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The impacts of climate change on food consumption, household income, and child nutrition in Boseth District, Kampong Speu Province, Cambodia

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សង្ខិត្តន័យ

ការប្រែប្រួលអាកាសធាតុបានក្លាយទៅជាបញ្ហាប្រឈមដ៏ធំមួយចំពោះការអភិវឌ្ឍប្រកបដោយចីរភាពនៅក្នុងបណ្តាប្រទេសដែលមានប្រាក់ចំណូលទាប។ ការប្រែប្រួលអាកាសធាតុបានជះឥទ្ធិពលលើស្បៀងអាហារនិងសុខភាពមនុស្ស ជាពិសេស អាហារូបត្ថម្ភរបស់កុមារ។ កង្វះអាហារូបត្ថម្ភក្នុងសព៌ាង្គកាយកុមារ គឺបណ្តាលមកពីការទទួលទានអាហារមិនគ្រប់គ្រាន់ និងការកើតជំងឺផ្សេងៗ ដែលធ្វើឱ្យរាងកាយកុមារខ្វះសមត្ថភាពស្រូបយកសារធាតុចិញ្ចឹមពីអាហារ។ កម្រិតនៃកង្វះអាហារូបត្ថម្ភដែលអាចកើតមានក្នុងរាងកាយទារក និងកុមារត្រូវបានវាស់វែងដោយសូចនាករមួយក្នុងចំណោមសូចនាករចំនួនបីគឺ៖ មិនគ្រប់ទម្ងន់ ក្រិន និងក្រិស។ ការស្រាវជ្រាវនេះបានអនុវត្តវិធីសាស្ត្រចម្រុះ ដើម្បីសិក្សាពីផលប៉ះពាល់នៃការប្រែប្រួលអាកាសធាតុលើអាហារូបត្ថម្ភរបស់កុមារនៅស្រុកបរសេដ្ឋ ខេត្តកំពង់ស្ពឺ ដែលជាតំបន់ជនបទនៃប្រទេសកម្ពុជា។ ការសិក្សានេះបានរកឃើញថា៖ (1) ការប្រែប្រួលអាកាសធាតុមិនត្រឹមតែប៉ះពាល់ដល់ប្រាក់ចំណូលគ្រួសារប៉ុណ្ណោះទេ ថែមទាំងមានផលប៉ះពាល់រយៈពេលវែងជាច្រើនសណ្ឋានផ្សេងទៀតលើការវិវត្តរបស់កុមារ ដោយសារបញ្ហាសុខភាព និងកត្តានានាដែលបណ្តាលឱ្យមានភាពតានតឹងក្នុងចិត្ត របបអាហារនិងការទទួលទានប្រូតេអ៊ីន មិនគ្រប់គ្រាន់ ការផ្តល់អាហារមិនល្អ ការថែទាំស្ត្រីនិងកុមារមិនបានល្អ និងបន្ទុកគ្រួសារផ្សេងទៀត; (2) អ្នកភូមិដែលមានប្រាក់ចំណូលក្រោមបន្ទាត់ក្រីក្រត្រូវប្រឈមនឹងការខ្វះស្បៀងគ្រប់ពេល ហើយថែមទាំងងាយរងគ្រោះជាពិសេស ក្នុងអំឡុងពេលនៃការប្រែប្រួលអាកាសធាតុនិងភាពតានតឹង។ ការទទួលទានអាហារមិនគ្រប់គ្រាន់តាមការណែនាំថ្នាក់ជាតិស្តីពីការប្រើប្រាស់អាហារជោគីដែលជាកត្តាសំខាន់បំផុតដែលបណ្តាលឱ្យមានកម្រិតកាន់តែខ្ពស់នៃការខ្វះទម្ងន់ ក្រិន និងក្រិសរបស់កុមារ; និង (3) នីតិវិធីក្នុងការធានាឱ្យមានការថែទាំល្អ និងការបំបៅឱ្យបានគ្រប់គ្រាន់មានសារសំខាន់ណាស់ចំពោះទារកចាប់ពីពេលកើតរហូតដល់អាយុ៥ឆ្នាំ ដើម្បីឱ្យមានអាហារូបត្ថម្ភកាន់តែប្រសើរដែលជួយឱ្យប្រព័ន្ធការពាររាងកាយរបស់កុមារមានការលូតលាស់និងរឹងមាំល្អ។ ប៉ុន្តែ ទោះជាយ៉ាងណាក៏ដោយ ការសិក្សាបានរកឃើញថា ការផ្តោតខ្លាំងលើការធានាស្ថេរភាពនៃជីវភាពរស់នៅក្នុងគ្រួសារបានក្លាយជាកត្តាខាងដល់ការលើកកម្ពស់អាហារូបត្ថម្ភរបស់កុមារក្នុងដំណាក់កាលលូតលាស់ដ៏សំខាន់របស់កុមារទៅវិញ។ ដូច្នេះ ការកាត់បន្ថយផលប៉ះពាល់នៃការប្រែប្រួលអាកាសធាតុទៅលើអាហារូបត្ថម្ភរបស់កុមារគួរតែផ្តោតលើ ការធ្វើឱ្យប្រសើរឡើងទាំងការបរិភោគអាហារ និងទាំងប្រាក់ចំណូលក្នុងគ្រួសារ។ កត្តាទាំងនេះមានសក្តានុពលខ្លាំងបំផុតក្នុងការលុបបំបាត់ដើមហេតុទាំងបួននៃកង្វះអាហារូបត្ថម្ភរបស់កុមារ ដែលរួមមានការទទួលទានអាហារមិនគ្រប់គ្រាន់ សមត្ថភាពខ្សោយនៃរាងកាយក្នុងការស្រូបយកសារធាតុចិញ្ចឹម ជំងឺកុមារ និងការថែទាំមិនបានដិតដល់។

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ABSTRACT

Climate change has become a most challenging issue for sustainable development in lower-income countries. Climate change has impacted food consumption and human health especially children's nutrition. Malnutrition in children is caused by a combination of inadequate food intake and childhood infections that limit the capacity of the body to absorb nutrients from food. The degree of malnutrition experienced by infants and children is measured by one of three indicators: underweight, stunted, and wasted. This research applies a mixed-methods approach to study the impacts of climate change on child nutrition in a rural area of Cambodia, namely Borseth District, Kampong Speu Province. It was found that: 1) Climate change not only affects household incomes, but has multiple long-term impacts on child development due to health shocks and stressors, inadequate diets and protein intake, poor feeding practices, a lack of best-practice care for women and children, and other household burdens; 2) Villagers who have incomes that are below the poverty line can face food shortages any time but are especially vulnerable during periods of climate-related shocks and stressors. Household food consumption that is below national food consumption guidelines is the most significant factor causing persistently high levels of underweight, stunted, and wasted children; 3) Procedures for ensuring adequate care and feeding practices are crucial from birth to the age of five years to promote improved nutrition that adequately develops a child's immune system. However, the study found that villagers who focused on securing a sustainable livelihood become distracted from the factors that improve child nutrition during this crucial phase of child development. Thus, mitigating the impacts of climate change on child nutrition should focus on improving both household food consumption, and household income. These factors have the most significant potential to address the four main elements of the problem of child malnutrition, namely: inadequate food intake, the capacity of the body to absorb nutrients, childhood diseases, and inadequate care.

1. Introduction

Climate change has become a most challenging issue for sustainable development in lower-income countries. Anthropogenic drivers have been observed to be the leading cause of global warming since the mid-20th century (Pachauri et al., 2014). Regional climate predictions demonstrate that overall, sub-stantial variations in the amount and timing of rainfall are expected, yet the geographical distribution of these impacts is difficult to predict (Bernstein et al. 2007). Climate change impacts, such as increases in sea level will result in significant flooding in island nations and low-lying delta countries (Bindoff et al., 2007). Natural hazards are likely to displace millions of people and caused extensive damage to coastal ecosystems. The economic consequences of this damage will be particularly severe for developing countries (Dasgupta et al., 2009). Climate variability is expected to have a detrimental effect on food production (Selvaraju et al., 2011). Building the adaptive capacity of villagers to cope with future environmental changes and sustain their livelihoods, whether caused by climate change or other factors, will be of increasing importance (Nuorteva et al., 2010). Communities that continue to have a low adaptive capacity will be more vulnerable to climate change impacts, especially poor households dependent on natural-resource based livelihoods (Mendoza et al., 2014).

Cambodia is one of the most vulnerable countries in South East Asia to climate change due to having low adaptive capacity (Yusuf & Francis-co, 2010 & UNDP, 2011). The country has continued to experience decades-long droughts and other natural disasters throughout the history of the Khmer Empire (Buckley et al., 2010). Cambodia's population is highly vulnerable to climate-related impacts due to poverty, malnutrition, dependence on agricultural livelihoods, existing settlements located in flood-prone areas; as well as public health, governance, and technological limitations (Davies et al., 2015). Floods and droughts and their impacts on human health across the country are of substantial concern, given the pre-existing vulnerabilities and low adaptive capacity that is

characteristic of this context (Yusuf et al., 2010, Maplecroft, 2014 & MoH, 2011).

Climate change is expected to raise the number of malnourished people in lower-income nations, particularly in the tropics (IPCC, 2001; McMichael et al., 1997). In Cambodia, undernutrition rates are high and have changed little in the past ten years, with 24% of children under five years of age underweight, 32% stunted, and 10% wasted (CDHS, 2014). Moreover, 37% of children under two years are stunted indicating that infant health is precarious. Child malnutrition is more prevalent in rural areas, where 34% of children under five years are stunted, compared with 24% in urban environments (CDHS, 2014).

Food provides energy and nutrients to those who consume it, and its acquisition requires the expenditure of energy (McMichael et al., 2007). Climate change is deemed the most significant global health threat of the 21st century (Costello et al. 2009). The burden of human disease and deaths from climate-related risks (Pruss et al. 2016) is expected to increase as a result of increased variability causing an additional 250,000 deaths per year by 2030 (WHO, 2014). Although climate change will affect everyone, populations that are socially and economically vulnerable will face more significant risks, and it is important to address the needs of these people promptly (Da Silva et al., 2016). Vulnerable people cannot protect their families, livelihoods, and food supply from the negative impacts of climate variability leading to floods or water scarcity during extended droughts. Children are particularly affected by climate change.

For instance, many of the main threats to child survival, such as malaria, diarrhea, and undernutrition are highly sensitive to climatic conditions. Climate variability is expected to worsen as a result of climate change (UNICEF, 2008). The unique physical, cognitive, and physiological requirements of children place them at greater risk from intense droughts, recurring floods, and the impacts of climate variability on livelihoods, and other weather-related disasters (Save the Children, 2009).

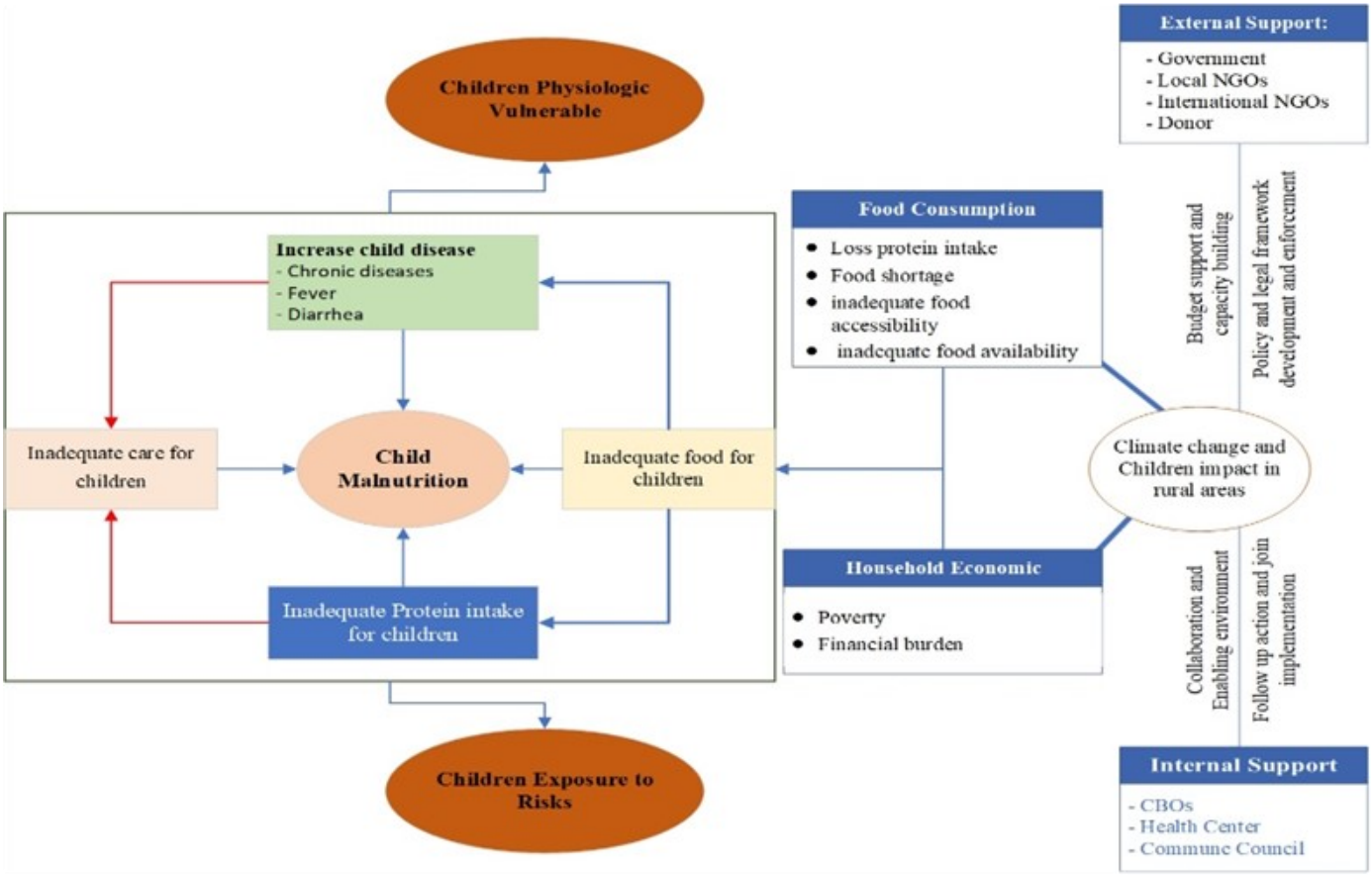

Fig. 1. Research framework describing how climate change impacts child nutrition status in rural areas. Adopted from Climate Change and children health impact (Philipsborn, & Chan, 2018) and UNICEF nutrition Framework.

Rural livelihoods in Cambodia depend on agricultural products for food consumption and income. As a result, Cambodia is highly vulnerable to climate change impacts. Therefore, climate change has and will continue to affect child nutrition, resulting in higher child malnutrition rates both for now and in the future. The 2002 World Health Report states that childhood malnutrition is the most widespread primary risk factor for significant diseases in children (WHO, 2002). Climate change may worsen malnutrition by directly affecting agricultural yields and worsening growing conditions in areas already experiencing food insecurity (Parry et al., 2005). Climate change threatens to reverse the gains in global child health made over the past 25 years and impede access to child rights (IPCC, 2014).

Climate change will disproportionately impact children and the poor, magnifying existing disparities in social determinates of health, with implications for all of humanity (Philipsborn, & Chan, 2018). For instance, climate change impacts two key factors that significantly influence child health, namely household food consumption and income. The impacts of climate change are wide-ranging. Extreme climate events increase the magnitude of problems such as food scarcity, clean water shortages, increased mortality, and child illness.

The conceptual framework outlined in **Fig. 1** represents the multifaceted nature of malnutrition. It is important to understand that malnutrition manifests as a result of four main dimensions: 1) inadequate food intake in children, 2) inadequate protein intake, 3) inadequate care, and 4) child illnesses. Many factors can cause malnutrition, most of which relate to poor diet or severe and repeated infections, particularly in less privileged situations. Inadequate diet and disease, in turn, are closely linked to general standards of living, environmental conditions, and whether a population can meet its basic needs such as food, housing, and health care. When child malnutrition results from changes in food consumption as a result of climate change, two main factors increase the severity of malnourishment: exposure to risks, and physiological vulnerabilities to diseases and death for those under five years of age. Collaboration is required to improve the enabling environment of all key stakeholders in implementing joint action to promote climate change adaptation and mitigation for better child health. To this end, it is necessary to build capacity and allocate adequate budgets to develop and enforce a policy and legal framework to respond to the impacts of climate change on child health.

2. Materials and methods

The study applies a mixed-methods approach to examining climate change impacts on child nutrition in a rural area of Cambodia. A descriptive approach was employed to investigate how climate change affects child nutrition. Participatory, qualitative methods were used to analyze primary and secondary data related to climate change and nutrition status. Primary data was collected via participant interviews with key people in local government and health centers, as well as community leaders and NGO staff. Secondary data such as climate change and child health publications, data on child health and nutrition from the National Institute of Statistics and information and standards from international organizations were analyzed as part of this research. Fieldwork was conducted in August 2020 in two communes in *Boseth* District, *Kampong Speu* Province. A total of 230 households were sampled, including 141 households with a child under the age of five years as a member. The World Health Organization (WHO) Anthro Survey Analyzer was used to survey the growth and malnutrition status of these children.

The Statistical Package for Social Science software was used to process and quantitatively analyze the data. The research employed several advanced statistical techniques, and hypothesis testing, including 1) a one sample t-test to compare the mean score of samples with a known value (e.g., child malnutrition rate; 2) an independent-sample t-test to compare the means of two studies to determine whether statistical evidence exists that the population are significantly different; 3) a chi-square test to identify the significant relationships between climate change and child malnutrition; and 4) a five-point weighted average index to rate the degree of vulnerability and satisfaction of respondents regarding climate change impacts and child health.

The five-point scale ranged from considerably less, to less, to moderate, to high, and very high.

3. Results and discussion

3.1 Child growth and malnutrition status

The WHO definition of malnutrition usually refers to both undernutrition and overnutrition, however, this research only refers to undernutrition. A child's malnutrition status may be compromised by either disease with an environmental component, such as those carried by insects or protozoic vectors; or diseases caused by an environment scarce in micronutrients. In this study, children under five years of age (0-60 months), who lived in a selected household, were surveyed using the WHO Anthro Analyzer Software. The results were used to measure the growth and nutrition status of each selected child based on measurements represented by a z-score (see **Fig. 2)**.

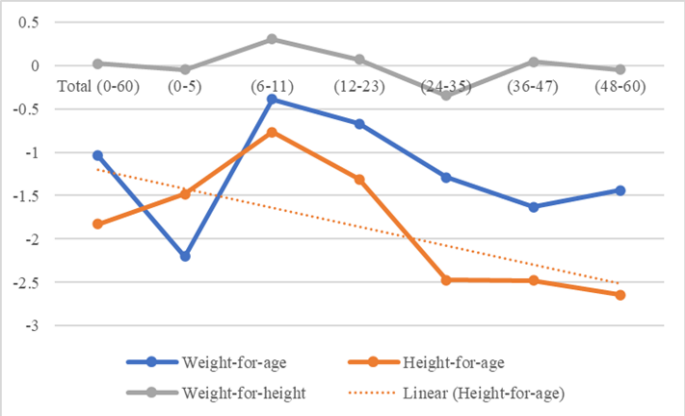

Fig. 2. Growth and malnutrition standards for children under 5-years of age

Note 1) The median standards for child age groups for weight-for-age, height-for-age, weight-for-height, and BMI-for-age. A z-Score < -3SD refers to severe malnourishment, a z-score <-2SD refers to moderate/mild malnourishment, a z-score >-2D >2SD refers to normal nutrition, and a z-score >3 refers to over-nutrition/obesity. 2) The weight-for-age standard is used to define children as *underweight*. The height-for-age standard is used to define children as *stunted*. The weight-for-height standard is used to define children as *wasted*.

The calculation of the weight-for-age of each child was used to identify underweight children (z-score > -2 SD) under conditions of normal nutrition. The result demonstrated that the average weight for children aged between 0 and 5 months was low (z-score < -2 SD). This suggests that the children sampled had a low birth weight in comparison with the height-for-age standard for normal nutrition. Meanwhile, sampled children aged between 6 and 60 months were in line with a normal weight measurement (z-score > -2 SD) but lower than the WHO standard (z-score > 0 SD). Children between the ages of 6 and 11 months were found to have a weight closest to the WHO standard. Only a small percentage of children (3.4%) were classified as severely malnourished (z-score < -3 SD), while a much larger percentage (27.4%) were classified as mildly malnourished (z-score < -2 SD).

The percentage of children classified as stunted in this study in 2020 (33.7%) appears to be consistent with the findings in the literature surveyed from 2014 (32%) (CDHS, 2014). This suggests that problems with malnutrition have continued and still threaten children in the study area. Height-for-age measurements were used to classify children as stunted. It was found that the overall average for all children was normal (z-score > -2 SD) but not above average (z-score 0 – 2 SD) for children aged between 0 and 23 months. However, the average for children aged between 24 and 60 months indicated that they were mildly stunted (z-score < -2 SD). Further, the linear height -for-age plot indicated slow development and that children may become malnourished as they get older due to poor dietary intake, living environments, and levels of caregiver and health support. Acute malnutrition (stunting) was found to affect 33.7% of the 175 children surveyed (31.3% of a total of 83 boys; and 35.9% of a total of 92 girls).

Weight-for-height measurements were used to classify children as wasted. It was found that the average measurement indicated that children demonstrated normal growth based on the WHO standard (z-score > -2 SD and < 2 SD). Overall, the percentage of children classified as wasted was 17.7%, comprising 5.1% of children with severe malnourishment (z-score < -3 SD) and 12.6% of children who were mildly malnourished (z-score < -2 SD). In the study area, most malnutrition-related deaths were associated with mild-to-moderate, rather than severe malnutrition. This was because there was a much larger cohort of mild-to-

moderately malnourished children than severely malnourished children.

For instance, many children aged between 2 and 5-years-old were found to have low weight-for-height. 'I stay home to take care for my grandchildren because their parents leave home every day to work in a garment factory. They are thin and only eat two times per day. They go to village from the morning till the afternoon and some days do not come back home for lunch' (Personal communication, 51-year-old female villager, August 2020).

3.2 Impact of climate change on child malnutrition

A chi-square test (X2) was used to determine if any relationship existed between climate change impacts in the study area and child malnutrition, thus, whether household challenges related to climate change in the study area were significant **(Table 1)**. The test revealed that the relationship between climate change impacts and child malnutrition was significant. For instance, the likelihood that stunted children who received low height-for-age results (z-score < -2 SD > 2 SD) were also members of households that have been affected at any time, or had specifically experienced food shortages as a result of climate-related impacts. These relationships were found to have perfect significance.

Similarly, a chi-square test was also used to determine whether a correlation existed between households affected by climate-related impacts and severe malnutrition. The relationship between *stunted* children with a very low height-for-age result (z-score < -3 SD), or severe malnourishment, and those where climate change impacts had caused a reduction in household income, and long-term mental and physical shock and stress were found to be very significant. This suggests that building community capacity to adapt to the impacts of climate change and resilience in young people, particularly those under 5-year-old is highly important. Overall, it was found that climate change has multiple significant impacts on child nutrition.

3.3 Impact of household income on child malnutrition

Another chi-square test (X2) was used to determine if any correlation existed between food shortages and poverty in the study area **(Table 2)**. The test found a significant relationship between food security and the poverty status of a villager. This is telling as villagers who have incomes below the national poverty line tend to face food shortages at any time, but this is especially the case

Table 1. Relationship between climate change and child malnutrition

Child malnutrition and climate change impacts						
Variable		Impacted by climate change				
		N	No	Yes	X^{2a}	P^b
Malnutrition	Malnutrition	48	4	44	34.861	0.000***
	Normal	93	56	37		
	Total	141	60	81		
Climate change impacts and the severity of malnutrition						
Severe mal-nutrition	Yes	10	0	10	7.973	0.005**
	No	131	60	71		
	Total	141	60	81		

Note: **a.** x^2: Critical Chi-square values were 34.861 and 7.973 with 1 degree of freedom. The Chi-square Distribution Table provided similar P values of 0.000. This meant that the test results of the two variables were perfectly significantly different. Chi-square results for the relationship between the impact of climate change and child malnutrition (P=0.000) and the seriousness of malnutrition (P=0.005). **b** ** is very significant at the level 0.005 and *** perfectly significant at the 0.000 level.

during periods of shock and stress due to climate change impacts. The same chi-square test regarding food shortages did not significantly render all villagers living in the study areas seriously disadvantaged. Food shortages were more likely to impact poor households who face financial burdens in addition to climate change impacts such as droughts, or floods.

Observations within the study area revealed that NGOs and the local government have worked to build the adaptive capacity of community members under normal situations of food shortages. However, villagers still possess a limited capacity to cope with additional impacts on top of the climate-related impacts that they have not already specifically planned adaptation practices for at either the community or household scale. Moreover, from the focus group discussions, planning on coping with food shortages was limited. Usually, there was a vague statement that food may be borrowed from a neighbor or relative when this situation arises. In contrast, however, this does not reflect a pragmatic view of how unpredictable shocks and stressors may be responded to, such as the COVID-19 outbreak which caused a crisis of reduced income in the commune, particularly for villagers who lost their monthly salary. In this situation, villagers needed to cut expenditures on food, as well as reduce the amount of food they consumed due to both reduced income and increased food prices. An additional chi-square test (X^2) was used that found a significant correlation between poverty status and the severity of food shortages **(Table 2)** in this context. Severity was defined by the constraint of not being able to access food of adequate quality for child nutrition. The research also confirmed that, overall, the proportion of villagers concerned about food shortages in each of the study areas (68.3%) was not significantly different, with the average length of time that respondents had concerns about food shortages, being around 112 days per year **(Appendix A1)**. In, reality, only 32.2% of respondents experienced food shortages and 67.4% were not able to access their preferred food. This is lower than those with concern about food shortages and not significantly different across the two study areas. The average occurrence of food shortages was 32 days/year. 'With the 2 ha of agriculture land concession I received from the government in 1980, following the Khmer Rouge

Table 2. Correlation between food shortages and poverty status.

Food shortages and the poverty line						
			Food Shortage			
Variable		N	Yes	No	X^{2a}	P[b]
Poverty Line	Below	167	65	102	12.723	0.000***
	Above	63	9	54		
	Total	230	74	156		
Food shortages and their severity						
Severe food shortage	Yes	195	39	156	87.027	0.000***
	No	35	35	0		
	Total	230	74	156		

Note 1) X^2: critical Chi-square test values were 12.723 and 87.027 with 1 degree of freedom. The chi-square distribution table provided similar p-values = 0.000. The main test showed a perfectly significant correlation between food shortages and poverty (P=0.000). The chi-square result for the relationship between food shortages and the severity of the food shortage also suggested a perfectly significant correlation (P=0.000).**2)** *Significance at the 0.05 level; **Significance at the 0.001 – 0.002 level and *** significance at the 0.000 level.

regime, I have grown rice productively and have never faced food shortages. However, over the past decade, my land has been divided into portions for my six children to build a house and conduct small-scale agricultural activities. Nowadays, I live with two of these children on 0.30 ha of land and produce little rice. We face food shortages most years for a period of between 30 and 50 days' (Personal communication, 52-year-old female, August 2021).

It was found that rice is the most common staple food, consumed almost 7 days a week in the study area, at an average of 344.76 grams per person per day, followed by fish consumption, at an average of 69.80 grams. Rice and fish are an important contribution to the daily dietary intake and nutrition of villagers. Child nutrition status was determined by multifaceted interactions between household food consumption, protein intake, and the nature of health and care practices. Overall, villagers were found to have consumed an average of 195.15 grams of food per individual per day for the past 7 days. This included a protein intake of 52.92 grams per person per day, which is significantly lower than both the national average protein consumption (62.8 grams) and the national average rural consumption (60.1 grams) (CSES, 2009).

3.4 Impact of child-centered care and feeding practices on child nutrition

The first three days of breast milk after birth contains colostrum, which is a highly nutritious food that has antibodies that protect newborns from disease. However, infants only benefit from the early initiation of breastfeeding, which also fosters a bond between mother and child. Of the 141 households with children under 5-year-old surveyed **(Table 3)**, 49.7% did not initiate breastfeeding during the first three days after birth due to many reasons such as mothers not producing early breast milk; and minorities opting not to follow the advice of nurses about breastfeeding (Focus group discussion, August 2020). Overall, the average number of days children received early initiation breastfeeding (1.4 days) was lower than the national standard (3 days). Overall, 41.8% of children received three full days of early initiation breastfeeding, another 5.7% received two days, and 3.5% received just one day. The remaining 49.7% did not receive early breast milk and may have received a pre-lacteal food of processed milk or milk powder instead.

Families in rural areas often do not receive enough information about maternal and infant care before birth, especially regarding maternal nutrition before and during pregnancy. The early initiation of breastfeeding is encouraged for infants, however, nearly half of the women who deliver at the health center, don't breastfeed within the first three days after birth and use milk powder instead of breastfeeding. This practice continues until their child can receive soft and solid food leading to child malnutrition. 'Following the national nutrition program of the Ministry of Health and other support from NGO partners, a nutrition awareness campaign is conducted with villagers almost every year. However, due to livelihood constraints, villagers often forget their child's nutritional needs. Almost half of the children in the village stay with their grandparents, where they receive less care and dietary support' (Personal communication, health center staff, August 2020).

Exclusive breastfeeding is recommended for the first few months of life as breast milk is uncontaminated and contains all necessary nutrients necessary for survival (CDHS, 2014). Early supplementation is discouraged because 1) It exposes infants to pathogens and increases the risk of infection; 2) It decreases the intake of breast milk and therefore suckling, which reduces the volume of breast milk production; 3) In harsh socioeconomic environments, supplementary food is often nutritionally inferior, especially concerning the antibodies in breast milk that provide immunity to disease. However, the research found that only 39% of infants received breastmilk exclusively for the first 180 days of their life. Of the infants that did not receive breastmilk, 34.4% received a pre-lacteal food or plain water, 29.8% of children received liquid porridge, while a very small proportion of infants (1.3%) received condensed milk. 'Exclusive breastfeeding was suspended by families for many reasons including; mothers lacking supplementary food causing a reduction in breast milk production; and climate change impacts, which affect household income and food

Table 3. Breastfeeding practices of villagers

Variable	*Svay Rumphear*	*Preah Khae*	Overall	P-value
Children receiving early initiation breastfeeding (%)				
Early initiation breastfeeding	49.2	51.3	50.3	0.433
Non-early initiation breastfeeding	50.8	48.7	49.7	
Average number of days	1.29	1.48	1.4	
Children receiving exclusive breastfeeding for the first 180 days of their life (%)				
Exclusively breastfeeding	80.3	77.5	78.7	0.556
Non-exclusively breastfeeding	19.7	22.5	21.3	
Average number of days	113.72	106.68	109.73	

Note 1) The percentage of children who received early initiation breastfeeding for three days was 41.8%; two days was 5.7%, and one day was 3.5%. **2)** The percentage of children who received a full six months of exclusive breastfeeding was 39%. **3)** The percentage of children who received complementary feeding in the first six months of prelacteal powder was 34.4%; condensed milk was 1.3%, liquid porridge was 29.8%, and plain water was 34.4%.

production. This affects the development of infants and increases their risk of infection' (Personal communication, Ponleu Ney Kdey Songkum Organization, August 2020).

In the transition to eating food from the diet of the rest of the family, children from the age of 6 months should be fed small quantities of solid and semi-solid food at least 2 to 3 times per day. However, the research found that children aged between 6 and 23 months received complementary food less than 3 times per day. Thus, children in rural areas received inadequate complementary food and breast milk during this transition period, and as a result, the prevalence of malnutrition increased **(Fig. 1)**.

Child malnutrition has been linked to three main causes: 1) inadequate access to food; 2) inadequate care for children and mothers; and 3.) insufficient health services and unhealthy environments for children (UNICEF, nutrition framework). Climate change impacts are closely related to child nutrition in multiple ways. For instance, this research demonstrates a primary cause of malnutrition is a lack of access to and availability of food. Other significant causes include food shortages resulting from poverty, which limits access to food supplies to ensure adequate child nutrition. Early initiation of breastfeeding and adequate feeding of complementary food for the first 1,000 days of life was also found to have high importance in reducing the rate of malnutrition for children under five years of age. Another significant factor identified is that villagers report having a low consumption of food in general, and a low protein intake, compared with the average rural population. Based on the present study it is concluded that child malnutrition is closely related to the negative impacts of climate change, namely food insecurity and reduced household income. This leads to inadequate food intake, a reduced capacity for children to absorb nutrients, childhood disease, and inadequate child-centered care.

Nutritional status is the outcome of multiple relationships between food consumption and the overall status of health and care practices. Household income and other behavioral factors strongly influence decisions about feeding practices, which in turn influences nutritional status. Adequate nutrition is critical to child development, particularly for the period between 0 and 2 years of age, where additional care is required to ensure child development. Children who do not access adequate nutrition during the period can be vulnerable to stunting, micronutrient deficiencies, and common childhood illnesses, such as diarrhea and acute respiratory infections. The nutritional status of children under five years of age is an important measure of child health.

Climate change impacts a range of other contextual factors leading to malnutrition such as land-use change, agricultural production, population growth, and the depletion of freshwater resources that in turn have consequences for food consumption and human health.

Moreover, climate change impacts all four dimensions of food security including food production, access to food, stability of food supplies, and food utilization (FAO, 2006). The poorest regions in the world, with the highest levels of persistent hunger globally, are also those with the highest degree of uncertainty about food production (Bruinsma, 2003). The world continues to face significant challenges in securing adequate food supplies that are healthy, safe, and of high nutritional quality for all (Redden et al. 2014a). Any changes to food choice or the conditions under which food is produced have potential consequences for the nutritional quality of diets and food safety, hence, potential health impacts (Balucombe et al. 2009). Climate change has increased the number of malnourished people in developing countries, particularly in the tropics (IPCC, 2001; McMichael, et al. 1997).

The results obtained about the nutrition status of children in the study area indicates that multiple factors cause malnutrition, most of which relate to poor diet or severe and repeated infections, in less privileged populations. Inadequate diet and disease, in turn, are closely linked to the general standard of living, environmental conditions, and whether a population can meet basic needs such as food, housing and childcare practices. It was found that 33.7% of children under five years of age were affected by acute malnutrition (stunting) (31.3% male, and 35.9% female), with no significant difference between the cohorts from the two villages surveyed. Thus, the problem of child malnutrition continues to affect children in the study area. Most malnutrition-related deaths are associated with mild-to-moderate, rather than severe malnutrition, because the number of moderately malnourished children is much larger than for severely malnourished children based on height-for-age and weight-for-age measurements, respectively. The early initiation of breastfeeding is encouraged for infants, however, nearly half of the women who deliver their child at a health center do not breastfeed over the first three days of their life and infants are fed with milk powder instead. This child-care practice continues until the child can receive soft and solid foods, which can lead to malnutrition.

The other main finding of the research suggests that while villagers may possess good knowledge about how to improve child nutrition, they may not do so due to household income, burdens, and other needs. Often households have time constraints and have limited capacity to act on the information. Overall, around half (49.7%) of the children in the two study areas did not access early initiation breastfeeding in the first three days of their life, with no significant difference for each village studied. The main reason cited for this is that mothers are unable to produce early breastmilk, while a minority of mothers did not follow the advice of nursing staff on initiating early breastfeeding. Early supplementation of breastmilk was discouraged because 1) it exposes infants to pathogens and increases their risk of infection; 2) it decreases breast milk production, and 3) in harsh socioeconomic environments, supplementary food is often nutritionally inferior.

It was found that food shortages were more likely to affect poor households with financial burdens related to external shocks and stressors such as climate change impact (drought, flood, or other significant issues such as pandemics). Issues of poverty and food shortages were found to be closely related to the capacity of villagers to access ability adequate food of sufficient quality to ensure good child nutrition. Moreover, water-related climate change impacts have become more severe over time, and now have a significant impact on local socio-economic resilience. A high proportion of villagers working in farming as a legacy occupation (29.6%) will likely transition to new livelihood activities, such as livestock trading. This will mean those with limited knowledge and capacity of these activities will become more vulnerable. Average household income in the study area from agricultural production was already found to be significantly lower than the national and rural poverty line. This has significant implications for household food consumption and nutrition in rural areas like

Borseth District.

4. conclusion

In conclusion, child health, and in particular, child nutrition status is closely related to climate change impacts for multiple reasons. These include health shocks and stressors, poor dietary intake for children, lack of best practice child-centered care, inadequate protein intake, poor feeding practices, and household income and burdens. These factors continue to affect child nutrition in the study area with high rates of stunting still experienced. In particular, child nutrition between the age of 0 and 24 months are particularly important for child growth and development. However, during these ages, climate change impacts were found to impact strategies such as adequate breastfeeding, exclusive breastfeeding and complementary feeding, hence malnutrition and disease left children sensitive to diseases and malnutrition vulnerable.

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Appendix

Appendix 1. Types of employment.

Attribute	Svay Rumphear (N=113)		Preah Khae (N=117)		Overall (N=230)	
	Current	Future	Current	Future	Current	Future
Rice Farmer	72.6	46.9	61.5	42.7	67.0	44.8
Vegetable Farmer	5.3	1.8	12.0	0.9	8.7	1.3
Animal Husbandry	3.5	11.5	8.5	15.4	6.1	13.5
Employed worker	11.5	20.4	13.7	22.2	12.6	21.3
Self-employed business owner	6.2	18.6	4.3	18.8	5.2	18.7
Employee	0.9	0.9	0	0	0.4	0.4