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RESEARCH ARTICLE

Impacts of a participatory action project: how reducing crop raiding has implications for health

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ABSTRACT

Human-wildlife interactions include wild animals foraging on agricultural crops, often called crop raiding. Crop raiding can result in disease transmission, poor nutrition, stress, and loss of income. Crop raiding also affects conservation because retaliatory events can result in wildlife being harmed. Around Kibale National Park, Uganda, a community action project implemented mitigation strategies that reduced crop raiding. We surveyed 95 of 106 (90%) project participant households to determine if participants perceived their health to have changed due to the project. We conducted open-ended, oral surveys during July and August 2018. Most participants said their overall health had improved (80%) and that their diet (83%), stress (82%), sleep (82%), and exposure to zoonotic diseases (64%) improved. Other benefits included income to pay medical bills and school fees. No participant reported negative effects. We found evidence that reducing crop raiding had positive implications for people's health and income stability.

KEYWORDS

Conservation; crop raiding; health; human-wildlife conflict; sleep; stress

Introduction

Wildlife habitats face rising pressure from human encroachment as the proximity of people to protected areas and the density of people around protected areas has increased (Hartter et al., 2015; Hoffman, 2017; Sitati et al., 2005; Thouless & Sakwa, 1995; Zommers & MacDonald, 2012). People living near these protected areas are more likely to report crop destruction by wild animals, which is associated with zoonotic disease transmission and loss of food (Paige et al., 2014; Rwego et al., 2008; T. Goldberg et al., 2008). Zoonotic diseases, including Ebola, monkeypox, COVID-19, dengue, and influenza, are major global health concerns and are more likely to spread when people have increased interactions and overlap with other animals. When wild animals destroy crops in people's gardens, transmission of these diseases to people can occur directly through aggressive interactions or indirectly when farmers handle crops and other items contaminated with the saliva, blood, urine, or feces from the wildlife or are bitten by disease vectors, such as mosquitos, that have previously bitten wildlife species. Thus, in addition to the stress and food insecurity associated with crop destruction, the potential for zoonotic disease transmission can have far-reaching consequences for human health and well-being (Chapman, Gillespie, et al., 2005; Córdoba-Aguilar et al., 2021; T. L. Goldberg et al., 2008; Tiwari et al., 2020).

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Crop destruction is a common source of human-wildlife conflict and commonly occurs during crop foraging by wild animals, whereby animals enter gardens to eat foods grown by farmers, often also causing damage to additional crops beyond those that are eaten. The resulting crop loss can be particularly devastating for subsistence farmers who have little to no other resources. Crop foraging and damage by wild animals is often referred to as crop raiding, which indicates the negative perception farmers have of these events (Mackenzie & Ahabyona, 2012; Milich et al., 2021). Farmers who experience crop raiding are at a heightened risk for disease transmission; they experience poverty and hunger as a direct result of crop raiding (Mwangi et al., 2016; Paige et al., 2014; Rwego et al., 2008; T. L. Goldberg et al., 2008). Crop raiding limits access to food both by eliminating food grown for direct consumption and destroying excess crops that can be sold at market providing farmers' main source of income (Kagoro-Rugunda, 2004; Kaswamila et al., 2007; Siljander et al., 2020). Around Kibale National Park in Uganda, the majority of farmers report animals raiding crops as threats to their livelihoods (Hartter, 2009), as many as 60% of households located along the Kibale park border indicated they suffered economic losses as a result of crop raiding (MacKenzie et al., 2017).

In addition to disease transmission and food insecurity, crop raiding disrupts sleep because farmers need to guard their crops at night (Barua et al., 2013; Hoare, 2000; Jadhav & Barua, 2012). Researchers have also noted the mental toll and undue stress caused by crop raiding (Barua et al., 2013; Jadhav & Barua, 2012). Additional consequences of crop raiding include lower scholastic achievement for children (Mackenzie & Ahabyona, 2012; Mackenzie et al., 2015; Mwangi et al., 2016) because children are either asked to guard crops during the day or their parents are unable to pay fees associated with test taking and uniforms (Hoare, 2000; Mackenzie & Ahabyona, 2012).

Fortunately, mitigation strategies can reduce crop raiding events. Trenches dug to certain dimensions that are regularly maintained offer an inexpensive barrier between protected areas and farms for terrestrial animals such as elephants (King et al., 2017). Because these trenches cannot be dug in swampy areas, beehive fences built across swamps can be used in combination with trenches to create a continuous barrier between a protected area and farmland (Figure 1). Previous studies have found beehives deter elephants while also providing opportunities for community members to harvest honey as an alternative source of nutrition and/or income (King et al., 2011, 2017).

Other mitigation strategies to offset the losses from crop raiding include planting crops considered unpalatable by wildlife that have a high market value, such as garlic (Gross et al., 2016). Although these plants may not prevent crop raiding of other crops, they provide an alternative revenue. Additionally, buffer crops, such as tea, planted between the park boundary and people's land can prevent primates from crop raiding (Seiler & Robbins, 2016).

Given the damaging impacts of crop raiding to people's well-being, interventions to reduce crop raiding have the potential to alleviate food insecurity, poverty, and zoonotic disease transmission. Although many studies have documented the damages caused by crop raiding, few studies have investigated the impact of mitigation strategies on health and well-being. In this study, we used open-ended, oral surveys to examine how subsistence farmers who live along the border of a protected area self-reported how their health was affected by mitigation strategies aimed at reducing crop raiding. The findings of this study have far-reaching implications for interventions intended to improve human health.

Figure 1. Beehives hung from wire along park boundary create "bee fences" that deter elephants. These can be placed across swampy areas where trenches cannot be dug.

Methods

Study Area

This research was conducted in three communities bordering Kibale National Park, Uganda (Figure 2). Kibale National Park is a moist evergreen forest, which is approximately 766 square kilometers in size, located between the coordinates 0.18–0.69° N and 30.22–30.55° E. Elevation ranges between 1,100 and 1,600 meters (McGrew et al., 1996). There are two rainy seasons annually, occurring in March through May and September through November, and two dry seasons, which occur December through February and June through August. Mean annual rainfall in Kibale National Park is 1749 mm (Chapman, Struhsaker, et al., 2005). Kibale National Park is home to 13 species of primates, as well as other large mammals including elephants.

For more than two decades, researchers have been documenting issues of human-wildlife conflict caused by crop raiding in this area (Hartter, 2009; MacKenzie, 2012; Naughton-Treves, 1998; Onderdonk & Chapman, 2000; T. L. Goldberg et al., 2008). Human population density has been increasing around Kibale (Hartter et al., 2015), almost doubling in 13 years from 160 people/km^2 in 2002 to 308 people/km^2 in 2015. Although the boundaries of Kibale remain intact, much of the surrounding forest has been reduced to fragments and small groves (Hartter & Southworth, 2009).

Kibale National Park is managed by the Uganda Wildlife Authority (UWA), which is the main government agency overseeing wildlife protection in Uganda. When possible, UWA assists with chasing animals away from farms and back into the park. These are often stressful moments that can lead to hostile interactions between community members and UWA representatives (Naughton-Treves, 1997; Richard, 2011).

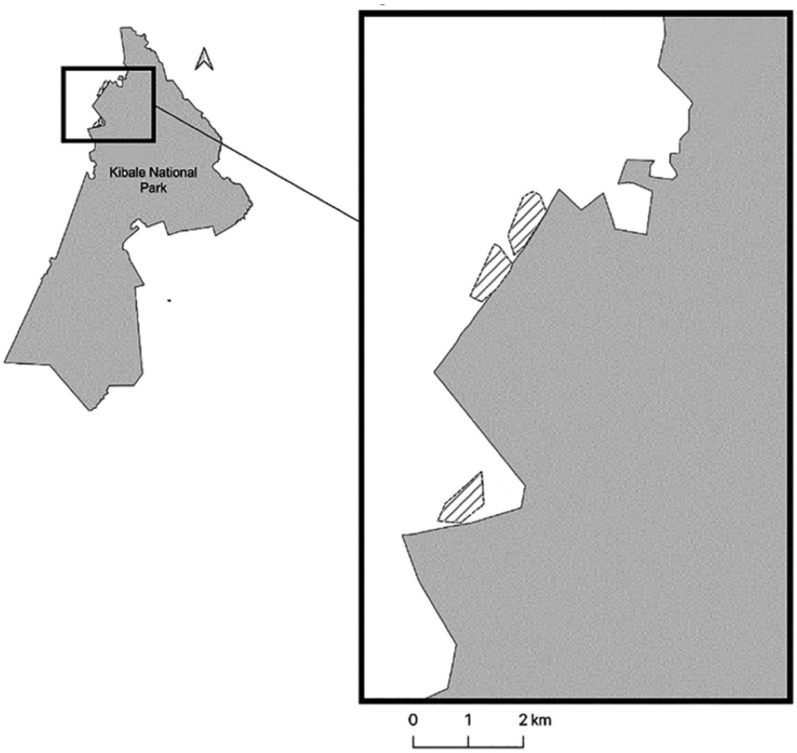

Figure 2. The locations of participating communities are indicated in stripes on this map (adapted from Milich et al., 2021) of Kibale National Park.

Participant Selection and Household Surveys

Participants were chosen from three communities due to their participation in a community action project that had been working to reduce crop raiding in the area prior to and during our study. The community action project specifically worked with households that directly bordered the park. The community members identified four mitigation strategies to reduce crop raiding or offset the associated losses: extending and maintaining the trench that borders the park, establishing beehive fences in swampy areas where the trench could not be dug (Figure 1), growing garlic as a cash crop, and growing tea as a buffer crop. They began implementing these mitigation strategies two years prior to our study and were continuing to improve upon and expand these mitigation strategies at the time of this study; however, the tea seedlings had not grown into buffer crops at the time of this research. These interventions were successful at reducing rates of crop raiding in the participating communities (Milich et al., 2021). All households involved in the community action project were invited to be part of the study.

We consulted with Ugandan researchers from the community to develop our questions. We then tested the questions with local community members and incorporated their feedback. The questionnaire included both open-ended and closed-format questions. Respondents were first asked whether the community action project's mitigation strategies had impacted their lives. Then they were asked to list each way the mitigation strategies had

impacted their lives, including both beneficial and detrimental effects. They were then asked specifically if the mitigation strategies had impacted their diet, sleep, stress levels, exposure to zoonotic disease, and general health quality. If they indicated that the mitigation strategies did impact these aspects of health, they were asked to elaborate how their health was affected. If respondents indicated that the mitigation strategies did not influence their lives, they were asked what prevented the project from being more effective.

Data Collection and Analysis

Data were collected in July and August 2018. The survey was administered orally by a local research assistant. He asked the questions in Rutooro, the local language, and transcribed the participants' responses in English. Surveys were administered in the participants' homes, between 12 p.m. and 5 p.m., when people were finished with their gardening. This study was approved by IRB at Washington University in St. Louis (ID #201805007).

All comments collected during interviews were coded into a posteriori codes derived from the transcripts. These codes included- whether the individual experienced beneficial effects due to the mitigation strategies or not; and for those who experienced beneficial effects, we developed additional codes for each benefit mentioned. If participants had indicated detrimental effects, those would have been coded, however, none were reported. Themes emerging from the data were reported using illustrative quotations to underscore the views of the participants.

Results

Participants

We recruited one adult from each household participating in the community action project. Household members chose amongst themselves who, if anyone, would participate.

Of the 106 households that border the park in these three communities, we were able to collect data from 95 (90%). We were unable to collect data from 11 households because we did not find someone at home during any of our attempts. We conducted 95 oral surveys from people ages 18 to 80, which included 56 women and 39 men (Table 1). The age of one participant was not recorded.

Table 1. Participant Demographics.

	Total (*n*=94)	Men (*n*=38)	Women (*n*=56)
	n	n	n
Age			
18–27	16	4	12
28–37	26	10	16
38–47	21	10	11
48–57	12	3	9
58–67	8	6	2
68+	11	5	6

*There was a total of 95 participants but one of the men did not report his age, which is why only demographic data for 94 participants are reported here.

Effects of the Mitigation Strategies

The majority of participants ($n = 82$) reported that they benefitted from the community action project's mitigation strategies. Thirteen participants reported that the mitigation strategies did not affect their lives. No participants reported the mitigation strategies resulted in detrimental effects (Figure 3). For the 13 participants who did not experience benefits from the project's mitigation strategies, 9 reported they did not experience benefits because of issues growing their garlic. The other members reported they were too new to the project to experience changes ($n = 2$), they were too old to participate ($n = 1$), or that crop raiding persists despite the mitigation strategies ($n = 1$).

An example response from a participant who experienced benefits from the mitigation strategies:

> The trench has helped to reduce elephants which were coming to destroy my gardens. Now I can grow my crops and harvest them. This helps me get income from selling the crops that I grow unlike before. Also, through getting much harvest from my gardens I am able to pay school fees for my children unlike before.

An example response from a participant who did not experience benefits from the mitigation strategies:

> I planted garlic and it failed to grow well. This is because it was affected by the dry season.

The most commonly listed effects of the community action project's mitigation strategies were income from growing garlic ($n = 38$), the medicinal properties of garlic ($n = 29$), and having more food ($n = 33$) (Figure 4). Six participants listed unique benefits that were not mentioned by any other participants (and are not shown in Figure 4), those included: brought community together, trench made detecting crop raiding by baboons easier, income from harvesting honey, opportunity to earn income working someone else's tea plantation, improved mood, and presence of international visitors.

Example responses from participants who experienced the commonly reported benefits:

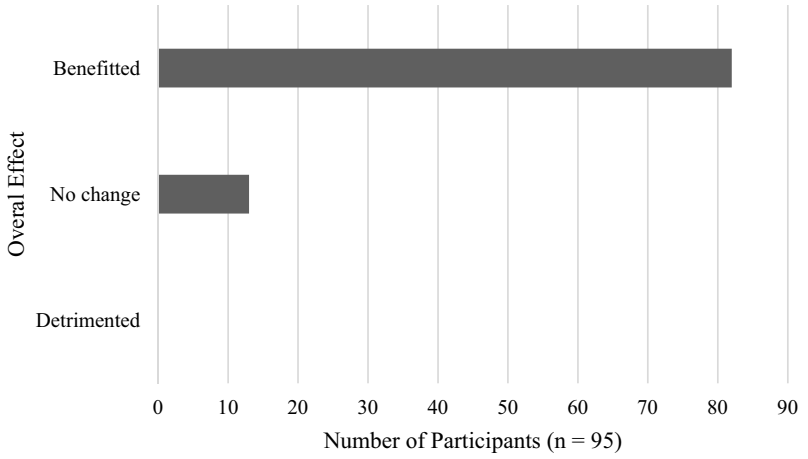

Figure 3. The number of participants who experienced benefits from the project's mitigation strategies (82), who experienced no changes (13), or who experienced detrimental effects (0).

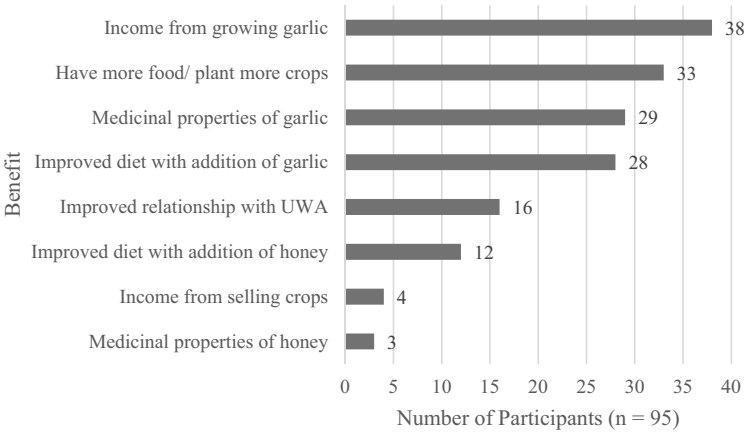

Figure 4. Responses to the open-ended question: "In what ways has the project impacted your life?".

> At least now we do harvest enough food unlike before. We grow most of the crops and harvest them unlike in the previous days. We eat enough food at home and the children pack meals to school unlike before. We also sell some of the crops to buy what is needed in the family. The elephants do not destroy much as before.
>
> The income from garlic has helped me very much to change the quality of my health. This is because the income was used to buy food that would help to improve on the diet and also when I fall sick, I buy drugs or get the health services because I am able to pay the bills.
>
> Now because the elephants have reduced, I am able to grow various crops which I sell to get income to support the family, paying school fees for my children, buying household assets and others. Also, because I have enough food to support the family, I am no longer stressed very much unlike in the previous days where I would lack enough food to eat at home, which would cause such stress.

More than 80% of respondents reported improvements in their diet, sleep, and stress levels as a result of the mitigation strategies, and 64% reported fewer instances of zoonotic disease exposure; 80% of participants reported improvements in their general health quality. No participant reported that their health worsened as a result of the project's mitigation strategies (Figure 5).

Example responses from participants:

> Now I plant my crops and harvest them unlike before. I get enough food to eat in my family and the surplus is sold to get cash to buy the necessities like clothes and even pay school fees and clear medical bills for my family members or myself.
>
> Now I am not stressed because of food to eat in the family. This is due to elephants reduction in the area after these interventions have come. I can now pack food for my children when going to school and even eat more meals than before.
>
> Previously I used to wake up at night to scare the elephants, and sometimes I would sleep late, which would disturb my sleep.
>
> Because we do not guard the gardens at night, the chances of being bitten by mosquitoes are reduced, so these interventions have reduced my exposure to disease like malaria. Also because I eat well, food which are rich, the disease which would attack me and my family are reduced.

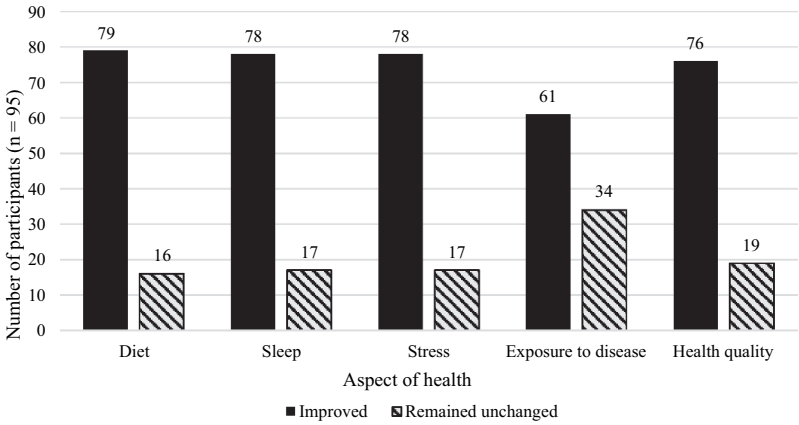

Figure 5. Participants reported how the community action project's mitigation strategies affected aspects of health.

While administering our surveys, some patterns emerged in unprompted anecdotal comments. Twenty participants mentioned that the community action project's mitigation strategies had reduced rates of malaria by allowing the opportunity to sleep inside with protection from mosquitoes, rather than staying outside to guard their gardens at night. An additional 6 participants mentioned that sleeping inside has reduced their amount of mosquito bites, but they did not specifically connect fewer mosquito bites to lower rates of malaria.

An example response from a participant who experienced lower rates of mosquito bites and malaria:

> Because of the elephants not coming to destroy our crops, we do not guard at night. We do not get mosquito bites which transmits malaria fever to us, so I am not exposed to these mosquitoes now unlike before.

Additionally, 18 participants mentioned that they can now have enough money to purchase medicine when needed, 28 participants mentioned they now have enough money to pay school fees, and 12 participants mentioned they now have enough food to pack lunch for their children when they go to school. Three participants made comments about improved mental health such as, "now I am no longer worried, I feel free" and "now I feel happy and relaxed."

Discussion

Our findings corroborate previous research that the mitigation strategies of trenches, beehive fences, and garlic do in fact reduce and offset the effects of crop raiding (Milich et al., 2021). Our study further shows how these interventions improve local people's perceptions of their health and well-being. The majority (80%) of participants felt that their health improved as a result of the mitigation strategies. The majority felt their diet had improved (83%), their stress levels had reduced (82%), they were sleeping better (82%), and they had less exposure to zoonotic diseases (64%). Other researchers have found that crop raiding has negative implications for human health, such as injuries from wildlife, poor

nutrition, increased stress levels, and possibly poorer mental health (Barua et al., 2013; Jadhav & Barua, 2012). By alleviating these threats to human health, mitigation strategies can help improve overall health quality.

Previous research has connected crop raiding to zoonotic disease transmission, primarily due to increased contact with wildlife (Paige et al., 2014; Rwego et al., 2008; T. Goldberg et al., 2008). Fewer papers mention the relationship between time spent outdoors at night, insect bites, and malaria (Barua et al., 2013; Jadhav & Barua, 2012). While we did not systematically study this potential relationship between lower rates of crop raiding, sleeping indoors, fewer insect bites, and lower rates of malaria, 21% of participants described unprompted how reducing crop raiding allowed them to sleep indoors, which resulted in fewer insect bites and lower rates of malaria. Future research should explore this relationship further.

Our findings also echo the numerous studies that show ways that crop raiding relates to food insecurity and creates barriers to enrollment in schools (Mackenzie & Ahabyona, 2012; Mackenzie et al., 2015; Mwangi et al., 2016). Several participants (29%) in our study mentioned that they can pay for school fees as a result of the project. Twelve participants (13%) also mentioned that they can now pack lunches for their children to bring to school, which also could possibly improve education outcomes by ensuring children are not hungry throughout the day.

In addition to improving people's health, reducing crop raiding has implications for improving attitudes toward conservation. There are documented links between crop raiding, poor health outcomes, and negative attitudes toward conservation (Barua et al., 2013; Kolinski & Milich, 2021). People who experience crop destruction, loss of income, and poor nutrition as a result of living near parks report animosity toward wildlife, which can harm conservation efforts (Dickman, 2010; Hill, 2000; Linkie et al., 2007). Farmers have been documented desiring to cut down national parks and drain wetlands in their defense when they experience crop raiding (Hartter, 2009; MacKenzie et al., 2017). Communities also retaliate against the animals by both directly killing the animals or aiding illegal hunting (Sifuna, 2005; Siljander et al., 2020; Thouless, 1994; Travers et al., 2019). Human-wildlife conflict poses serious concerns for both human well-being and wildlife conservation. These conflicts are continuing to increase as there is more demand on resources; thus, intervention strategies to manage or mitigate these conflicts are of crucial importance.

In our study, we found a link between a reduction in crop raiding and perceived health improvements, but we did not specifically assess changes in attitudes toward conservation initiatives. Sixteen participants (17%) stated that the reduction in crop raiding has improved the relationship between community members and UWA, which has promising implications for attitudes toward conservation. Reducing crop raiding means improving people's lives and their health with the potential for many cascading benefits ranging from improved childhood education to investment in biodiversity conservation.

Given the huge efforts that have been put into improving health and educational attainment in places like Uganda, the fact that a relatively simple project had such an impact on people's perceptions of their health seems very promising. Community action research projects, which involve researchers and participants working together to understand a problem and change it for the better, offer a promising method for improving health and well-being. Including farmers and stakeholders in research from the onset of a study leads to higher engagement from participants and improved

research outcomes (Méndez et al., 2017). These types of collaborative projects can increase the practical and academic impact of research findings, including centering local voices rather than marginalizing them when producing knowledge about their area, as well as tangibly helping research subjects (Dodsworth, 2019). These types of research projects have been shown to be effective (Ferré et al., 2010). Rather than the traditional approach to global health work and development work, a community-based or community action research approach that involves local people can be extremely effective.

Our study found that people perceived health benefits from reduced crop raiding and participation in the community action project but did not include direct health measurements for either physical or mental health. Future studies should incorporate these measurements and include comparisons before and after the interventions have been established. Future research with psychologists or social workers would help quantify and characterize the mental health impacts of fewer crop raiding instances. For physical health, these measurements could include caloric intake, blood pressure, sleep patterns, and rates of disease infection. Samson et al. (2017) used actigraphy to measure participants' sleep patterns, which could be a useful method for assessing the perceived improvement in sleep by the participants. Anecdotally, twenty participants commented that they contracted malaria less often and eighteen participants had increased access to medicine from health clinics, which could both be measured systematically in future research. Additional limitations of our research include our lack of a control group. We recommend future researchers study additional community action projects and include control groups in their studies.

Our results show that mitigating crop raiding leads to several benefits for human health and well-being. The vast majority of participants experienced several benefits as a result of the mitigation strategies, most reporting benefits from additional income or food (Figure 4). The majority of participants also reported their health improved as a result of reduced crop raiding, including improved diet, sleep, stress levels, and exposure to zoonotic diseases. Our research demonstrates how strategies aimed at mitigating crop raiding, administered by a small local-level community action project, have far-reaching implications for improving health.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Author Contributions

Acquisition, field work, data analysis, manuscript preparation: JEM; conceptualization, study design, editing: KMM

Ethical Standards

This study was approved by IRB at Washington University in St. Louis (ID #201805007).

Data Availability Statement

Data will be stored and available for sharing via the Washington University in St. Louis Digital Research Materials at https://doi.org/10.7936/6yea-xv36.

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