as resources (p=.33 and p=.34, respectively). Decision-making was not associated with dietary diversity in the model with schooling as a resource (p=.091) but was positively associated in the model with income-earning (β_{53}= 0.41, p=.038). Based on the data, we concluded that the relationship between women's post-primary schooling

and their dietary diversity was partially mediated by voice with husband in the rural sample but was not mediated by women's agency in the urban sample.

When we used multilevel structural equation modeling to decompose items to their individual-level and community-level components in a pooled sample of rural and urban women, we observed that the positive relationship between post-primary schooling and dietary diversity remained strong at the individual level (β=0.22, p<.001). However, the same relationship did not exist between the community-level components of women's schooling and dietary diversity (p=.57). This indicated that the proportion of women with post-primary schooling in the community was not associated with the average dietary diversity of women in that community. Schooling was not associated with the latent variables for decision-making, voice with husband, and freedom of movement (p=.44, .90, and .22, respectively), which in turn were not associated with dietary diversity (p=.093, .40, and .057, respectively) at the community level. In other words, these variables do not operate at the community level in our pooled sample.

Thus, the most consistent associations that we observed were between schooling and dietary diversity at the individual level. For individual women in both our rural and urban samples, having any post-primary schooling was strongly and positively associated with women's dietary diversity. The community-level aggregation of women's schooling was not associated with women's dietary diversity at the community level. The mechanism through which this relationship operates at the individual level, however, remains somewhat unclear. Schooling could be associated with a number of other factors that in turn may positively influence women's diets, either within or outside the realm of women's empowerment.

Results in context

Prior to this research, studies primarily examined associations between individual domains of empowerment (or proxy measures for empowerment) and nutrition outcomes. In general, the evidence suggested a positive relationship between women's empowerment and nutrition outcomes. The largest volume of evidence, as discussed in the literature review of this dissertation, was for a positive association between maternal schooling and child nutrition. Very few studies had examined women's nutrition outcomes, and even fewer had used complex models to look at pathways through multiple mediators. This dissertation therefore represented the first use of the resources-agency-achievements framework to examine pathways leading to women's nutrition outcomes. We observed pathways from schooling through voice with husband to dietary diversity in a rural population and from income-earning through decision-making to dietary diversity in an urban population. Quantifying these pathways can shed light on the mechanisms through which resources such as schooling and income-earning may influence women's nutrition.

Implications

Research implications

The results of these studies point to a need for additional research in several areas. As stated above, further research will be needed to validate the measures of women's empowerment. We also noted that schooling may be an important resource for women's agency in rural areas but not in poor urban areas. Therefore, it will be important to identify whether schooling is an important resource for other domains of agency in urban

areas, beyond those measured in these studies, or whether other resources beyond schooling may be important for women's agency. Other potential research questions relate to whether other domains of agency may be important for dietary diversity, especially as mediators of the relationship between schooling and dietary diversity. Finally, given that our study was the first to use MSEM to examine nutrition outcomes, a wide scope exists for research examining associations at the community level.

It is important to note that this dissertation focused exclusively on specific sub-populations within Bangladesh and that research implications and priorities may be different in different populations within and outside of Bangladesh. Specifically, prior research suggested that women in Sylhet Division, where the FAARM study is located, have lower levels of empowerment compared to women in other regions of Bangladesh (3). Similarly, it may be that women in poor neighborhoods of Dhaka have lower levels of empowerment compared to women in richer neighborhoods. Given the context-dependent nature of women's empowerment, the domains of empowerment that we deemed relevant in our study may not be relevant in other regions of Bangladesh or in other countries. Researchers may therefore consider using existing evidence or formative research to determine the domains of empowerment that are most relevant for their study populations.

Future research should also use more rigorous study designs, including longitudinal designs and randomized controlled trials. The majority of the evidence related to women's empowerment and nutrition comes from cross-sectional studies and often from secondary analysis. A clear need therefore exists for more trials to test interventions designed to impact specific domains of women's empowerment for

women's nutrition. Studies should follow women longitudinally to capture the process of empowerment over time. In addition, given that empowerment is an intangible construct that does not inherently lend itself to quantitative measurement, studies should use mixed methods designs to measure empowerment more comprehensively. An iterative process that uses cognitive testing as well as qualitative research to both improve quantitative tools and explain quantitative results would result in richer data that could substantially advance the understanding of relationships between women's empowerment and nutrition.

Program implications

The results from these studies are in line with other evidence documenting positive associations between schooling and domains of women's agency in Bangladesh. For example, a cross-country analysis of Demographic and Health Survey (DHS) data from 58 countries found that schooling was a significant correlate of women's decision-making, freedom of movement, and experience of intimate partner violence and noted that secondary schooling was of particular importance in Bangladesh (4). A study in Bangladesh noted that having any secondary schooling was inversely associated with early marriage (5), while another observed that schooling was positively associated with women's decision-making (6). Thus, our findings reinforce the idea that schooling may be an important resource for agency, particularly in rural areas.

In addition to the inherent value of schooling as a basic human right and its instrumental value as a potential mechanism to increase women's agency, schooling also has value in its association with women's dietary diversity. Women's dietary diversity, in turn, is important for its own sake, because of its relationship with women's

micronutrient intake (7), but it can also have instrumental value in promoting child nutrition. Maternal nutrition is important pre-conceptionally as well as during pregnancy and lactation (8). A positive association has also been observed between maternal and child dietary diversity in Bangladesh, suggesting that maternal diets may be important for child nutrition beyond the nutrients transferred during pregnancy and lactation (9). Girls' schooling, therefore, may benefit society through a number of mechanisms and may benefit women and their children over the life course. Projects should seek out opportunities for intersectoral work to increase girls' school attainment.

Projects such as FAARM work by bringing women together in groups and transferring skills and assets to improve women's productive capacity. FAARM uses the Helen Keller International (HKI) homestead food production model, which was shown to positively impact women's social solidarity and decision-making in a randomized controlled trial in Burkina Faso (10). This provides some reason to expect improvements in these domains of empowerment in Bangladesh as well. However, while these interventions can be empowering for women, projects should not assume that their interventions will inherently result in women's empowerment (11). Agriculture-nutrition projects work within women's established gender roles as homestead food producers (12); in some ways, this can reinforce potentially harmful gender norms. Also, as noted by Gammage *et al.*, "improving income and the terms and conditions of employment and production does not necessarily spill over to agency in other domains such as the household" (11).

In addition to building women's skills and capacity, projects should follow a gender-transformative approach that challenges existing gender norms. Projects should

particularly focus on the specific domains of agency that are most strongly associated with nutrition in a given context in order to increase impact from their interventions. In rural Bangladesh, projects may seek to actively strengthen women's voice with husband as a means of both transforming gender norms and improving women's dietary diversity. HKI is doing this in some projects with a curriculum that has been designed to promote intra-household communication and negotiation skills (13). An impact evaluation is currently underway to measure the effect of this training. In all agriculture-nutrition projects, is important to ensure that women retain control and decision-making power over their newly acquired assets and any resulting income (14).

In addition to strengthening women's voice and decision-making power, projects may also aim to improve women's self-confidence and self-efficacy. We did not measure these domains of empowerment in our studies, but, in addition to being important components of psychological well-being, several authors have theorized that these domains may also contribute to women's ability to achieve their desired outcomes. For example, Nussbaum lists "her own perception of her worth" among factors that determine a woman's bargaining position (15). Similarly, Agarwal writes, "what is needed is less making women realize they *deserve* better, than having them believe they *can do* better (by building their self-confidence, providing information, etc.), and by helping them to in fact do better, through strengthening their bargaining position" (16). This may be a fruitful area for future projects to explore.

In a paper written in 2006, Sethuraman *et al.* argue that "operations research is needed in community-based nutrition programs to determine whether empowering women can have a multiplier effect on improving nutrition outcomes, and how this can

be achieved" (17). More than ten years later, this remains true. In their operations research, programs should attempt to use standardized tools to measure women's empowerment, or should rigorously test the tools that they choose to use. Many questions still exist as to how to measure women's empowerment across contexts and whether the tools being used in the field are actually measuring what they aim to measure (18). Ideally, programs will collect data longitudinally, to measure the *process* of empowerment. At the same time, when measuring outcomes, programs should bear in mind that their interventions could have unintended harmful effects, and these should be measured as well.

Policy implications

Secondary school enrollment has increased over time in Bangladesh, and data from 2014 indicate that 55% of girls were enrolled in secondary schools nationally (19). However, early marriage reduces the likelihood that girls will complete their studies (20), and Bangladesh has the eighth highest prevalence of child marriage globally (21) as well as the fourth highest prevalence of early childbearing (22), both of which threaten progress. Legally, girls in Bangladesh must be 18 years old to marry, but many officials fail to enforce this policy in practice (21). The government recently introduced the Child Marriage Restraint Act 2016; this new law would allow marriage for girls under 18 in "special cases" but does not delineate which cases would qualify as "special" (21). Activists have therefore raised concerns that the law will facilitate child marriage and that the prevalence of child marriage will increase rather than decrease. In order to protect girls' rights and continue the trend of increasing girls' secondary school enrollment, it is important that the government of Bangladesh enforce laws prohibiting child marriage.

A key policy area of relevance to women's dietary diversity relates to food systems. Bangladesh produces only 22% of the fruits and vegetables necessary for the population to meet dietary guidelines (23), and the limited supply of fruits and vegetables likely constrains women's dietary diversity. The National Agricultural Policy (2013) promotes crop diversification and livestock production for nutrition security, but with 75% of agricultural land devoted to rice, the potential policy effects are limited (24). Additional incentives are needed to stimulate the production and distribution of micronutrient-rich foods. Policies that promote equal access to extension services and agricultural loans for smallholder farmers can help women farmers produce more food for their households (25). Ensuring equal access to physical assets (e.g., land), including through reform of property and inheritance laws, can also increase the number of women participating in agricultural production and can contribute to their broader empowerment and well-being (25).

Policies around social safety nets may also have some potential to promote the consumption of diverse diets. Emergency relief programs carry out food distribution in the wake of natural disasters, but these almost exclusively provide rice and, to a lesser extent, wheat (24). Similarly, food-for-work programs distribute food grains as a mechanism to alleviate food insecurity in rural areas during the lean season (24). It may be possible for these food distribution systems to provide a more diverse and nutrient-rich basket of foods for their beneficiaries, but additional research will be needed. Social safety net programs also include cash transfer programs, such as cash-for-work and conditional or unconditional cash transfers. Evaluations of these programs have noted mixed results globally in terms of both nutrition and women's empowerment (25).

Additional research will be needed to determine whether cash transfers may hold promise for women's empowerment and dietary diversity in Bangladesh.

Strengths and innovations

Women in Bangladesh suffer from multiple forms of malnutrition, and this dissertation contributes to our knowledge of factors influencing women's nutrition in Bangladesh. Given that women's nutrition is largely neglected as a research area, this work begins to fill a large gap in the literature. Our findings are supported by rigorous methods, including the use of MSEM (26). To my knowledge, this is the first use of MSEM in the nutrition literature. MSEM is a relatively new analytic approach that originated in the social sciences but remains under-utilized in nutrition. Through this approach, my co-authors and I were able to address a major gap in the literature, where several scholars have called for further research on women's empowerment at the community level. We had panel data from both rural and urban areas, which we were able to use to estimate usual intake over the period of one year or more, thereby reducing bias in the data. Finally, a major contribution of this dissertation has been to provide tested modules that can be used by researchers and program implementers to measure women's decision-making and voice with husband in rural and urban Bangladesh. These modules are only three and four questions long, respectively. This makes them practical and feasible to include in nearly any survey.

Limitations

This research has several limitations, primarily relating to its scope and generalizability. Both the rural and urban studies focus on married women, and our measure of voice focuses on a woman's voice with her husband. We do not examine other groups (e.g. adolescent girls) or other relationships that may be important for intra-household communication (e.g. with mothers-in-law). We are also limited in the generalizability of our results based on our geographic sample. Our rural sample is representative of the FAARM study population, while the urban sample is representative of neighborhoods in the poorest three deciles of Dhaka City Corporations. Thus, we cannot draw conclusions about rural or urban areas more generally or about Bangladesh as a whole.

This research is also limited in its ability to establish definitive conclusions due to the study design. All three of the studies in this dissertation use observational data and cross-sectional analyses. It is therefore not possible to establish temporality or causal relationships along the pathway from resources to agency to achievement. Ideally, the studies would have collected data longitudinally to measure whether higher schooling attainment during childhood leads to higher agency during adulthood, and whether higher agency in turn leads to higher dietary diversity. A more rigorous study design would also have used a randomized controlled trial design to establish a counterfactual.

On a broader scale, a major limitation of any study of women's empowerment is the difficulty of measuring an intangible construct. We attempted to measure dimensions of women's agency that we theorized would be important for women's nutrition. However, we lacked tools that had been validated to measure our selected dimensions of empowerment in our selected context. In addition, it was logistically not possible to measure all the dimensions of empowerment that could potentially have been of interest.

Therefore, our analyses do not include some dimensions that may have been important for nutrition.

Conclusions and future research

This research demonstrates the use of cutting-edge methods for understanding the relationships between women's empowerment and nutrition. Our work strengthens the evidence around women's empowerment and nutrition and provides an analytic framework that is applicable to studies of other contextual factors and nutrition as well. Our findings suggest that domains of women's agency play a potentially important role in influencing women's dietary diversity. In particular, women's voice with husband is positively associated with dietary diversity in rural areas, while women's decision-making is positively associated with dietary diversity in urban areas. By focusing on the specific domains of agency that are most strongly associated with nutrition in a given context, programs can potentially see an increased impact from their interventions. Additional work will be important to validate tools to measure women's empowerment. Further research is also needed to better understand these pathways and to explore other domains of women's empowerment that may be important for nutrition.

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