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ABSTRACT

The paper investigates predictors of the increased probability of Human-Wildlife Conflict (HWC) fatalities from attacks on humans. The study uses data from 137 HWC victims in the six wildlife districts of Botswana. A logistic regression model is used to assess demographic, ecological/environmental and geographic predictors of increased probability of fatality. Findings reveal that older victims, winter season, Ngamiland Wildlife district, elephants and distant health facilities present an increased probability of human fatality from animal attacks. In conclusion, several predictors from different aspects contribute to increased probability of fatality in the event of attacks. Therefore, there is need for a holistic approach to reduce HWC fatalities. We recommend that seasonality of HWC attacks on humans should be considered when deploying resources to mitigate against. Further, there is need for the formulation and development of the HWC policy which will guide HWC related issues, holistically.

Key words: Botswana, elephants, fatalities, human-wildlife conflict, holistic approach, predictors.

1. INTRODUCTION AND JUSTIFICATION

Human-Wildlife Conflict (HWC) is one of the most researched topics around the world (Dickman, 2010). According to Worldwide Fund for Nature (2005), HWC results from encounters between wildlife and human beings. These encounters affect all aspects of the human life; habitats and the conservation of the species involved. HWC transpire when wildlife needs encroach on those of human populations, with costs both to humans and wild animals (IUCN, 2005). According to Mukeka et al. (2018) and Mukeka et al. (2019), an interplay of factors contributes to HWC. Literature suggests that biological, geographic, and ecological factors equally contribute to HWC incidents. These include such factors as the life stage of an animal, sex, behavior, home range, species distribution, climatic conditions, and bushfires (Chiyo et al., 2012; Lambert et al., 2006; Sukumar & Gail, 1988). Amongst others, these include the increase of wildlife, livestock and human populations, rangeland degradation and fragmentation, uneven distribution of wild prey and climatic predictors. As long as communities of humans and wildlife co-exist, conflicts are inevitable (Le Bel et al., 2011). These conflicts are not animal specific as they involve a variety of animals ranging from mammals, birds, fish to reptiles (Conover, 2019).

The cost of conflictual interactions with wildlife is two-pronged, resulting in both visible and invisible impacts (Barua et al., 2013; Mayberry et al., 2017). The visible impacts are often immediate and manifest in several forms such as loss of life or injury to humans and animals (both wild and domesticated), destruction of the ecology/environment, destruction of property and crop raiding (Nyirenda et al., 2011; Gemeda & Meles, 2018). On the other hand, hidden impacts are often realized in the long run and manifest through, diminished mental wellbeing of the affected people, compromised quality of life, disruption of the normal livelihood routines, increased vulnerability to poverty and susceptibility to health conditions (Barua et al., 2013; Mayberry et al., 2017; Blackie, 2022). These affect resilience due to crop, property or livestock loss.

HWC in Botswana is on the rise, with wildlife damaging crops, property and preying on livestock (World Bank, 2016; Rutina et al., 2016; Dunnik et al., 2020). Furthermore, other forms of HWC include wildlife poaching, transmission of diseases between wildlife and livestock, threats as well as wildlife poisoning due to retaliations (Masole et al., 2019; Gaodirelwe et al., 2020). The Department of Wildlife and National Parks (DWNP) conducted a survey on HWC incidents between 1994 and 2006 on crops and livestock in Chobe, Ngamiland and Central districts. About 1, 212 and 1,013 crop and livestock incidents were recorded in Chobe, respectively (World Bank, 2016). Further, in Ngamiland, 1, 919 and 5, 666 crop livestock incidents were recorded, respectively and in Central 1, 712 crop and 8, 254 livestock incidents of conflicts were documented. Additionally, Statistics Botswana (2017), documented 19,198 HWC incidents in Botswana between 2010 and 2014 for species attracting compensation[1]. The figure implies

1 These are buffalo, cheetah, crocodile, elephant, hippopotamus, leopard, lion, rhinoceros, and wild dog.

that the total number of HWC incidents were more. Further, Botswana's compensation budget for damages caused by wildlife increased from BWP 4million in 2014 to BWP21 million in 2018/19 (Statistics Botswana, 2016). The DWNP commits approximately BWP 15 million (equivalent to US$1, 4 million) of its annual recurrent budget, and up to 60% of the time of district staff on HWC issues (Bowie, 2009; DWNP, 2018).

Numerous studies addressing HWC in Botswana are more inclined to visible aspects of the conflict (Rutina et al., 2016; World Bank, 2016; Yurco et al., 2017; McNutt et al., 2018; Dunnik et al., 2020). However, the studies are more skewed towards crop raiding and predation, leaving a gap about another equally important visible impact, human injuries, and deaths. Human casualties due to HWC are often trivialized and deemed rare (Karidozo, 2016) hence the limited attention. Consequently, literature quantifying injuries and deaths due to attack by wildlife is scanty. Furthermore, none of the studies has established predictors of likelihood of harm or deaths from these attacks to inform policy. Evidence suggests that, if HWC is inadequately addressed, communities can be hostile to both conservation institutions and wildlife (Noga et al., 2018). This study, therefore, aims to determine factors that lead to increased probability of fatalities during wildlife attacks.

This continuous and inevitable phenomenon has drawn the attention of conservationists and decision makers alike. This has resulted in the development of policies and strategies such as the Wildlife Conservation and National Parks Act 1992, Wildlife Policy 2013, Comminity-Based Natural Resources Management (CBNRM) policy 2007, elephant management and action plan 2021, HWC strategy for Kgalagadi & Ghanzi districts 2020, National Biodiversity Strategy & Action Plan 2016 etc. These pieces of legislation are both directly and indirectly geared towards reducing HWC. However, in the absence of a holistic policy combating HWC, as is the case currently, efforts may render futile. Further, failure to effectively abate HWC compromises meeting the vision 2036 pillars particularly 'sustainable economic development' and 'sustainable environment' which speak to better and resilient livelihoods, as well as disaster risk reduction given that HWC erodes livelihoods and makes them vulnerable to hunger and poverty. This also hinders the achievement of Sustainable Development Goals, especially goals 1 and 2 on ending hunger and poverty which are aligned with the aspirations of Vision 2036.

2. LITERATURE REVIEW

2.1 Injuries and Fatalities Resulting from Human-Wildlife Conflict

Studies on human attacks by wildlife in other parts of the world are broad and explain the issues from various perspectives. Nonetheless, there is a general consensus that attacks on humans especially non-fatal ones are under reported (Inskip & Zimmermann, 2009). To some, the decision to under-report the incidents is deliberately made to avoid scaring potential tourists to various destinations (Barrreiros et al., 2019). Notwithstanding that, Conover (2019) estimated the number of people injured and killed annually by wildlife and those infected by a zoonotic disease in the United States of America (USA) and reported that approximately 174,000 people are injured and sickened while about 700 are killed by wildlife annually. Still in the USA, Cherry et al. (2018) investigated human injuries resulting from bison interactions at Yellowstone National Park between 2000 and 2015.The study found that human-bison encounters resulted in 25 injuries, which included 21 visitors and 4 employees. Majority of the victims were older and were female.

Kudrenko et al. (2020), published a study on human casualties caused by brown bears in Russia. A total of 338 incidents of brown bears that led to injuries and deaths between 1932-2017 were recorded. In Nepal, Acharya et al. (2016) studied the spatial and temporal patterns of human-wildlife conflicts caused by large mammals between 2010 and 2014. The authors noted that Asiatic elephants and common leopards were responsible for most attacks and fatalities on humans. These attacks mostly occurred in the winter season, both in and outside protected areas. In Mozambique, 265 people were reported killed while 82 were injured during conflicts with wildlife between July 2006 and September 2008. Crocodiles were responsible for most deaths accounting to 66% (Dunham et al., 2010).

2.2 Probability of Fatalities During Human-Wildlife Conflict Attacks

Most of the studies examined ecological factors in predicting the risk of attack on humans (Kushnir et al., 2014; Nyhus, 2016; Naha et al., 2018). Our study, however, will focus on determining the predictors that increase the probability of fatality in the case of wildlife attacks. We consider the ecological/environmental factors (season and animal type), demographic factors (age and gender) as well as geographic factors being location (district) and proximity to health facilities (distance). The logistic regression model was used in predicting the probability of fatalities. Below are some of the studies that have investigated factors associated with increased likelihood of fatality resulting from an attack.

Nicholl et al. (2007) explored the relationship between the distance that patients in emergencies travel to seek medical care in a hospital, as a geographic factor and fatality rates. The observational cohort study sought to understand 10, 315 patient cases with life-threatening conditions including accidents. Results revealed that increased travel distance to a hospital was associated with increased risk of fatality. This was however not changed by adjustment for confounding by age, sex, clinical category and the severity of the illness.

Singh et al. (2021) conducted a study on the patterns of injuries due to HWC which have become a public health challenge not only in Eastern India but worldwide. The cross-sectional study investigated the demographics of the victims, type of injury and its pattern as well as the after-effects of the attack. Findings revealed that the mean age of the victims was 46 years with a male to female ratio of 4:1. Elephants were associated with most wild mammalian attacks, and these occurred early mornings (4am to 8am). The attacks were responsible for polytraumas, lacerations, soft tissue injuries and neurotoxicity which may result in death.

A study conducted in Nepal, Acharya (2016) analysed the trends of human injuries and fatalities caused by HWC. The factors considered were, species involved, time/season, location and whether the incident was within or outside protected areas (PA) boundaries. The study used available national survey data on attack incidents as well as their spatial-temporal dimensions collected from 2010 to 2014. A logistic regression approach and Fisher's exact tests were employed to analyse the data. The Asiatic elephants and common leopards were responsible for a significant number of attacks and fatalities. The elephant attacks were high in the winter season and majority occurred in human settlements, outside the PAs making them HWC hotspots.

In Kenya, Mukeka et al. (2019) analysed how HWC vary across several wildlife species, seasons, years, and region with the view to quantify its extent, cause and effect. The data used was collected by the Kenya Wildlife Service in Narok county during the period 2001 to 2017. Results showed that majority of the conflicts were caused by elephants followed by buffalos. Further, the results revealed that high incidents were recorded in the late wet season and during the drought years that the region experienced. The outcomes were both injuries and fatalities.

In addition, there is a dearth of information on studies that have used the logit model to predict fatalities in the event of an attack. A typical example is that of Acharya et al. (2016) who modelled three predictor variables namely, location, season, and the wildlife species responsible for the attack. Hence, the need to conduct the current study to close the gap.

2.3 Epidemiology Theory and Human-Wildlife Conflict

This study is guided by the epidemiology theory. The theory was initially used to study the relationship between environmental factors and diseases, and was later extended to study causal relationships between environmental factors and accidents (Gordon, 1949). In this paper, HWC incidents resulting in casualties are regarded as accidents, hence the adoption of this concept.

Gordon (1949) identified three sources that result in accidents; these are the host, agent, and environment. The combination of forces from these three sources results in an accident. The theory postulates that, accidents are likely to occur (though inevitable) when the host characteristics predispose them to disease, injuries and ultimately death. These causes of accidents lie within people themselves and include factors such as age, sex, and race. On the other hand, agents concerned with injuries and accidents are either physical, chemical or biological in nature. Lastly, the environment is composed of three major elements, the physical, biologic and socio-economic, which can make one susceptible to diseases or injuries (Gordon, 1949). Therefore, an accident is a result of these interwoven factors that reside in the agent, host and environment as depicted in figure 1.

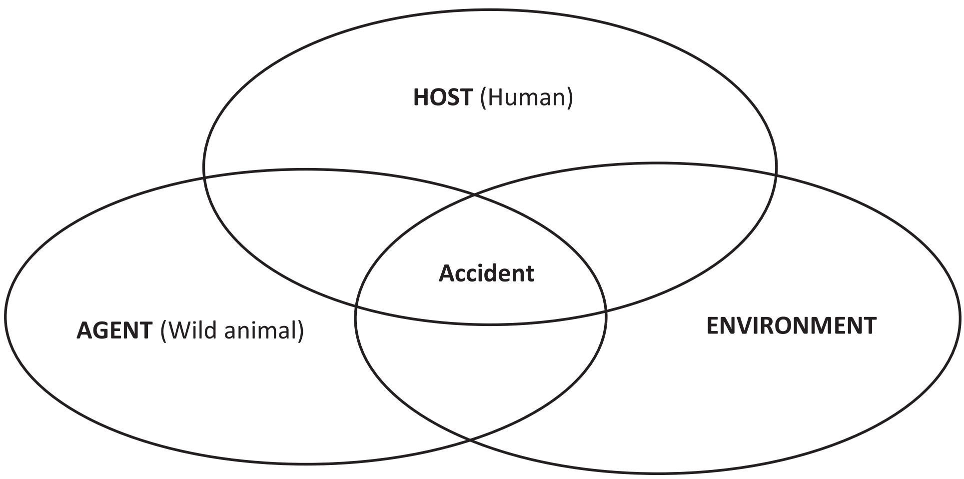

Fig 1: The epidemiology framework; adapted from Gordon (1949).

Contextualizing the theory to HWC, the inborne characteristics of human beings (host), their race, age, gender, and their perceptions towards wild animals predispose them to accidents, which results in either injury or death. For example, old people and children are likely to be more susceptible to injuries and deaths during HWC accidents.

Wild animals' (agents) physical, biological, or chemical characteristics can influence whether an accident takes place or not. People's assessment of the risk at hand when confronted by a wild animal determines whether an accident takes place or not. Some animal's behavior and characteristics differ, with some being big in size, venomous, strong, and aggressive which makes it unlikely to be waded off by human might, whereas some are so weak that a person can easily defend themselves against. In making a decision that can lead to or abate an accident to happen, these wild animals' characters play a pivotal role.

The environment within which a person lives also can predispose one to injuries or death. The physical environment, including the climate and weather, seasons, topography and soils, can influence the interactions of the host (human beings) and agent (wild animals). Their convergence will always result in an accident (HWC incident), which might result in injuries or deaths. For instance, wild animals often migrate during droughts in search for water and food and often encroach in human settlements. When the two (wild animals and people) meet, conflicts ensue.

3. METHODOLOGY

3.1 Study Area

The study focused on all the six (6) wildlife districts of Botswana being Ngamiland, Chobe, Kgalagadi, Central, South Central and Gantsi (Figure 2). This is despite the fact that Botswana's wildlife endowment including the 'big five' is mostly concentrated in the Northern part of the country, primarily Chobe and the Northwest (commonly known as Ngamiland) regions where the prominent Okavango Delta World Heritage site is located (Blackie, 2019). This is necessitated by the fact that HWC is currently topical hence the study used national statistics of these incidents which now occur across the country.

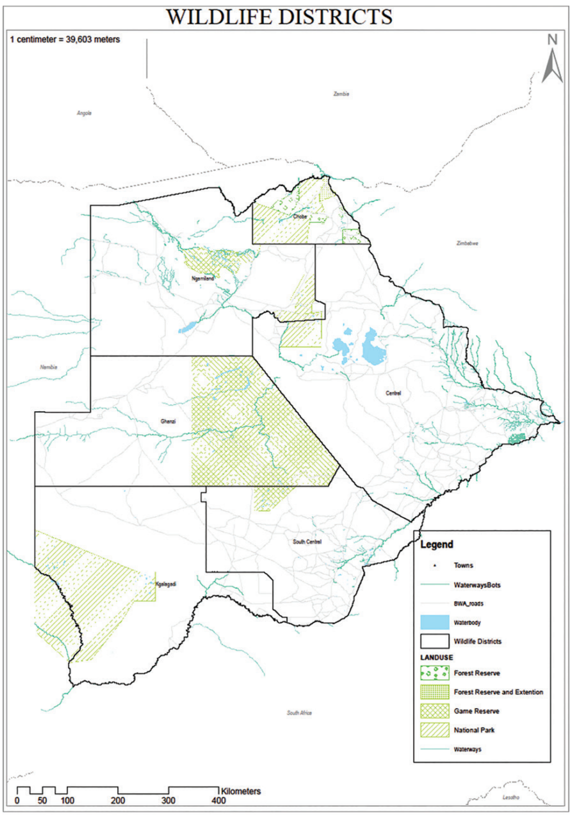

Fig 2: Wildlife districts of Botswana

3.2 Data and Sample

The study was conducted during times when human movements were restricted under COVID-19 prevention protocols, research activities were also suspended at the time. This made it impossible to undertake any interactive field work. The study, therefore, uses secondary data sourced from wildlife district offices of the DWNP in the Ministry of Environment, Natural Resources Conservation and Tourism. The data was collected from HWC incidences reported by the community to wildlife officers. Therefore, it focuses on immediate fatalities. The data characterizes the moment of the incident and does not include follow up data for those deceased at the time of the incident. The data includes the demographic characteristics of the victims, the animal responsible for the casualty as well as the location of the incident.

A total of 137 incidents of casualties are recorded between 2009-19 countrywide and are all used in the analysis. For a national study, the population was relatively small to sample from. Therefore, the study employed a total population sampling approach.

3.3 Data Analysis

For analysis, the study uses descriptive statistics to provide a summary for the sample data statistics. Further, a logistic regression model is used to predict increased probability of death by victims in the case of attacks determined by several parameters namely, location, age, gender, animal, season and proximity to health facility. The dependent variable, casualty is a binary outcome coded 1 for death and 0 for injuries. According to Greene (2017), the model is thus specified as.

$$Y^* = \alpha + \beta_i x + \varepsilon_i$$

Y^* is a latent variable that cannot be directly observed by the analyst. However, the analyst has data on casualties from an HWC incident. Therefore, it is possible to estimate the value of the latent variable Y^*. To do this, the following model is used; $Y^* = \alpha + \beta_i x + \varepsilon_i$ where Y_i is the outcome of victim i, it equals 1 if the attack resulted in death and 0 if otherwise. x_i are characteristics associated with victim i while ε is a random error term that is assumed to follow a logistic distribution (Train, 2005). β_i are the parameters to be estimated. The βs in the logistic regression are log of odds and can be interpreted as such. However, to give them a probability meaning, and to ease interpretation, logistic regression results are usually presented as marginal effects.

According to Norton et al. (2019), marginal effects are a beneficial way to describe the average effects of changes in the explanatory variables on the change in the probability of outcomes in the logit regression. The marginal effects are basically derivatives which show the effect of an additional unit change on the outcome variable for continuous variables and the effect of being in any given category compared to a reference category for a specific variable for categorical variables.

4. RESULTS AND DISCUSSIONS

The results in Table 1 indicate that victims of average age 45 years were injured while those of average age 47 years died following HWC attacks. Those injured were on average, 92 km away from the nearest health facility whereas those who died were on average,109 km away from the nearest health facility. There was a significant difference between distance to the nearest health facility and casualty at 10% significance level. Health facility in this study refers to a hospital and excludes clinics, health posts and mobile clinics. The hospital was chosen over other health facilities because it has various health specialists and has amenities to fully handle HWC victims unlike other health facilities.

There were more deaths than injuries for both males and females accounting for 60% and 53%, respectively. Most injuries were in spring (52%) while most deaths occurred in winter (71%). There was a significant difference between wildlife districts and casualty at 5% significance level while animal and casualty were different at 1%.

Table 1: Mean of predictor variables by HWC casualties

Variables	Injury	Casualty Death	t-value
Age (years)	44.9	47.0	0.69.8
Dist. to health facility (km)	92.0	108.9	1.088*
			χ^2 value
Gender			0.629
Male	40.2	59.8	
Female	46.7	53.3	
Season			0.234
Summer	45.0	55.0	
Autumn	43.3	56.7	
Winter	28.6	71.4	
Spring	52.0	48.0	
Wildlife District			15.983**
Kweneng	14.3	85.7	
Chobe	53.3	46.7	
Central	28.6	71.4	
Ngamiland	46.2	53.9	
Kgalagadi	0.0	100.0	
Gantsi	0.0	100.0	
Animal			40.655***
Leopard	3.3	96.7	
Lion	8.3	91.7	

Elephant	34.4	65.6
Buffalo	30.0	70.0
Crocodile	57.1	42.9
Black mamba	66.7	33.3
Hippo	38.5	61.5
Hyena	0.0	100.0

Note: *, **, ***=significant at 1%, 5% and 10% level. Figures for continuous variables are means, while for categorical variables are percentages.

4.1 Predictors of Human-Wildlife Conflict (HWC) Fatalities

Table 2 shows predictor variables used in the logit regression model and their explanation. Kgalagadi and Gantsi wildlife districts recorded incidents of 3 each, while hyena and hippo recorded 1 and 3 incidents respectively, hence these variables were dropped in the analysis due to few observations.

Table 2: Explanation of variables used in the model

Variable	Explanation
Casualty (dependent)	Dummy; 1 for death and 0 for injury
Age	Continuous, in years
Distance to health facility	Continuous, in kilometers
Gender	Dummy; 1 for male and 0, otherwise
Season	Seasons of the year categorized as;
Summer	Dummy; 1 if summer
Autumn	Dummy; 1 if autumn
Winter	Dummy; 1 if winter (reference group)
Spring	Dummy; 1 if spring
Wildlife districts	Wildlife districts in Botswana categorized as;
South Central	Dummy; 1 if South Central
Chobe	Dummy; 1 if Chobe
Central	Dummy; 1 if Central
Ngamiland	Dummy; 1 if Ngamiland (reference group)
Kgalagadi	Dummy; 1 if Kgalagadi
Gantsi	Dummy; 1 if Gantsi
Animal	Species responsible for HWC categorized as,
Leopard	Dummy; 1 if Leopard
Lion	Dummy; 1 if Lion
Elephant	Dummy; 1 if Elephant (reference group)
Buffalo	Dummy; 1 if Buffalo
Crocodile	Dummy; 1 if Crocodile

Black mamba	Dummy; 1 if Black mamba
Hyena	Dummy; 1 if Hyena

The model is significant (p=0.000) at 1% level implying that the explanatory variables used in the model are suitable in explaining the probability of fatalities associated with HWC attacks (Table 3). Thus, the data fits the model well. A Pseudo R2 of 31 % was recorded. Evidence suggests that a Pseudo R2 >20% shows a good fit for the model (Johnson & Hensher, 1982).

Table 3: Probability of HWC fatalities

Variable	**dy/dx**	**Std. Err.**	**Z**	**P>z**	**[90%**	**C.I.]**
Age	-0.019	0.013	-1.42	0.156	-0.045	0.007
Age squared	0.000	0.000	1.82	**0.069**	0.000	0.001
Gender	-0.163	0.134	-1.22	0.224	-0.425	0.099
Autumn	-0.157	0.132	-1.19	0.236	-0.416	0.102
Spring	-0.929	0.139	-0.67	0.505	-0.366	0.180
Summer	-0.258	0.113	-2.29	**0.022**	-0.480	-0.037
Kweneng	0.093	0.250	0.37	0.708	-0.396	0.583
Chobe	-0.092	0.136	-0.68	0.499	-0.358	0.174
Central	-1.694	0.131	-2.38	**0.017**	-2.057	0.593
Leopard	-0.479	0.077	-6.22	**0.000**	-0.630	-0.328
Lion	-0.319	0.079	-4.05	**0.000**	-0.474	-0.165
Buffalo	0.201	0.153	1.31	0.189	-0.099	0.501
Crocodile	-0.147	0.167	-0.88	0.378	-0.475	0.180
Black mamba	0.074	0.253	0.29	0.769	-0.421	0.570
Dist. health facility	1.697	0.162	1.92	**0.055**	0.043	1.984
Constant	3.495	0.387	2.04	0.041	1.975	4.860
Number of observations		137				
LR chi^2(15)		57.88				
Prob> chi^2		0.000				
Log likelihood		-63.725575				
Pseudo R^2		0.3123				

To avoid assuming that the effect is linear across ages, the square of the variable age was calculated. The results show that age was not very impactful (0.000) however the effect portrayed a positive relationship with fatalities. This finding implies that older individuals are likely to die from attacks than younger persons. This is so because elderly people often suffer from chronic illnesses which lowers their chances of survival during attacks. Additionally, as people grow older their physical abilities are compromised making it difficult to withstand or defend themselves. Nonetheless, caution should be exercised when interpreting these results because younger children will also be helpless in the event of HWC attacks. The results obtained in this study support what the epidemiology accident causation theory postulates regarding the host (human beings), that age as an inborne human characteristic can predispose one to accidents (Gordon, 1949).

Findings reveal that the type of season was significant and has a negative relationship with HWC fatalities. In summer, the likelihood of deaths from HWC attacks was lowered by 2.6% than in winter. The winter season is usually characterized by limited surface water, reduced vegetation cover and frequent fires (Lindsey et al., 2011; Becker, 2013). Availability of surface water network outside protected areas tend to exacerbate out migration of elephants and other dangerous mammals outside protected areas to new ranges and often in human settled areas (Bennitt, et al., 2014). These are the main push predictors for wildlife encroachment into human settlements in search for food and water, where the two (wildlife and human beings) meet, conflicts ensue. Furthermore, in winter there is limited agriculture food supplies including fodder, hence human beings also encroach into wildlife habitats in search of pasture to graze their livestock.

The Central Wildlife District as a dummy for location is found to be associated with low probabilities of fatalities compared to Ngamiland Wildlife District. Individuals from Central were less likely to die from attacks than in Ngamiland by 16.9%. Most HWC incidents in Botswana are recorded in Ngamiland, where abundant wildlife is found. Ngamiland is home to the world-renowned Okavango Delta, a Ramsar site and a UNESCO World Heritage Site. According to Statistics Botswana (2016), there were 767 lions, 706 elephants, 407 wild dogs, 307 leopards, 170 crocodiles, 45 hippos, 14 cheetahs and 2 buffalo incidents in Ngamiland in 2014. Studies also point to Ngamiland as a HWC hot spot (Songhurst et al., 2015; Karidozo et al., 2016), hence it is not surprising that many attacks and fatalities are documented in the district.

As for the animals involved in HWC, leopards and lions are found to be less likely to result in deaths compared to elephants in the case of attacks. Leopard and lion attacks are less likely to result in fatalities by 4.8 % and 3.2%, respectively in comparison to elephants. Most deaths in HWC incidents in Botswana are by elephants, while the other animals were responsible for most injuries. Due to their huge bodies, elephants have a high requirement for food and water and where their demands are not met, they often traverse long distances outside protected areas in their search, raiding crop fields and attacking people in the process. These findings support those of Mukeka et al. (2018) who documented that, elephants have large home ranges as they trek long distances in search of food and water leading to increased conflict along the way. Also, the HWC situation is not helped by the fact that elephant bulls compared to cows and calves, often destroy branches, and push over stems of large trees to access browsing material, and sometimes as a way of 'confidence building' and muscular training (Barnes et al., 1994; Midgley et al., 2005). Additionally, adult elephant bulls periodically experience musth, a condition associated with increased androgen levels in the blood which results in aggressive behavior (De Nys et al., 2010). Elephant bulls in musth often attack and kill other animals and people and may destroy almost anything along its way. Currently, there are between 120 000 to 160 000 elephants in Northern Botswana (GoB, 2021). Thus, the country holds the highest population of elephants in Africa (Thouless et al., 2019). Therefore, elephants encroached into hinterlands, areas that they previously did not occupy such as the Kgalagadi and the Southern districts. According to GoB (2021), nearly half (42.7%) of the conflicts recorded in 2019 were due to elephants.

There is a significant relationship between fatalities and the distance to the nearest health facility. The longer the distance the victim travels from the HWC incident scene to the nearest health facility, the more likely they are to die before receiving medical attention. Moreover, most HWC incidents happen in remote areas with poor telecommunication facilities and rough terrains which prolongs the response time by health personnel. In some instances, there is need to air lift the victims to the nearest health facility due to accessibility challenges (especially in the Delta) and it might take several hours for the aircraft to arrive at the scene which also increases the likelihood of the victim to die. The above discussion is in sync with both the agent and the environment aspects of the epidemiology theory which hypothesised that, the agent characteristics (wild animals) as well as the geographic, ecological, climatic, and topographical environment can make one vulnerable to accidents (Gordon, 1949).

5. CONCLUSIONS AND POLICY IMPLICATIONS

The primary objective of this paper is to determine predictors that increase the probability of fatalities from animal attacks. The main predictor variables that are significant are age of victims, season, location, animal type and proximity to a health facility. Older victims, the winter season, Ngamiland Wildlife District, elephants, and distant health facilities present an increased probability of fatality from animal attacks. In conclusion, increased probability of fatality is a result of various factors such as demographic, ecological and/or environmental and geographic. Therefore, a holistic approach is needed to address HWC. As a policy implication, Government (Ministry of Environment, Natural Resources, Conservation and Tourism) is encouraged to develop a HWC Policy which will holistically provide guidance, consistently and efficiently to decision makers on HWC related issues covering all species of concern countrywide. Regarding the animal type, there is need for continuous sensitization of communities about animal behavior which should also tap on indigenous knowledge of the locals and increase community engagement on mitigating HWC by relevant stakeholders such as the district wildlife personnel. There is also need to take health services to the people and equip those already existing facilities with the latest equipment and medical specialists who would attend to HWC casualties timely to avoid loss of lives.

Further studies should explore some more predictor variables, such as the time, educational level, ethnicity in order to enhance HWC prevention strategies including follow-ups of those injured.

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