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## **Gender Roles and Food Safety in 20 Informal Livestock and Fish Value Chains**

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## **ABSTRACT**

Food-borne disease remains a major public health challenge in Africa and Asia. Most of the foods that carry the highest pathogen risk are produced by smallholder farmers, marketed through the informal sector, and sold in wet markets. Given the significant role of informal markets in African and Asian food systems, attention is invested in understanding (1) how the people that participate in informal markets are exposed to risk, and (2) how they manage risk. We conduct a participatory risk analysis with a gender lens in 20 livestock and fish value chains to study whether gender-based differences influence risk of food-borne disease. We find that socially constructed gender roles are more important determinants of health risk than biological differences between men and women. Variations in risk exposure between men and women are mainly due to gender-based differences in occupational exposure, and secondarily to differences in consumption patterns. Women are important but under-recognized risk managers in the realms of food production, processing, selling, preparation, and consumption. Understanding the influence of gender on risk exposure and management is essential for improving food safety in informal markets.

**Keywords:** gender; informal markets; food safety; value chains; Africa; Vietnam

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# 1. INTRODUCTION

Food-borne disease remains a major public health problem in Africa and Asia. Studies from countries with relatively good attribution data show that food is an important route for pathogen transmission and that the riskiest food products are meat, milk, fish, eggs, and fresh fruits and vegetables (Thomas et al. 2013; Mangen et al. 2014; Kirk et al. 2014). In Africa and Asia, the majority of these foods are produced by smallholder farmers, marketed through the informal sector, and sold in wet markets (Grace et al. 2010; Gómez and Ricketts 2013). There is widespread concern about food safety risks associated with food produced by smallholders and sold in wet markets. Indeed, these concerns about public health are one of the main reasons policymakers in poor countries often favor modernization and industrialization of agriculture rather than developing the traditional and informal sector (Grace et al. 2007).

The informal food sector is an important source of income and employment, especially for women, in developing countries (Grace et al. 2008). Women interact directly with informal markets as producers, consumers, and at many other nodes of the value chain. Almost two-thirds of the world's 925 million poor livestock keepers are rural women, and women play important roles in livestock production, processing, and livestock product retail (Herrero et al. 2013). Women act as risk managers in their productive responsibilities, and the roles they take on in these value chains have bearing not only on their own health but on a broad network of people including their families and downstream consumers.

Women are also important risk managers when it comes to food production, preparation, and consumption, and informal markets are important sources of food for women and their families. In most developing countries, women have the primary responsibility for preparing food for their families (Kristjanson et al. 2010). In most countries in Africa and Asia, food in the informal sector costs less than food purchased in the formal sector. Thus, informal markets facilitate the access of poor women to nutritious foods (FAO 2013). Moreover, informal markets are usually more physically accessible than supermarkets and meet the preference of poor people for buying small amounts of fresh foods frequently (Cadilhon et al. 2006). In addition, informal markets often sell food with characteristics desired by customers, such as meat from livestock of local breeds or traditional products (Jabbar, Baker, and Fadiga 2010).

Gender is increasingly understood as an important mediator in people's ability to participate in and avoid harm from agricultural and livestock value chains. Gender and value chain research has shown that men and women often face different barriers to participating in value chains that stem from gender-based differences in social norms and access to assets such as land, financial capital, social capital, information, and education (Quisumbing et al. 2015). These differences lead to processes of food production, processing, sale, preparation, and consumption of food products that are highly gendered, with men and women occupying diverse but often segregated or complementary roles along the value chain.

Research has also investigated how participating in value chains can also lead to unintended harm based on gender in domains such as time poverty, energy burden, capacity for childcare, or dispossession of women's gains by other actors (SPRING 2014; Rubin and Manfre 2014).

However, information is limited on how gendered participation in value chains affects food safety and health risks. Gender approaches to food safety remain limited within the wider food safety literature, and the gender, value chain, and nutrition literature, while providing useful frameworks for gender analysis, has not yet fully addressed gendered dimensions of food safety. This paper presents findings on how gender roles affect participation in informal food systems and the risks and benefits that arise from gendered differences in participation. It also considers how rapid change in food systems is affecting gender roles. Finally, it makes recommendations for how to incorporate gender into research and interventions to improve food safety.

## 2. METHODS

We summarize findings from a series of ongoing and recently completed research projects focused on food safety in informal markets of Africa and Asia between 2009 and 2011. The results from the risk assessment are published elsewhere (Grace et al. 2010). This paper shares the results relevant to gender and equity that have not been published as a paper. The studies followed a common approach, in which the national partners were universities, and graduate students were assigned to conduct the studies. All project graduate fellows and partners (supervisors) were trained in participatory risk assessment and developed the data collection tools and methods with the International Livestock Research Institute scientists. The partner institutions recruited and trained all enumerators. Instruments were modified for local context, translated, and pretested in conformance with good research principles.

The projects used a value chain approach, which involved mapping value chains and identifying common processes, and identifying men's and women's participation throughout the chains. Value chains are defined as the linked groups of people and processes by which a specific commodity is supplied to the final consumer (FAO 2012). Value chain stages are categorized as follows: (1) production, fish capture, or hunting; (2) aggregation of products at dairy plants or abattoirs; (3) processing, including offal preparation; (4) retail (wet market, hawking, and street sales); and (5) consumption. The projects for which gender analysis is presented are summarized in Table 2.1.

**Table 2.1 Twenty food safety studies in livestock and fish value chains**

Country	Product	Location	Focus of study
Côte d'Ivoire	Milk	Urban	Value chain
Côte d'Ivoire	Fish	Urban	Processing
Ethiopia	Milk	Urban	Value chain
Ghana	Milk	Rural	Value chain
Ghana	Fish	Urban	Value chain
Kenya	Beef	Urban	Abattoir
Kenya	Beef	Urban	Retail
Kenya	Milk	Peri-urban	Production
Kenya	Milk	Rural	Dairy plant
Mali	Milk	Rural and urban	Value chain
Mozambique	Poultry	Urban	Abattoir and market
Nigeria	Beef	Urban	Abattoir and market
South Africa	Biltong	Urban	Retail
South Africa	Goats	Rural	Slaughter
South Africa	Game	Rural	Slaughter
South Africa	Poultry	Urban	Retail
South Africa	Street food	Urban	Retail
Tanzania	Milk	Rural	Value chain
Tanzania	Meat	Urban	Public houses
Vietnam	Pork	Rural and urban	Value chain

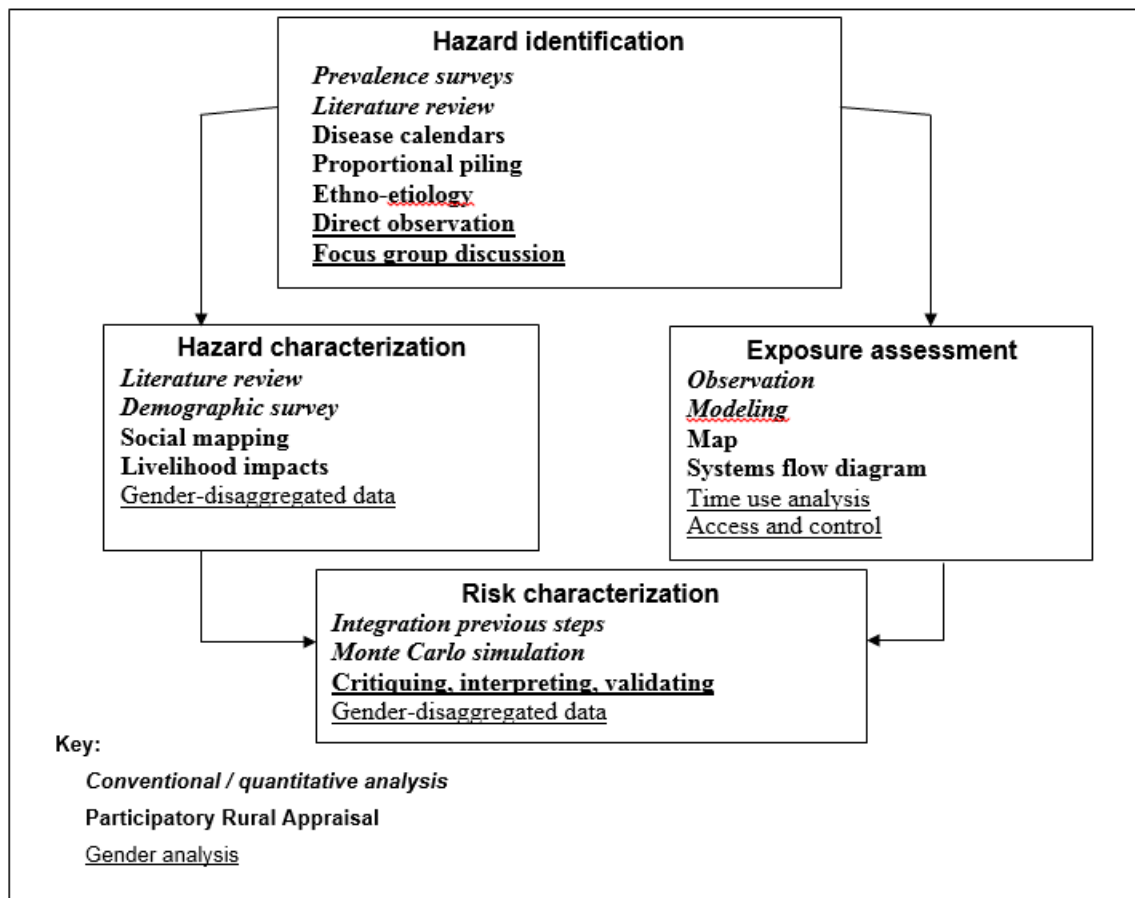
Source: Authors.

To assess food safety, the projects used a participatory risk assessment approach. This method adapts conventional risk assessment frameworks by incorporating participatory methods, including social and gender analysis and stakeholder engagement to reduce the costs and increase the impacts of food risk assessment in poor countries (Grace et al. 2008). In each project presented, an initial phase of qualitative research was followed by questionnaire-based surveys and biological sampling for food-borne pathogens. Figure 1.1 outlines the participatory risk assessment framework developed and used by the projects. This



framework brings together tools from three disciplinary areas: epidemiology, participatory appraisal, and gender analysis. Literature review, surveys, and modeling are commonly used tools for understanding disease and health in populations. Participatory methods use a set of visualization and interviewing tools, suitable for use in groups where literacy is limited and designed to provide qualitative data in short time frames. For example, in proportional piling participants provide estimates of the size of categories by distributing objects across them. Tools may be developed for disciplinary research (Catley 2005): for example, ethno-etiology is an interviewing technique to understand how different cultures view the causes of animal or human disease. Gender analysis also uses a suite of tools—many from sociology.

**Figure 2.1 Model of participatory risk assessment, integrating participatory research and gender analysis**



Source: Grace et al. (2008)

The gender analysis methodology was based on the Harvard Analytical Framework for Gender Analysis (March, Smyth, and Mukhopadhyay 1999) with modifications for analyzing livestock systems (Njuki et al. 2011). This methodology describes the techniques and instruments used in the studies to gather information about livestock production, labor division, and benefits derived from participation in livestock value chains. This methodology provides a structured way to gather information and subsequently analyze activities (who does what); access and control (what resources are needed for the activities and who has access to them and control of them); and influencing factors (what affects gender differences in activities and resource use).

We used information on activities, resource use, and influencing factors to address four questions:

1. How do the activities and resource use patterns of women and men differ according to value chain and according to the stage in the value chain?
2. How do these activities and resource use patterns affect the exposure of women and men to hazards?
3. How does the biology of women and men, young and old, healthy and sick, affect their vulnerability to different diseases?
4. As food systems undergo change and evolution, how might this advantage or disadvantage different women and men?

### **Statistical Analysis**

To test the difference in participation by men and women at different stages in the livestock and fish value chain, different regions, and modernity of value chain, the chi-square test was used with the value chain as the unit of analysis; if requirements could not be met, the Fisher exact test was used. To test the difference in participation in value chains of men and women in different regions and in rural versus urban value chains, the Freeman-Halton extension of the Fisher exact probability test was used.

### 3. RESULTS

In this section, we first review results on the gendered division of labor in each of the value chains studied. Then we examine how the gendered division of labor can subject men and women to differential risk exposure. Next, we consider whether biological sex influences health risk, and finally, we address how changes in food systems will alter gender roles and relative risk.

#### How Men's and Women's Activities and Use of Resources Differ

The case studies showed that women and men carry out a wide range of activities (summarized in Table 3.1), and yet participation in many value chains, as well as activities within value chains, is divided by gender.

**Table 3.1 Activities of women and men at different stages of 16 livestock and fish value chains in Africa and Asia**

Category	Value chain	Production/ capture	Slaughter/ collection	Processing	Marketing
Fish	Fish: Urban Côte d'Ivoire	Men catch fish	Women	Women smoke fish	Women
	Fish: Urban Ghana	Men catch fish	Women	Women dry fish	Women
Milk	Milk: Peri-urban Kenya	Women feed and milk	n/a	Women ferment milk	Women
	Milk: Rural Mali	Men feed and milk	n/a	Women ferment milk	Women
	Milk: Rural Ghana	Men feed and milk	n/a	Women	Women
	Milk: Urban Côte d'Ivoire	Men feed and milk	Men	n/a	Men
Poultry	Broilers: Mozambique	Men	Men	n/a	Men and women
	Poultry: Rural Mozambique	Women	Women	n/a	Men and women
	Poultry: Urban South Africa	Men work in commercial farms	Men	n/a	Women sell informally
Livestock	Pork: Rural and urban Vietnam	Men and women	Men	Men and women	Mainly women
	Goats: Rural South Africa	Men and women	Men	Women cook	n/a
	Beef: Urban Tanzania	Men	Men	Women cook	Men run pubs
	Beef: Urban Kenya	Men	Men	n/a	Men
	Beef: Urban Nigeria	Men	Men	Men and women	Men, some women
	Game: Rural South Africa	Men hunt game	Men	Men and women	Men and women
	Biltong: Urban South Africa	n/o	n/o	Men and women	Men and women

Source: Authors.

Notes: n/a = not applicable, because the process does not occur in the value chain; n/o = not observed, because the study did not cover this step. Out of the 20 value chains studied, 16 of the value chains examined all points of the value chain from production to consumption and can be compared in this table.

In all locations, a gendered division of labor is apparent. The individual stages of the value chain tend to be segregated by gender, but only three value chains over their entire course were completely dominated by one gender. Some nodes of the value chain tended to involve one gender across locations. Men were more likely to work in production and slaughter/collection activities than women, while women tended to be more active than men in processing and retail. All differences were statistically significant, with the exception of retail (Table 3.2).

Only in a minority of activities were men and women equally involved, and the difference between these and gender-segregated activities was highly significant ( $p < 0.0001$ ). Dual-gender tasks were more likely in the poultry and livestock chains, while the fish and dairy value chains were segregated by gender. Processing and marketing were more likely to be tasks shared by men and women. However, it is important to note that no gender role trends, either in activities or value chains, are completely consistent across the 20 value chains studied.

**Table 3.2 Gender division of labor at different stages of 16 livestock and fish value chains in Africa and Asia**

Variable	Production	Slaughter/ collection	Processing	Retail	Consumption
Men dominate	11	9	0	4	1
Women dominate	2	3	7	7	0
Men and women, involvement similar	2	2	4	4	15
Difference between men and women ( $p$ )	0.001	0.022	0.004	0.256	1.000

Source: Authors' calculation.

Note: Cell numbers represent number of value chains studied that feature the given gender involvement in the stage of the value chain being considered.

Certain trends by value chain appear. Across all activities in the value chain, women were more active in fish and milk chains, and men in beef and game chains. There was a difference between regions with Southern and East Africa featuring more male dominance than West Africa ( $p = 0.026$ ). Urban value chains tended to have more male dominance, but this was not significant ( $p = 0.250$ ).

Next we examine gender roles in each stage of the value chain: (1) production; (2) aggregation; (3) processing; (4) retail; and (5) consumption.

### **Production**

The production stage in these value chains involves catching fish, hunting game, and caring for livestock, including feeding and milking. At the production stage, men dominated value chains for dairy, beef, commercial poultry, fish, and game, and women dominated backyard poultry. In production activities, women and men were equally involved only in pork production in rural and urban Vietnam and goat production in rural South Africa.

In all value chains, children or hired workers frequently helped with care for animals. In Mali, milking cows was done either by the male Fulani herders or the male children in the family. The male head of the family rarely did the milking himself. Women were not allowed to milk cows.

Only in two value chains did women dominate production: Kenya milk and Mozambique poultry. In both cases, women were involved throughout the chain, from production to marketing. Men were almost entirely excluded from the chains, except for the marketing stage in Mozambique. In peri-urban Kenya, women controlled informal urban smallholder dairy production, even hiring men for labor, while in West Africa men have taken on this role in peri-urban areas (Schneider et al. 2007). Women decided how and where to market their animals and how the revenues would be used. They could share the profits with men but did not have to.

Women's lack of participation in production, however, does not preclude them from controlling other stages of the value chain. In Mali, though men were in charge of caring for and milking the cows, the moment the milk entered the calabash, it belonged to the women. Women decided whether to take milk to the market, and if so, how much should be sold and how much kept for home consumption. The business and family administration of milk fell under the female domain, even though social norms prevented women from participating in production.

Even when men dominated production activities, women often assumed supporting roles. For example, in the West African dairy value chains, men were considered responsible for herding, feeding, and milking the cows, and in some traditional rural Fulani communities, women fed and milked cows. However, in the urban system, men have assumed the role of milking, while women participate in processing and selling the milk, in addition to cleaning, collecting water, and feeding cattle.

### ***Slaughter and Collection***

The next stage of the value chain is the collection or aggregation stage, where animals, animal products, or fish are bulked after leaving the farm or capture site.<sup>1</sup> Slaughter and aggregation tended to be managed by men across the value chains. Slaughter of cattle and pigs at abattoirs was dominated by men, as was slaughter of commercial poultry in Mozambique. Women dominated the shore-side fish markets for wild caught fish in West Africa. In Mozambique, in contrast to the other countries studied, some live animal traders were women.

Even in male-dominated slaughter activities, women would contribute with some activities relevant to risk exposure and management. Table 3.3 shows the gender division of roles in the Nigerian abattoir and associated meat market.

**Table 3.3 Gender division of labor in processing and marketing of cattle and meat products in a Nigerian abattoir and associated wet meat market**

<b>Variable</b>	<b>Men only</b>	<b>Women only</b>	<b>Men and Women</b>
Movement of cattle from holding pen to slaughter room	X		
Tying cattle down in preparation for slaughter	X		
Slaughtering cattle with a knife	X		
Cutting the cattle into quarters and removing offal	X		
Fetching water in buckets from the well		X	
Cleaning of the offal			X
Selling of skin, offal, legs, and head			X
Gathering dung and refuse and taking to a dump			X
Carrying the quarters of meat to the adjacent wet market			X
Selling meat in the wet market			X

Source: Authors.

### ***Processing***

Some of the value chains included an important processing stage, and if present, this was usually dominated by women (smoking or drying fish and producing traditional dairy products in West Africa). However, both women and men took part in the processing of offal (Nigeria and South Africa) and the making of biltong (South Africa).

<sup>1</sup> This node of the value chain is absent in several products. Aggregation did not occur in the most traditional milk value chains where producer households sold the milk directly to consumers (often neighbors) or to small-scale retailers. Likewise, slaughter of goats and backyard chickens was done in the home or village without an aggregation stage.

## **Retail**

In all the value chains studied, the majority of meat and fish was sold in small-scale, traditional markets (which may also be called “informal” or “wet” markets).<sup>2</sup> Wet markets are typically covered or open markets run by local or municipal authorities, which consist of tens to hundreds of small kiosks, tables, or spaces on the floor selling food and other products. These markets often lack refrigeration, reliable electricity, running water, and proper waste disposal. In such markets, women dominated the selling of fish, but in most countries men dominated the selling of meat. The study in Kenya found only two female butchers, and in Nigeria male butchers outnumbered female by 15 to one.

In South Africa, the majority of street sellers of ready-to-eat chicken and chicken by-products were women between 25 and 50 years old, with very few young people and men involved in the trade. Most had completed secondary education and some of them even tertiary.

## **Consumption**

In all the case studies, women were responsible for preparing and cooking food for family consumption within the household. Men’s and women’s consumption within the household was generally reported to be similar. In most countries, milk was given preferentially to children. In Ghana women made up 55 percent of milk consumers and 60 percent of fish consumers. Meat was consumed by both sexes, but in Nigeria women were more likely to consume offal and men to consume muscle meat. Almost all the consumers of meat kebabs in Tanzanian pubs were men, and men also made up the majority of consumers of street food in South Africa. In South Africa, children were not allowed to eat kidneys, as this was believed to cause urinary problems. In Vietnam, pregnant women avoided a range of foods. Pregnant women in rural Vietnam avoided fish and fermented pork, while urban women avoided spicy food, dog meat, and boiled pork served with fresh (uncooked) fig leaves.

## **Different Activities Lead to Different Health Risks for Men and Women**

The different activities that women and men carried out led to different health risks. Table 3.4 summarizes some examples of gender-specific risks from exposure to occupational hazards in the value chains studied.

**Table 3.4 Differential risk exposure linked to gendered division of labor**

<b>Stage of value chain</b>	<b>Activity</b>	<b>Occupational hazard</b>	<b>Who is more exposed to risk?</b>
Production	Milking cows	Zoonoses from direct contact with cattle	Men (West Africa) Women (Kenya)
	Manual labor and handling livestock	Back pain, physical risks	Men (Nigeria)
	Handling aborted material with bare hands	brucellosis	(Mali), (Kenya)
Slaughter and collection	Slaughter of diseased animals	Brucellosis or anthrax infection	Men (Mali)
	Goat slaughter and inadequate sanitation	Infection if hands are not washed and touch their mouths or food	Men (South Africa)
Processing	Smoking fish to preserve them	Carcinogens such as polycyclic hydrocarbons; symptoms include headaches and eyestrain	Women (Côte d’Ivoire)
Retail	Retail activities in busy, dangerous locations	Risk of violence; strain from 10 to 12 hours of continuous work	Women (South Africa)
Consumption	Food consumption preferences	Contamination in offal	Women (Nigeria)
		Meat skewers served in pubs	Men (Tanzania)

Source: Authors.

<sup>2</sup> In Vietnam sales to the large canteens of factories, schools, and universities were also important.

In West Africa, men were more exposed to occupational zoonoses associated with direct contact with cattle during milking; on farms in Kenya, where women were responsible for milking, the situation was reversed. Where men dominated production and slaughter activities, they were exposed to more occupational risks associated with handling livestock and the manual labor in unmechanized slaughterhouses. In Nigeria, men reported a higher incidence of back pain.

In Mali, cattle were slaughtered and eaten only when diseased or when they died of exhaustion. Slaughtering such diseased animals exposes men to occupational diseases such as brucellosis or anthrax infection. In South Africa, goats were killed for traditional ceremonies and were mainly healthy, but the men who slaughter and grill goats do not wash their hands prior to preparation as they assume hazardous agents will be killed when the meat is roasted. This may expose them to infection if their contaminated hands touch their mouths or food.

Women dominated processing and were exposed to other occupational risks. In Côte d'Ivoire, the fish-smoking process was found to be high risk for the women, who were exposed to carcinogens such as polycyclic hydrocarbons. Many women complained about symptoms possibly related to the smoking process (headaches and eyestrain). However, in the Ghana study, where fish are air dried but not smoked, the bacterial hazards assessed were eliminated by cooking, so women were not at greater risk.<sup>3</sup>

Women also dominated retail activities, which in some cases were associated with occupational risks. The mainly female street sellers in South Africa worked about 10 to 12, and up to 15, hours a day continuously, sometimes starting as early as three in the morning when commuters leave for work. They worked in the streets rather than inside open market areas provided by the municipalities (for a daily fee) in order to exploit areas with numerous clientele such as bus terminals, taxi ranks, and industrial sites, but this was a sometimes violent working environment, exposing them to additional risks.

In general we see no marked differences in the reported frequency of consumption of livestock and fish products between women and men. However, in those chains where differences do exist, they expose women and men to different risks from food-borne disease. The white offal consumed more by women in Nigeria may be more contaminated than the muscle meat consumed by men, since animal intestines are contaminated with feces. Pregnant women in Vietnam reduce their risk by avoiding some products that are likely to be high risk (dog meat, fresh vegetables, and fermented pork). In the study on meat sold on skewers in public houses in Tanzania, nearly all the consumers were men, and because meat was often served in dark conditions and to customers who were also consuming alcohol, it was more difficult for consumers to assess the quality of the meat they consumed. In South Africa, kidneys were associated with urinary disease and were not given to boys.

### ***How Biology, and the Reproductive Role of Women, Affects Risk***

Women bear additional risk because of greater vulnerability to pathogens associated with their biological reproductive role. There may also be biological differences in preferences for and aversions toward meat (Fessler 2002). However, only one of the studies identified differences in risk attributable to biological sex. This was in Ghana, where milk was contaminated with *Listeria spp.* and milk was commonly consumed uncooked. Listeriosis is a cause of miscarriage in pregnant women, and almost half of the women in our survey had experienced spontaneous miscarriages, about one-third of them more than once. Nearly nine out of 10 experienced at least one case of stillbirth, and for most women, this occurred during the third trimester of the pregnancy.

### ***How Rapidly Changing Food Systems Affect Women's Participation and Risk***

The case studies included both traditional and new value chains. Overall, women predominated in traditional value chains and men in new value chains. This difference was significant ( $p = 0.011$ ). Traditional value chains tended to be more gender segregated than new value chains (75 percent and 60 percent, respectively), but this was not statistically significant. In contrast to the traditional West African

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<sup>3</sup> Smoking fish is also important in Ghana, but this was not addressed in our study.

dairy sector dominated by women, the new private dairy sector developing in Abidjan, Côte d'Ivoire, was dominated by men from production to marketing. The milk producers are largely immigrants who are not married, so men fill the milk processing and selling gap in the absence of women. In other dairy value chains, men and women within the same household often share duties along the value chain.

It is not only women who are affected by changes in food markets. Previously, in West Africa, hired herders were paid in kind with milk for their work, but today they are often paid in cash. Women in Mali now have better access to markets and can generate cash from selling the milk. However, in many cases herders prefer to maximize revenue at the expense of household consumption, with overall milk consumption decreasing, harboring potentially deleterious effects on household and especially child nutrition. In a similar study in Mauritania, home milk consumption declined from 10 liters per day per household to two liters after the entry of the dairy industry (Ould Taleb et al. 2011) as milk is sold to increase the household income.

Interventions to upgrade value chains even with the intention of inclusion can also backfire. In Mali, a development initiative started a small dairy plant. It actively tried to include women, and many started working for the cooperative that supplied the dairy plant. While the dairy plant successfully included women, its quality standards led to an unanticipated increase in women's risk exposure. The cooperative bought the milk from the women only if it complied with quality standards. The milk that did not pass the test was rejected, and the women took that milk back for home consumption, concentrating higher-risk milk in the household.



## 4. DISCUSSION

Overall, women are very involved in the informal livestock food systems studied in nine African countries and one Asian country. Most value chains rely on the participation of both men and women, but activities tend to be segregated by gender. The one value chain with both men and women participating throughout was the biltong value chain in South Africa, which stems from a European rather than an African or Asian food culture. The gender differences arise mainly from customary rules that view certain activities as “male” or “female” (FAO 2013). The arbitrariness of the cultural determination of gender roles can be seen in the case of butchers: in African countries, most butchers are male, but in Vietnam most are female; similarly, fish selling was dominated by women but meat selling by men.

Our studies were in accordance with wider findings of gender roles in livestock and food production that show men typically are responsible for production of large animals, fishing, hunting, and slaughter, while women are responsible for poultry, dairy products, processing, and preparation of food in the household and preparing and selling street food (the latter, only in cultures where a public role for women is possible) (Tangka, Jabbar, and Shapiro 2000; Fellows and Hilmi 2011).

Whereas marked differences were seen in the activities of men and women, differences were less evident in food consumption frequency, but the qualitative methods used in our studies are not suitable for detecting small to moderate differences in consumption quantities. However, food taboos are common. Meat is the main target of proscriptions for pregnant women (Fessler 2002). Functionalist explanations propose that taboos have a utilitarian basis (fostering sustainable resource use or avoiding disease), while symbolists explain taboos through the meanings associated with food. In our study eating kidneys was associated with urinary disease, which supports a symbolist interpretation, and some of the foods avoided by pregnant women in Vietnam are high risk, supporting a functionalist interpretation.

Most differences in risk in our studies were attributable to gender rather than sex. Men were most exposed to occupational injuries associated with livestock production, fishing, hunting, and slaughterhouse work. Women were more exposed to food-borne pathogens encountered in processing, selling, and preparing food. Only one study (listeriosis risk) identified differences in health outcomes as attributable to sex or biology. However, gender and sex are enmeshed (Coen and Bannister 2012), and some of the differentiation of activities between men and women may reflect biological differences (for example, the greater involvement of men in slaughter of large animals).

Livestock and fish production are changing rapidly as the result of urbanization, increasing wealth, and changing preferences. Our studies show the persistence of the traditional dairy system (Waters-Bayer 1985; Tangka, Jabbar, and Shapiro 2000) in rural Mali, in which men dominate production and women processing and retail. However, the emerging dairies in urban Côte d’Ivoire were male dominated in all stages of the value chain. Likewise, the formal poultry slaughterhouses in Mozambique and South Africa employed only men, although poultry keeping and slaughter is traditionally within the women’s sphere. The literature cites many cases where women’s control over livestock enterprises and incomes is diminished with increasing commercialization (Kristjanson et al. 2010). But as the Mali case study showed, if efforts are made to include women, they can continue to participate in a formalized food system, handling greater quantities of food and meeting higher standards.

However, the Mali study suggests another risk of increasing standards of food safety. Not only do higher standards risk excluding small-scale producers, who find it more difficult to attain quality levels, they may concentrate contaminated food among the poor or the less informed (Roy 2013). In addition, formalizing food safety standards in such a way that enhances the product’s commercialization can reduce household consumption of the food if the product becomes more attractive to sell than to consume. In such cases, diets may suffer if the income earned is not spent on nutrition-enhancing foods, due to absence of markets for nutritious foods or the preferences and knowledge of the person with control over the income.

The differentiation of gender from sex is only starting to inform health research (Phillips 2005) but has great potential to make a difference in such research (Coen and Bannister 2012). In our studies, there were marked differences in the activities carried out by women and men in food systems and relatively smaller differences in consumption patterns. The major driver of differences in health risks was the socially constructed gender differences, which influence the value chain and food-related activities women and men undertake.

Increasing attention to the role of gender in agriculture (FAO 2011; World Bank 2012; Meinzen-Dick et al. 2014) and in nutrition (SPRING 2014) does not yet address food safety or health risks. Our studies suggest that another important consequence of gendered division of labor is differential health risk. Conducting gender analyses can also provide important information on male and female risk managers' behavior and beliefs regarding food safety.

## 5. CONCLUSIONS

Given the important role of women in informal markets, and given the wide variation between men's and women's roles, understanding gender is important for improving food safety in informal food markets. Our case studies show that different stages of the food value chain tend to be segregated by gender, though most value chains involve both men and women at different stages. This varies by culture and geography and is determined by gender rather than biological sex. As a result of their different activities, and to a lesser extent different consumption patterns and biology, women and men derive different benefits from informal food markets and are exposed to different risks.

Women are important risk managers in realms of food consumption, preparation, processing, selling, and to a lesser extent, production. Even though women's roles may be less visible when they are not the primary owners of or decision-makers over livestock and other productive assets, they contribute to these value chains, and their knowledge and behavior in these activities have an impact on their own health and those around them. Though risk exposure is most closely associated with the gender that is dominant in the given stage of the value chain, the other gender may also contribute supporting tasks and come into contact with pathogens as well.

Finally, women are unrivaled risk managers at the household level and rely heavily on informal markets for their family's food, so investigating women's knowledge and preferences related to market and food selection and the preparation of foods is critical for household-level food safety. Addressing women's and men's varying and evolving roles in value chains is essential for improving food safety in informal markets and reducing health risks for the majority of people in the developing world who rely on them.

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