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A qualitative investigation of childbearing and seasonal hunger in peri-urban Ouagadougou, Burkina Faso

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Abstract

Poor women who live in peri-urban communities are often faced with food insecurity due to seasonal variations in food availability and accessibility. Additionally, in these communities, fertility levels are often elevated despite geographic proximity to urban areas with low cost contraception. We conducted five focus group interviews to investigate the lived experiences of childbearing in peri-urban Ouagadougou, Burkina Faso to understand the behavioral and biological determinants of fertility outcomes. In the analysis of the interviews we pay particular attention to seasonal food insecurity experiences and the biological and behavioral determinants of childbearing. Our results suggest that there are less optimal times of year for childbearing and that poor, peri-urban women adjust their behavior accordingly. The results also suggest that there remain important barriers to contraceptive use even in cases where individuals associate pregnancy and childbearing with physical and psychological risk. This paper provides greater depth in understanding the determinants of fertility in resource-poor, peri-urban communities and points to some barriers for lowering fertility in similar areas.

Introduction

The highest fertility populations often face food insecurity. Research linking food insecurity, fertility and fecundity has heavily focused on rural, subsistence areas (see Mosher 1979, Panter-Brick 1996, Bongaarts 1980, among others). However, contemporary discussions of both food insecurity and fertility suggest that comparatively high fertility and inadequate nutrition are also characteristic of non-rural people; many of whom live in urban and peri-urban communities in Africa (WHO/UNICEF 2015, Zezza and Tasciotti 2010, UN 2015). Previous research linking episodic food insecurity with fertility outcomes has not examined the specific challenges faced by childbearing and food insecure women who live in peri-urban communities as distinct from those challenges faced by rural or urban dwellers. Moreover, neither classic birth seasonality research nor contemporary food insecurity research has well addressed women's own lived experiences and perspectives related to childbearing in a context of food insecurity. Considering the seasonality of birth outcomes among subsistence producers provides a framework to investigate the ways that nutrition,

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food, fertility, and fecundity interact and may be useful in explaining fertility differentials within and between urban and peri-urban communities.

In a subsistence farming community, inadequate food and uncertain provision availability could motivate changes to the behavioral or biological responses impacting birth outcomes (Panter-Brick 1996, Bongaarts 1993, Black et al. 2008). However, these responses have not been well investigated in a peri-urban context. The contextual details of peri-urban food insecure communities are not identical to those of rural, subsistence communities. The seasonal physical labor demands and seasonal resource constraints that lead to nutritional deficits brought about by reduced food availability and accessibility for poor people, however, are virtually the same (Ellis and Sumberg 1998, Zezza and Tasciotti 2010). Our goal is to apply to examine the experiences of poor, reproductive-aged women using the organizing framework previously applied to rural, high-fertility and food constrained communities. This research therefore examines childbearing within a peri-urban food insecure community on the outskirts of Ouagadougou, Burkina Faso.

Typically, communities assumed to be non-contracepting are the focus of studies of birth seasonality (Frisch 1974; Mosher 1979). Deliberate attempts to space births or to avoid birthing/pregnancy during specific periods of time associated with hunger periods is less studied. However, in peri-urban Ouagadougou a wide variety of contraceptive technologies are available in the nearby city at extremely low costs (Rossier and Hellen 2014). The availability of these technologies suggests that they can be employed to deliberately manipulate the timing of future pregnancies to reduce the costs associated with an ill-timed birth. The ways that food insecure women, those who are physically and psychologically coping with the stress of inadequate nutrition (see Black et al. 2008), perceive optimal birth and breastfeeding timing and use contraceptive technologies is not well understood.

Using five focus group interviews with mothers of young children, we explored participants' experiences with sex, pregnancy, miscarriage, contraception and breastfeeding in a context of routine food shortages. Specifically, the focus group data allowed us to examine the biological and behavioral determinants of births as they related to annual fluctuations in agricultural production in a peri-urban context. This research contributes to an improved understanding of women's reproductive goals, (unmet) contraceptive needs, and decision-making in highly food insecure environments in rapidly expanding urban areas. It also expands the ongoing discussion of demographic and psychosocial responses to food insecurity.

Birth Seasonality Framework

Past research has examined the relationship between nutrition, agriculture, fecundity, and fertility levels, often from an anthropological and demographic perspective, and with a focus on questions of seasonality (e.g., Huss-Ashmore 1988; Bailey et al. 1992; Ellison et al. 1993; Dorélien 2016; Philibert 2013). The idea is that when childbearing women face seasonal food constraints, their reproductive outcomes change in response. Bongaarts (1993) identifies six proximate determinants of birth seasonality that can be broadly categorized as either behavioral or biological (Panter-Brick 1996, Philibert et al. 2013). Duration of

postpartum infecundability, coital frequency, and age at marriage make up the behavioral components while the age at onset of sterility, intrauterine mortality, and conception failure are categorized as the biological components. Breastfeeding relates to biological as well as behavioral determinants as breastfeeding habits can change during periods of limited food or as a result of increased labor demands, which can then influence fecundity (Panter-Brick 1996). Some researchers argue that the behavioral responses, including seasonal outmigration, will have the greatest impact (Bongaarts 1993, 1980), while others suggest that the relative strength of biological or behavioral responses may vary according to the food security or environmental conditions (Panter-Brick 1996, Grace and Nagle 2015).

Food Insecurity in a Peri-Urban Setting

Food security is a state when food is available, accessible, usable and stable¹ (FAO, 1996; Brown et al. 2015). If there is a failure in any one of these four pillars, people are said to be food insecure. The food insecurity framework addresses the spatial, temporal, biological, economic, and psycho-social aspects of inadequate nutrition. This framework also creates a relevant connection between people who live in subsistence communities, where most research of the biological and behavioral determinants of birth seasonality has been focused, and poor people who live in peri-urban communities.

Rural and peri-urban communities face seasonal hunger periods for similar reasons – typically a failure in food availability or accessibility. The major difference between peri-urban and rural subsistence dwellers is that peri-urban populations may have greater access to markets where they can buy food, although seasonal price spikes and the necessity to buy rather than grow crops for subsistence may reduce the true usefulness of this strategy (Brown et al. 2009). Further, peri-urban residents may face additional vulnerabilities that are not experienced by rural dwellers because their agricultural plots are often on more marginal lands that are at risk of being sold or developed (Simon, 2008). Given the fact that both groups are typically seasonally nutritionally constrained in very similar ways (because of labor demands as well as limited food availability during the hunger season), we argue that birth outcomes reflecting the biological and behavioral reproduction strategies used to cope with food insecurity are likely similar.

Context: Burkina Faso

We conducted this study in Burkina Faso, a francophone country in West Africa and one of the least developed countries in the world (UNDP 2013). Households in the peri-urban zone of Ouagadougou exhibit livelihood diversification which combines crop production for sale and subsistence alongside non-farm income (Chagomoka et al. 2015, FEWS, 2010). The Ouagadougou area receives around 700 mm of rain a year, which falls during the summer months, from June to October. Peri-urban households that engage in agriculture tend to eat from their own harvest for as long as possible, and then to purchase food with cash obtained

¹The widely used FAO definition of food insecurity from which the four pillars are pulled is “when all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.” This definition is widely used but also is not without limitations that are beyond the scope of this article. Please see Barrett (2010) for further discussion on the concept and measurement of food insecurity.

by working in non-farm employment or selling market produce (in the rainy season), livestock, or harvested products such as wood or other wild plants (FEWS, 2010). Additionally, the farming activities are mostly the responsibility of women and they either sell what is produced or use it to feed their families. The seasonal hunger season exists because of this dependence on seasonal and rainfall-based production for most of the year when crops are available.

Approximately 16 percent of married women use some form of family planning for spacing or stopping births, including both modern and “traditional”² methods (INSD, 2012). Further, 74 percent of women indicate that they are aware of at least one method of contraception (INSD, 2012). The urban (combining the urban center with the peripheral areas) fertility rate is approximately 3.9 births per woman while the rural fertility rate is 6.7 births per woman (INSD, 2012). The differences in fertility rates between urban and rural dwellers may relate to unmet contraceptive needs or different cultural values associated with childbearing and family formation.

Peri-urban communities outside of Ouagadougou report fertility that is twice as high as that of the more established urban center, but that is still lower than rural areas (Rossier et al., 2011). The reasons underlying fertility differences that exist when comparing non-rural places are not well established (Weeks, 2010). For the inhabitants of central Ouagadougou compared to those of the peri-urban area, the differences may reflect the fact that many of the women in peri-urban areas are recent migrants from rural communities who may bring with them fertility regimes that reflect the rural sending communities (Rossier et al., 2011). Additionally, differences may reflect difficulty accessing services (*ibid*).

Methods: Focus Groups

Qualitative data was collected in a series of five group interviews in a peri-urban community, located on the outskirts of Ouagadougou. In total, 26 women participated in the focus groups, which ranged from 2–7 participants in each group. Criteria for inclusion in the study were that the women reside in the target community and that they have at least one child. The focus groups were conducted in the early afternoon between July 15th and July 18th, 2013. During the days leading up to the focus groups, a research associate prepared the terrain by visiting the community and informing residents that we would be conducting focus group interviews. Those who chose to participate arrived at the site at the specified time. Participants ranged in age from 19 – 32 years and had between 1 and 5 children. The youngest child was between 5 months to 3 years of age.

Focus group interviews were directed by our local research collaborator, and conducted in the local language of Mooré. The focus group protocol was semi-structured and each interview lasted approximately two hours. The protocol consisted of four main topics: hunger, pregnancy, birth spacing, and breastfeeding. We also included several probing questions to encourage discussion among the interview participants. Women were

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²Traditional methods include periodic abstinence, withdrawal and folk methods while modern methods include the pill, female and male sterilization, IUD, injectables, implants, male and female condom, diaphragm, and emergency contraception - See more at: <http://dhsprogram.com/topics/family-planning.cfm>

encouraged to talk amongst themselves, and were encouraged to talk about other subjects as they related to food and health. Focus groups were audio-recorded, and another local Mooré-French bilingual research associate translated and transcribed the focus groups word-for-word into French. The research associate who conducted the interviews then reviewed the translated transcriptions to ensure Mooré-French translation accuracy.

Data analysis was conducted by hand on the French transcriptions first using a bottom-up text coding technique, followed by top-down coding. We began by looking for themes within the data, and then conducted a second read to find additional evidence for the themes that emerged. The quotes used in the paper were translated by the third author, who has worked as a French-English translator, and then reviewed by the first author to ensure accuracy.

The Institutional Review Boards of the University of Utah and the National Health Ethics Committee of Burkina Faso approved the human subject protocols of this research in accordance with the Helsinki Declaration. We provided an oral summary of the consent form in Mooré at the onset of the focus group. No identifying information has been retained. We also do not provide the specific details of the community to protect participants' privacy.

Results

The following results present the main themes extracted from the focus group conversations. The participants described what it means to experience food insecurity or hunger and the biological and behavioral experiences related to childbearing outcomes in this food insecure community.

Definitions and experiences of hunger and its burdens for women

The discussion of hunger³ and food insecurity was based on a bilateral approach. We first asked participants to define “hunger” and to discuss their experiences with caloric insufficiency. Our results indicate that, rather than a purely physical sensation, hunger seemed to have hindered the participants psychologically and was characterized by insufficient food quality, quantity and diversity.

The women's experiences further indicated that household hunger was felt more acutely by women. Short- and long-term food security was important for women's physical and psychological health, and according to the participants, household hunger was a woman's issue. The men of this community, according to one focus group, are no longer interested in agriculture and prefer to work in the market selling shoes and other wares. Other women reported that children will not ask their fathers for money or food for fear that the fathers will react in anger. As a result, women are required to attend not only to their work in the field, but to the children's needs as well. Another participant noted that given the absence of men, tending to household chores and securing food and money for the household meant that “we are men and women at the same time.” The women felt stressed because they were

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³Because the concept of “food insecurity” is not meaningful to the participants, we first began our focus groups with discussion of hunger as an expression of food insecurity and what it means to the participants.

food insecure and felt additional stress because they were food insecure *and* responsible for providing for their children's needs.

Food insecurity and childbearing

We asked the participants directly about the relationship between hunger and fertility decisions, but we also included more indirect questions relating hunger and fertility planning in an effort to understand the topic from a variety of perspectives. For example, we addressed the seasonality of hunger and asked participants whether there were times of year when it was more difficult to be pregnant, or whether hunger affected women's ability to care for children.

In terms of the behavioral determinants, the most commonly mentioned behavioral component was sexual activity. The participants reported that hunger can affect marital relationships, increasing conflict and impacting the likelihood of conception during the hunger season. According to one participant,

During the hunger season, a man may say that his wife is unlucky, even though she's gone out searching in vain for food or work. When he was courting, he would never have called you unlucky – but now that you're his wife and the hunger season is upon you, he calls you unlucky. Hunger leads to accusations like that. He accuses you of being responsible for the situation you're in.

Not only does hunger bring increased stress to relationships, but during times of hunger, women reported being less interested in sex with their husbands. One participant stated,

Having all these kids, all you're going to do is make your hunger worse. But night falls, and your husband approaches you for sex – but you're unhappy because you're hungry. What do you do? Love-making is for when you've eaten. When you're hungry, how do you make love?

The physical and psychological toll of hunger can affect both a woman's desire to have sexual relations, as well as her ability to enjoy sex. Therefore, among this group of women we would anticipate observing decreased coital frequency during the hunger season, potentially leading to fewer conceptions.

In terms of biological experiences with food insecurity, the participants mentioned miscarriage as a major fear. They also discussed concerns over the health of a baby born during the hunger season as well as concerns over the birthing woman's survival during childbirth. The hunger season was characterized by increased physical labor for women and that physical taxation can be further exacerbated by the energy demands of pregnancy. Though women reported that they were unlikely to avoid pregnancy, the participants felt that this combination of hunger and labor can lead to negative pregnancy outcomes. One woman described her perspective on pregnancy during the hunger season:

The greatest sadness for a woman is to become pregnant during the hunger season. There are days where you want to reach in and pull out the pregnancy, just to have some peace. But since that's not possible, you just resign yourself to God's plan.

The negative consequences of undernutrition and physical labor during pregnancy on both mother and baby were also of concern to our participants. According to one woman:

It's recommended that pregnant women don't do too much physical labor. But after this interview, we're all going to work out in the fields, bent at the waist, even though that type of work is supposed to cause problems for the pregnancy. Only God can save us.

According to the participants, this type of physically taxing work is likely to bring about miscarriage, and one woman told the story of a friend (also present at the focus group) who attributed a lost pregnancy to the physically taxing, wage-earning labor of collecting sand. The participant reported that the pregnancy had been difficult and the woman had been ill, but it was not possible for her to rest and the result was a miscarriage.

For women who retained their pregnancies, there were concerns over her ability to endure labor:

A pregnancy during the hunger season is like a sickness. During labor, if the woman hasn't had enough to eat, she may have problems pushing the baby out. If you haven't eaten, you don't have the energy to birth a baby. It's a sickness, nothing more.

Still other women worried about the ill effects suffered by the baby. One participant described what happens to the baby when a mother has not had enough to eat:

There are people who bring their children to the health center, and you can see that their skin is wrinkled – wrinkled! The health center workers say that it's hunger that hurt the child, and that's why the child is so skinny. Essentially, the babies are born with just skin on their bones.

The ill-effects of pregnancy on mother and baby in a food insecurity context were well-understood by women, yet many women felt as though they had limited access to family planning services, or post-natal care once the baby was born.

Yet, despite women's understanding of the increased burden brought about by pregnancy and their understanding of the seasonality of food insecurity, women rarely expressed any deliberate determination to incorporate contraception into their lives. For some women, this was due to a sense that contraception was financially out of reach. For others, traditional methods of family planning do not seem realistic. Because of this, according to one woman, conception remains largely out of their control:

Sometimes, if you're fertile and you don't use contraception, by the time you realize that the hunger season is upon you, you're already pregnant. You have no other choice than to have the baby and suffer until the child grows up.

The participants observed the link between negative health outcomes and food insecurity in their own lives. However, despite the known seasonal periods of hunger, the identifiable difficulties, and the experiences with negative health outcomes for both the mother and the infant, participants did not indicate that they had successfully planned pregnancies to avoid certain times of year. Women, in fact, felt as though pregnancies were unavoidable and

brought by God. During the focus groups, we directly asked the participants “would you avoid pregnancy during a hard year or a bad season” and the women simply laughed.

The role of breastfeeding

Breastfeeding reflects an interaction of behavioral responses as well as biological responses. Breastfeeding is time intensive, increases that mother’s caloric needs and also can suppress ovulation. We discussed breastfeeding with the participants to determine if they modified their breastfeeding behaviors under hunger conditions. Our participants reported that hunger was most difficult to endure immediately following pregnancy when a woman was breastfeeding. When asked about the difficulties of nursing during the hunger season, one woman responded,

It’s when you have a baby in arms that hunger is most severe. You nurse the baby without having eaten – and you can’t even walk, you’re so dizzy. All the baby does is nurse, and you don’t even have any milk in there.

Yet despite the physical discomfort associated with nursing, and the fear that milk quality and quantity were insufficient, all of our interview participants stated the health benefits of nursing. This understanding of nursing may be due to campaigns by health workers to promote breastfeeding until the age of two. One woman noted health workers encourage breastfeeding, to ensure strong, healthy children:

When my child goes to school, no other kid will be able to knock him down with a punch. He’ll be resistant. If he’s not breastfed, he’ll end up sickly, he’ll get diarrhea.

In this case, too, women were aware of the importance of good nutrition in ensuring good health. However, rather than their own health, women commented more frequently on the quality of their milk – and how milk quality and quantity was related to the quality of their diet. According to one participant, food insufficiency was likely to lead to poor milk supply:

Nursing women are discouraged from fasting⁴, because that can influence the quality of their milk. When you’re fasting, when you haven’t had anything to drink or eat, it can cause a reduction in your milk supply.

For others, hunger leads to poor quality milk:

During the hunger season, when the child nurses – he doesn’t get any milk. It’s a liquid, but there’s nothing [healthy] in it.

Insufficient quantity and reduced quality milk, coupled with the increased physical burden, caused significant distress in women. Combining the discussion of breastfeeding with the discussion of the physical costs of pregnancy, the entire period from early pregnancy through weaning, represents a stressful period where the participants were concerned about maintaining a pregnancy, surviving labor/delivery, producing a healthy baby, and managing the physical demands of breastfeeding to support their child. Ultimately, childbearing as a

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⁴Annual fasting occurs in observation of Ramadan.

person who has inconsistent food access and availability is a physical burden that impacts both their physical and psychological wellbeing.

Despite the challenges associated with breastfeeding, all of the participants reported that they had breastfed all of their children, and planned to continue doing so. When asked whether the participants would consider bottle-feeding, one woman responds, “and how do you suggest we do that?” She went on to explain,

If you have no job, where are you going to find the money to buy a bottle? That’s only an option when you have a husband who has a job, who can give you permission to buy a bottle at 3,500 francs CFA [approx 6 USD]. Until then, the baby gets the breast.

When a day’s food costs approximately 600 francs CFA [approx 1.02 USD], spending nearly six times that amount on a bottle⁵ is unrealistic to most women. However, even the option of switching to solid foods was frowned upon by the participants. Some women stated that the comfort that babies derived from nursing was sufficient reason to continue, while others stated that they preferred to suffer themselves, than to see their children suffer. One participant echoed the sentiment of many when she stated:

Even if it meant that I would die from hunger, I would continue to nurse my baby. Let hunger take my life, so long as it doesn’t take my baby’s.

The women who participated in our study saw themselves as the last line of defense protecting their children from lack of sufficient food and nutrition.

There was some disagreement among women as to whether it was appropriate to stop breastfeeding their children before two years of age. One woman said that, given the poor quality of the milk and the discomfort to the mother, completely weaning the child before two years of age was a reasonable solution:

Yes, as I said, if a woman isn’t eating enough, there’s no milk. It’s better to wean the child and to pray to God that the situation improves. If hunger is making you weak, you’re going to eventually end up weaning, anyway.

However, her perspective was unique among the participants. The other women thought it was better to continue breastfeeding, even if it required supplementing with solid foods. For many women, continuing to nurse during the hunger season was a question of compassion. Breastfeeding represented a continued safeguard from the hunger that surrounded the women and their children.

Discussion and Conclusion

In this study, we investigated the biological and behavioral aspects of childbearing among poor, food insecure women in a peri-urban community in Ouagadougou. We used this framework because it was, at least partially, designed to measure the different sources of fertility variation amongst agriculturalists. The participants in the study lived on the

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⁵Infant formula would add an additional cost but this was not mentioned in the focus groups.

periphery of Ouagadougou where they faced reduced food availability and food access during some parts of the year – namely during the rainy season when they were interviewed for this study. Food insecurity is a common characteristic of peri-urban environments as these communities face limited access to the benefits of either rural or urban places (Lerner and Eakin, 2011). The participants observed wealth in the cities and provided cheap labor for city-based industries, but were not able to access the resources that a city could provide (such food, health-care, and lower cost transportation). They engaged in agricultural activities, but were not able to grow enough of their own food.

In terms of the behavioral responses related to fertility outcomes, our results suggest a reduction in sexual activity during the hunger season - at least in terms of women's desires to engage in sex with their partners. Despite mention of early weaning, we do not see any strong evidence of women changing their breastfeeding behaviors. Changes to breastfeeding frequency during a given day were not discussed, but the participants never indicated that they had modified their behavior at any point in the year. Breastfeeding behaviors were associated with the psychological and physical health of child and were considered, by almost all of the women, as non-negotiable.

In terms of the biological responses, the participants identified some biological responses as being significant. Namely, they identified miscarriage and stillbirth as real tolls when physical labor needs and the hunger season overlapped. Women did not report any difficulty getting pregnant at any point, so we cannot comment on the perceptions of or experiences with failed conceptions. Onset of sterility was also not relevant in this case as, according to informal conversations with both men and women in Ouagadougou, there is a strict upper age limit for bearing children, age 35. This age limit reflects a strong cultural preference and is not negotiable. Further, while not one of the six fertility determinants, but strongly related to a sense of security, women also felt as though their lives were at risk if they were to give birth during the hunger season or their babies' health was at risk if they were born during the hunger season. Overall the behavioral versus biological framework was helpful in organizing the research and provides a structure for evaluating the way that demography interacts with food insecurity. Given the widespread knowledge (and sometimes access) to contraception, the framework might benefit from incorporating more recent discussions of unmet contraceptive need and barriers to use of family planning technologies

In many ways, our participants felt their only recourse was to sacrifice their own physical and emotional wellbeing. To meet the needs of their children, they breastfed during periods of extreme hunger and to meet their partner's sexual needs, they engaged in sexual activity that might lead to additional pregnancies. They knew that adding additional children to the household would increase household demand for food, but ultimately the lack of interest in, or understanding of, contraception created situations where pregnancy was more likely to occur. The participants did not view the solution to their food insecurity and hunger and the associated stresses as being related to breastfeeding changes or to changes in their fertility.

The women in our study struggled with feelings of anxiety as they observed their young children cope with hunger. Yet, these women rarely did anything to avoid pregnancy. They either saw themselves as passive recipients of pregnancy (rather than active participants in

the choice to reproduce) or they were not interested in altering their fertility. It is important to note that this community has had visits from development agencies and health agencies and they had access to very low cost birth control in Ouagadougou, yet they still opted out of using contraception. Ongoing research of unmet contraceptive need in contemporary West Africa should include the special needs of peri-urban poor women, who are living between subsistence agricultural and urban worlds. Further investigation that moves away from interacting with women as being passive victims of food insecurity and resource constraints, may help to shed light on to the reasons underlying their attitudes towards reproduction.

References

1. Bailey RC, et al. The ecology of birth seasonality among agriculturalists in central Africa. *Journal of Biosocial Science*. 1992; 24(03):393–412. [PubMed: 1634568]
2. Barrett, Christopher B. Measuring food insecurity. *Science*. 2010; 327(5967):825–828. [PubMed: 20150491]
3. Black, Robert E., et al. Maternal and child undernutrition: global and regional exposures and health consequences. *The Lancet*. 2008; 371(9608):243–260.
4. Bongaarts J. Does malnutrition affect fecundity? A summary of evidence. *Science*. 1980; 208(4444): 564–569. [PubMed: 7367878]
5. Bongaarts, J. The relative contributions of biological and behavioral factors in determining natural fertility: A demographer's perspective. In: Gray, Ronald, Leridon, Henri, Spira, Alfred, editors. *Biomedical and Demographic Determinants of Reproduction*. Oxford: Clarendon Press; 1993. p. 9–18.
6. Brown, ME., Antle, JM., Backlund, P., Carr, ER., Easterling, WE., Walsh, MK., Ammann, C., Attavanich, W., Barrett, CB., Bellemare, MF., Dancheck, V., Funk, C., Grace, K., Ingram, JSI., Jiang, H., Maletta, H., Mata, T., Murray, A., Ngugi, M., Ojima, D., O'Neill, B., Tebaldi, C. USDA Technical Document. United States Department of Agriculture; Washington DC: 2015. *Climate Change, Global Food Security, and the U.S. Food System*.
7. Brown ME, Hintermann B, Higgins N. Markets, Climate Change, and Food Security in West Africa. *Environ Sci Technol*. 2009; 43:8016–8020. [PubMed: 19924916]
8. Brown ME, Funk CC. Food Security Under Climate Change. *Science*. 2008; 319(5863):580–581. [PubMed: 18239116]
9. Chagomoka T, Drescher A, Glaser R, Marschner B, Schlesinger J, Nyandoro G. Contribution of urban and periurban agriculture to household food and nutrition security along the urban–rural continuum in Ouagadougou, Burkina Faso. *Renewable Agriculture and Food Systems*. 2015:1–16.
10. Dorélien A. Birth seasonality in Sub-Saharan Africa. *Demographic Research*. 2016; 34:761–796.
11. Ellis F, Sumberg J. Food production, urban areas and policy responses. *World Development*. 1998; 26(2):213–225.
12. Ellison PT, Panter-Brick C, Lipson SF, O'Rourke MT. The ecological context of human ovarian function. *Human Reproduction*. 1993; 8(12):2248–2258. [PubMed: 8150934]
13. Famine Early Warning System (FEWS). Livelihood zoning and profiling report: Burkina Faso. 2010. http://www.fews.net/docs/Publications/bf_profile_en.pdf
14. Frisch RE. Population food intake and fertility. *Science*. 1978; 199(4324):22–30. [PubMed: 17569482]
15. Grace K, Nagle NN. Using High-Resolution Remotely Sensed Data to Examine the Relationship Between Agriculture and Fertility in Mali. *The Professional Geographer*. 2015; 67(4):641–654.
16. Huss-Ashmore R. Seasonal patterns of birth and conception in rural highland Lesotho. *Human Biology*. 1988:493–506. [PubMed: 3391588]
17. Institut National de la Statistique et de la Démographie (INSD) and ICF International. *Enquête Démographique et de Santé et à Indicateurs Multiples du Burkina Faso 2010*. Calverton, Maryland, USA: INSD and ICF International; 2012.

18. Lerner AM, Eakin H. An obsolete dichotomy? Rethinking the rural–urban interface in terms of food security and production in the global south. *The Geographical Journal*. 2011; 177:311–32. [PubMed: 22180921]
19. Mosher SW. Birth seasonally among peasant cultivators: The interrelationship of workload, diet, and fertility. *Human Ecology*. 1979; 7(2):151–181. [PubMed: 12262790]
20. Panter-Brick C. Proximate determinants of birth seasonality and conception failure in Nepal. *Population Studies*. 1996; 50(2):203–220. [PubMed: 11613333]
21. Philibert A, Tourigny C, Coulibaly A, Fournier P. Birth seasonality as a response to a changing rural environment (Kayes region, Mali). *Journal of Biosocial Science*. 2013; 45(4):547–565. [PubMed: 23231921]
22. Rossier C, Hellen J. Traditional birthspacing practices and uptake of family planning during the postpartum period in Ouagadougou: qualitative results. *International Perspectives on Sexual and Reproductive Health*. 2014; 40(2):87–94. [PubMed: 25051580]
23. Rossier, C., Lankoande, B., Ortiz, I. Fertility differentials in formal and informal neighborhoods of Ouagadougou. 6th African Population Conference; 5–9 December 2011; Ouagadougou, Burkina Faso. 2011. <http://uaps2011.princeton.edu/sessionViewer.aspx?SessionId=151> (cited 8 January 2013)
24. Simon D. Urban Environments: Issues on the Peri-Urban Fringe. *Annual Review of Environment and Resources*. 2008; 33:167–85.
25. World Health Organization (WHO). Trends in maternal mortality 1990 to 2008: estimates developed by WHO, UNICEF, UNFPA and World Bank. Geneva: World Health Organization; 2010.
26. United Nations Development Program (UNDP). 2013 Human Development Report. New York, NY: 2013.
27. United Nations (UN), Department of Economic and Social Affairs, Population Division. *World Fertility Patterns 2015 – Data Booklet*. 2015.
28. WHO/UNICEF. Progress on Sanitation and Drinking Water – 2015 update and MDG assessment. World Health Organization; Geneva: 2015.
29. World Food Summit. Rome Declaration on World Food Security. Food and Agriculture Organization of the United Nations; Rome: 1996.
30. Zezza A, Tasciotti L. Urban agriculture, poverty, and food security: Empirical evidence from a sample of developing countries. *Food policy*. 2010; 35(4):265–273.