Evaluating Limitations of Current Policies Addressing Climate Change-Induced Food Insecurity: A Narrative Review in the Context of Late Menarche in African Females

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Menarche is a critical developmental milestone signalling the onset of female reproductive function. Food insecurity, induced by climate change, has contributed to irregularities in menarcheal age, which has been linked to potential harmful disease outcomes. Specifically, the incidence of a late menarcheal age has been observed in Africa. Various climate impacts, influenced by existing socio-economic conditions, cause Africa to be disproportionately impacted in the incidence of late menarche in adolescent females. This narrative review aimed to examine existing policies impacting health risks associated with late menarche, that are a consequence of climate change-induced food insecurity. Potential policy solutions included the utilization of renewable energy sources, climate-smart agriculture initiatives, and social cash transfer programs. These policies were appraised relative to the African context; barriers to successfully implementing these policies were found such as misalignment of governance objectives, limited financial evaluation, lack of contextual considerations during policy design, and the inability to foresee unintended consequences. These insights highlighted the importance of contextual factors, trade-offs, and contingencies when creating such policies and were used to inform suggested future directions for policy frameworks.

Motivation

In the determination of basic needs for survival, three items are always among consensus: food, water, and air. However, what happens when these fundamental needs are challenged by the effects of climate change? How do these effects translate to different demographic populations? When aiming to distinguish between demographic implications, it is vital to examine the interrelatedness of these effects on the population of focus. Historically, this has been a challenge in consideration of sex-specific effects, as it was not until after the 1990s when the research community saw a shift towards increased inclusion of women in clinical trials research, after reports of underrepresentation of women in biomedical research. For this demographic, menarche is a critical period. With the potential for climate change-induced food insecurity to disproportionately affect females, including their menarcheal age, it is exceedingly important now to be inclusive of this demographic in conversations on mitigating the adverse effects of climate change.

Introduction

Climate and Food Insecurity

While difficult to quantify, Health Canada defines food insecurity as the inability or uncertainty in acquiring or consuming a sufficient quality or quantity of food in a socially acceptable manner.[1] Food insecurity has proven to be a notable outcome in the context of climate change. This is a result of climate change having the potential to impact agricultural systems by disrupting areas for specific crop growth, therefore disturbing the supply of food.[2,3] An experimental study found that controlled temperature increases of 1.3°C and 2.6°C in maize cultivation resulted in a yield decrease between 91%-98%.[3] As a result, climate factors, such as rising temperatures, can have disastrous effects on food production and, in turn, deprive a population of nutrients. Further, soil degradation, water stress, and desertification are additional climate change factors predicted to aggravate existing fragile food production systems, particularly impacting essential crops such as wheat, maize, soybeans, and rice.[4,5] It was predicted that stress caused by temperature increases will be specifically prominent in East and Southern Africa, North and South India, Southeast Asia, North Latin

America, and Central America, creating substantial changes to which agricultural systems must adapt to.[6] In contrast, wealthyregions such as North America, Europe, and Australia, which define food insecurity as the limited access to foods with nutritional value despite the availability of food,[7,8] are projected to have the lowest global impact of climate change induced food insecurity,[9] reinforcing disparities in an increasingly globalized world. Individuals in developing regions, primarily those who rely on agricultural sources of income, are disproportionally affected by the impacts of food security caused by climate change, suggesting a higher potential prevalence of rural poverty in these regions.[10]

Food Insecurity and Menarche

Menarche is noted as the onset of the physiological changes that represent a female's reproductive ability, as this is the first occurrence of menstruation, which normally happens during adolescent years.[11] The onset of menarche is strongly associated with an adolescent female's nutritional status, as menstruation will not commence until a female is expresses full reproductive potential, which is primarily dependent on adequate nutritional status.[12] This makes females sensitive to the effects of climate change-induced food insecurity, where there are increased nutritional demands leading up to and during menstruation.[13] The average age of menarche is around 12.4 years, but it can appear between the ages of 9 to 15 years of age.[14] In the western world, age at menarche has been found to be decreasing since the 1800s, primarily explained by enhanced quality of life and nutritional status.[15] However, with climate change impacting security of food supplies, this poses a threat to trends of menarcheal age for future generations. It has been found that specific nutritional factors can lead to a later age at menarche.5 Specifically, lack of adequate nutrients because of food insecurity has been found to be a factor leading to a later age at menarche.[5] Food insecurity and its effects on age at menarche can be seen where the mean age is higher for adolescent females from developing countries compared to those of developed countries.[16] In a nationally representative study in Colombia, it was found that while child height and body mass index (BMI), maternal BMI and education, and family wealth were inversely associated with age at menarche, food insecurity was positively associated with menarcheal age.[17]

In the past, females in arid regions have been found to be vulnerable to the effects of climate change through decline of natural resources that may lead to malnutrition, food, and water-borne illnesses.[18] A study conducted in 2013 has highlighted the larger impact of adverse climate events on the well-being of females in Bangladesh due to societal gender disparities.[19] With the household 'food hierarchies', in which men often receive a higher priority in regard to food consumption when quantities are limited, females of reproductive age are more likely to be nutritionally deficient.[19] For instance, protein deficiencies may be exacerbated in these regions,[18] and high protein intake is a nutritional factor attributed to early age of menarche,[5] therefore, it is important for females to have a balanced, nutrient-rich diet. Later menarcheal age is detrimental to female health as it leads to risk of disease consequences. Brooks-Gunn and Warren found that females with late menarche within a sample group had lower weights, possessed lean body types, and had lower eating scores when compared to females with on-time menarche.[20] Low body weight is often associated with lower bone mineral density, leading to higher risk of fractures, specifically at the lumbar spine and hip.[21] This lower bone mineral density leads to increased risk of osteoporosis.[11] For instance, a Japanese study found that females who experienced later menarche (> 14 years) were two times are likely of low areal bone mineral density at the hip before 40 years of age.[22] Other health risks associated with late menarche include depression within adolescent years, symptoms of social anxiety, fetal loss and Alzheimer's disease.[5,11,23] It is important to note that early menarche, when compared to on-time menarche, is also associated with health consequences, including increased risk of cardiovascular disease and breast cancer.[24,25]

Late Menarche in African Adolescent Females

In Africa, 21% of the population (1 in every 5 individuals) were facing hunger in 2020.[26] In a similar timeframe, it was found that prevalence rates of food insecurity in North America ranged from 14.8%-43.0%.[27] Due to its large population, multiple environmental stressors, and low climate adaptation, Africa is disproportionately affected by climate change, despite the continent being comparatively less responsible for anthropogenic drivers.[28] Africa's complex climate context further adds to increased climate change concerns, as it is the sole continent to be located almost equally within the northern and southern hemispheres, resulting in its numerous climate zones.[28] Further, in a global climate change analysis, Africa was reported to have a very high prevalence of undernourishment, as a result of high food insecurity.[9] This is due to factors such as drought, soil erosion, and Africa's significant dependence on agricultural activities.[29] Additional factors such as poor diet quality, low income, and high population growth within Africa further increase food insecurity prevalence.[30] In fact, a report from 2020 stated that the undernourishment prevalence in Africa in 2019 was 19.1% of the population, representing 250 million undernourished people.[31] This prevalence is the highest regional rate globally, and over twice the global rate of undernourishment.[31]

Various studies have found that African females are more likely to experience later menarche compared to their western counterparts, with a median age of 15 years old.[32] Further, African females residing in urban areas of the continent, such as affluent areas of South Africa, experienced menarche at similar ages to those found in western countries, with nutrition being a possible associative factor.[32] The implications of food insecurity on age at menarche in Africa are evident where the food-insecure group of adolescent females from the Jimma Zone in Southwest Ethiopia, had, on average, a year delay compared to their food-secure counterparts (15 years and 14 years of age, respectively).[33] The group of adolescent females with stunted nutritional status also experienced a one-year delay compared to the normal nutritional status group.[33] Both groups, however, had later age at menarche compared to adolescent females from developed westernized countries, where the age at menarche is around 12 years old.[11,16] Factors that led to an earlier age in menarche in these countries include environmental factors such as parental education,[34] family structure,[35] the lack of war conditions,[36] etc. This further exhibits the relationship between food insecurity in climate change-induced adverse conditions and an increased age at menarche, compared to countries with high food availability.

Current Policies Addressing the Issue

As food insecurity in Africa and its resulting effects on adolescent females is a multifaceted challenge, policy should stem from various contexts. Current policies within Africa have illustrated impactful steps taken to address climate change and its resulting food insecurity, with implications on Africa's most vulnerable populations. This inquiry will cover three existing policies in practice aimed at addressing the issue of climate change-induced food insecurity.

Inquiry Objectives

The inquiry objectives of this narrative review include:

» Reviewing existing policies impacting health risks associated with late menarche induced by climate change-related food insecurity in Africa.

» Commenting on learnings that arise from the shortcomings of existing policies while critically appraising policy viability relative to this climate health issue.

» Informing future direction on policy frameworks based on insights from analysis.

Current Policies in Practice

Utilizing Sources of Renewable Energy

A viable policy solution in practice is the utilization of renewable energy sources, which will also aid in providing equitable energy access for poorer communities in Africa.[37] Renewable energy sources are energy resources that have the potential to be renewed at, or close to, the existing energy consumption of the resource.[38] Renewable energy sources within Africa have risen at a rate of 10% annually between 1995 and 2017, and are predicted to grow at a higher rate in the coming years,[37] including sources such as wind, solar and biomass energy.[39] An example of a renewable energy project is the utilization of wind energy in South Africa.[40] When renewable energy is integrated with agricultural practices, food can be produced at lower prices, in turn increasing food security for vulnerable populations. With greater food security, adolescent females can have sustainable access to the nutrients required to prevent late menarche.

Climate-Smart Agriculture Practices

Smart agriculture policies and improved agricultural practices are beginning to become implemented within African countries.[37] Climate-smart agriculture (CSA) allows for the shifting of agricultural systems to address issues related to climate change-induced food insecurity.[41] For instance, the World Bank has worked to adopt CSA policies, such as creating shade trees in Uganda over coffee plants.[42] These shade trees effectively reduce the temperature over farmland and avoid loss of crop yield, allowing for increased cultivation.[42] Policies in CSA can assist in addressing the issue of late menarche in Africa by mitigating the loss of agriculture, which would otherwise contribute to food insecurity.

Social Cash Transfer Protection

Addressing poverty through reduced income inequality is illustrated as a significant factor in combating climate change in an empirical study.[43] One policy solution by the International Labour Organization (ILO) is the use of social protection to combat food insecurity, including potential money transfers to the poor, or directly organizing food programs within poor communities.[30] These programs could be targeted within specific areas, such as schools, thus protecting children, who are the most vulnerable group to malnourishment.[30] A specific policy is the "Child Grant (CG) model of the Social Cash Transfer (SCT) Program" in Zambia, where a household with a child under five is eligible for a cash transfer.[44] This program solicited an increase in the per-capita food expenditure, allowing for individuals to spend more on food than before.[44] When policy favours the nutrition of children, specifically females, and provides access to nutrient-rich foods, it can prevent late menarcheal age.

As previously mentioned, Africa is a low contributor of anthropogenic factors leading to climate change,[27] and a global effort is needed to combat climatic effects in Africa. Suffice it to say that policy in African nations alone is unlikely to solve the continental prevalence of food insecurity-induced late menarche. Therefore, solutions incorporating a multifaceted approach building on research and evaluation must be sought to address this ongoing issue.

Policy Limitations and Considerations

According to the United Nations, the total population of Africa was reported to be 1.34 billion in 2020.[45] This number is expected to increase by almost 100% by 2050.[46] In terms of demographic characteristics, 60% of Africa's population was reported to be under 25 years of age in 2019; making the youth population a significant proportion of the total population.[47] These changing demographic trends will also increase the agricultural demand, requiring systems to adapt to avoid food insecurity.[46]

Renewable Energy Sources

Considerations for policy implications in renewable energy sources must reflect the interests of the various actors that are involved with the implementation of such sources. As a result, divergent interests and equity concerns may be a source of conflict and potential implementation failure, which may prevent the true benefits of renewable energy sources from taking place, such as agricultural systems that operate with high efficiency. Another essential consideration relates to the infrastructural financing that is required for renewable energy to be implemented; a factor that can prevent specific regions of Africa from policy participation due to financial inequities, further exacerbating food insecurity.[48] Government willingness to participate and subsidize renewable energy projects is also something policymakers must consider with respect to the government's financing objectives.[48] For example, the South African Government was uncooperative during the implementation of a renewable energy project focused on wind energy, because the government failed to prioritise green energy as a policy objective.[40] Failure to recognize certain policy objectives can result in the divergence from a multidimensional policy. Finally, another key consideration is the land usage in the region of implementation, specifically relating to outcomes for land transformation. Transforming land from agricultural to renewable energy purposes requires the securing and occupation of land which can generate positive externalities that are difficult to realize and gain from for landowners.[49] This is observed in large parts of Africa, where willingness to facilitate land transfer remains lacking.[49] Further, when landowners allocate their land to build renewable sources of energy, they risk losing what was previously cultivated (even if it is temporary), further impacting crop security. This crop insecurity can deprive communities of nutrients required for adequate growth during vital periods, including the time leading up to menarche.

Climate-Smart Agriculture

Although the realisation of climate-smart agriculture (CSA) practices confers a multitude of opportunities in both the economic and environmental dimensions, its adoption amongst smallholder farmers in Africa is low.[50] In order to implement CSA practices, it is imperative that external parties are mindful of the traditions and beliefs of smallholder farmers.[50] In Kenya, a study conducted in 2021 found that 25% of red meat value chain actors discouraged CSA TIMPS (technology, innovation, and management practices) adoption as it did not align with their prevailing nomadic traditions and religious beliefs.[51] CSA cannot be effectively implemented until these characteristics are contextualized through CSA practice and sufficient trust is established to ensure farmers are eager and willing to acquire knowledge on novel agricultural practices and engaging with previously unexplored markets. Engaging with new markets can help to introduce agricultural goods in communities which may face barriers related to food security. Another important consideration is the need to establish successful and professional partnerships between farmers and communities in addition to organizations (both public and private) to enable the scalability of CSA and co-learning activities for all engaged parties. This was not the case with the partnership between farmers and the Bank of Agriculture in Ebonyi, Nigeria, where high interest rates set by the bank made it extremely difficult for farmers to pay back loans, causing them financial difficulties.[52] Considerations associated with the affordability of CSA practices arise when the issue of institutional support systems for farmers are made apparent,[50] creating barriers to enabling and upscaling CSA practices. For example, in Ethiopia, farmers ceased the usage of water harvesting technology systems when they were faced with a shortage of resources, specifically in the construction, maintenance and operations of the respective technologies.[53] This shortage of resources contributed to decreased operating efficiencies, despite being enacted to combat negative effects of climate change. This likely impacted the final cultivation potential and in turn contributed to an increased incidence of food insecurity. As previously mentioned, this has the potential to influence the menarcheal age due to unavailability of necessary nutrients.

Social Cash Transfer Program

Despite the short-term benefits from social cash transfer programs, these initiatives may bring forth many negative externalities leading to long-term implications for vulnerable populations. One of these externalities includes inflation of food prices. For instance, the Productive Safety Net Programme (PSNP) has distributed cash or transported food to millions of Ethiopians since 2005.[54] This program has aimed to tackle food insecurity through timed operations during "hungry season". However, it has been found that these cash transfers may have led to inflation of food prices, due to the reduction of market supplies, with farmers no longer needing to sell their products.[54] In addition, money transfer programs may fail to account for variations in food prices across regions or seasons. This was also a challenge faced by beneficiaries of PSNP in Ethiopia as cash payments did not consider regional differences or price fluctuations due to seasonal changes, thus making access to the same food a challenge year-round.[54] Moreover, inflation effects are not necessarily taken into consideration for adjustment of cash transfers. Consequently, such programs are challenged with beneficiaries' preferences shifting to food aid as found with the recipients of the PSNP in Ethiopia.[54] Furthermore, cash transfer programs may fail to account for other factors such as consistency of distributions. Recipients of a social welfare program in Zimbabwe reported that they have not increased their food consumption due to inconsistency of distributions, limiting improvement of food access.[55] Despite that the objective of these policies is rooted in tackling food insecurity through monetary aid, the anticipated implications were not realized. In some cases, these policies could have even promoted food insecurity further, notwithstanding their perceived benefits. Thus, such policies failed at delivering the sustainable food supplies necessary for adequate growth and development of females.

Future Considerations

In aiming to resolve the issue of climate change-induced food insecurity and its effects on age at menarche, it is important to consider the policies that have been created to facilitate a situational improvement for those who face this issue. Several key themes have been identified through evaluating the considerations related to each type of policy, namely governance objectives, financial awareness, and unintended consequences. Future policy frameworks should consider the inherent connectivity of these themes and integrate them to holistically enact policy. Future considerations in governance objectives should be mindful of the accountability and responsibilities associated with decisions, particularly when they have long-reaching implications, as seen in the discussed cases. With respect to future considerations in financial awareness, it is essential that trade-offs are critically examined, particularly when dealing with projects that involve a high level of investment. In developing regions like Africa, decisions should incorporate the needs of local communities, particularly factors that may impact population health. Every effort should be made to identify and address exploitation across all actors involved with financial processes that arise from policy, enabling equitable and transparent financial engagement. For future considerations related to unintended consequences, policymakers should incorporate corresponding contingencies, integrating the needs of all involved parties. These contingencies should be cognizant of risks that proposed policies carry. Such contingencies can mitigate the creation of barriers that further marginalize and associate inequities with specific parties to whom unintended consequences impact, a recurring notion seen throughout the policy considerations in this study. In doing so, specific research about the direct implications of these solutions on the populations of focus is warranted. Further research should also be directed at investigating the relationship between climate change and menarcheal age with food insecurity as a mediating factor.

A limitation of this review is that existing policies do not consider changes in age at menarche as a measured outcome. However, they remain possible holistic solutions to combat climate change's indirect impact on menarcheal age. This relationship is heavily multifaceted and should be investigated in a direct manner.

Conclusion

As illustrated within this narrative review, climate change detrimentally impacts global agricultural systems, thus increasing food insecurity within vulnerable regions. Food insecurity can delay menarche within young females, leading to harmful disease consequences due to the lack of essential nutrients consumed during developmental phases. Africa is disproportionately affected by climate change-induced food insecurity due to its large and growing population, multiple environmental stressors, and low climate adaptation. Moreover, regional differences depict limitations in adopting a uniform policy approach. To address the downstream menarcheal consequences of climate change-induced food insecurity on African adolescent females, renewable energy sources, smart agriculture programs, and social-cash transfer programs have been suggested as potential solutions. Both the shortcomings of current policies and the various barriers to future policy implementation must be considered, in addition to African cultural and social contexts to ensure higher probability of success. A multifaceted approach which considers trade-offs and contingencies is suggested to tackle the drivers of climate change-induced food insecurity and its consequential female health outcomes in Africa.

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