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Evaluation of the 2014-2016 Droughts on Provision of Prehospital Services in the Kingdom of Swaziland

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An abstract of
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Rollins School of Public Health of Emory University
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2018

Abstract

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By Anjni Patel Joiner

Background: Swaziland, a country of 1.3 million, experienced severe droughts between 2014-2016. The impact of this drought on provision of emergency medical services (EMS) is unknown. This study aimed to assess the impact of drought on EMS response and utilization in Swaziland.
Methods: We performed a review of emergency calls placed to Swaziland EMS from 1/28/2014 to 7/11/2017. We used a before and after study design with drought (between October 2014 to November 2016) as exposure. The main outcomes were chief complaints and 3 ambulance response time intervals, analyzed using mixed-effects quantile regression (50^{th}, 70^{th}, and 90^{th} percentiles), adjusted for age, sex, and shift, and clustered by administrative region. Chief complaints were aggregated into 10 categories and analyzed as outcomes separately, summarized with Mantel-Haenszel risk ratios, stratified on propensity score quintiles.
Results: We reviewed 136,540 consecutive calls. Median call-to-dispatch, dispatch-to-scene, and scene-to-facility times were 29 minutes, 27 minutes, and 39 minutes, respectively. The 50^{th} percentile of call-to-dispatch time increased by 13 minutes (95%CI 10-16), 70^{th} percentile increased by 32 minutes (95%CI 27-37), and 90^{th} percentile increased by 67 minutes (95%CI 57-78) during the drought. Other response times were unrelated to the drought.
Hypertension-related calls increased during the drought (RR = 1.17; 95%CI: 1.08-1.28). We found a reduction in calls during the drought for GI (RR = 0.97; 95%CI: 0.94-0.99), HIV (RR = 0.84; 95%CI: 0.79-0.89), malnutrition (RR = 0.78; 95%CI: 0.66-0.93), seizure (RR = 0.91; 95%CI: 0.83-0.99), and injury (RR = 0.94; 95%CI: 0.91-0.96) calls. There was no significant association between drought and calls related to respiratory, tuberculosis, diabetes, or obstetric-gynecologic emergencies. There were 2.03 more calls per day (95%CI: 1.92 - 2.14) in the drought period.
Conclusion: Increased number of calls per day and increased delays in call-to-dispatch times with no changes after ambulance dispatch suggest a strain on EMS resources during the drought period. Very small changes in chief complaint categories do not allow for an obvious interpretation.

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TABLE OF CONTENTS

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Conclusion: Increased number of calls per day and increased delays in call-to-dispatch times with no changes after ambulance dispatch suggest a strain on EMS resources during the drought period. Very small changes in chief complaint categories do not allow for an obvious interpretation.

INTRODUCTION

Between 2000 and 2017, nearly 400 million people worldwide were affected by drought. Just under 230 million of these people were in Africa [1]. With changes in climate over the last several decades, drought is becoming an increasing concern in many parts of the world. Projections indicate that Southwestern regions of Africa are at a high risk for severe droughts throughout the 21st century [2]. Little is known of the impact of drought on emergency conditions and prehospital care in this area of the world.

Unlike other natural disasters, such as hurricanes or earthquakes, droughts are typically insidious in onset, geographically widespread, and may last several months to years. Impacts of drought can extend across multiple sectors, including economic, agricultural, and health [3]. The magnitude of these effects is further dependent on the socioeconomic characteristics of the affected region and the duration of the drought period [4]. In low- and middle-income countries (LMICs), drought can lead to significant economic effects, loss of livelihood and farmland, lack of access to clean water, migration, famine and malnutrition [5]. Given multiple direct and indirect health impacts, direct attribution of drought-related morbidity and mortality can be challenging to quantify.

The Kingdom of Swaziland is a landlocked country along the western edge of South Africa with a population of 1.3 million [6]. Swaziland was impacted by a severe drought during the 2014-2015 and 2015-2016 rainy seasons that affected much of drought-prone southwestern region of Africa. Described as the worst in 30 years, the drought affected an estimated 12.3 million people [7, 8]. During the 2015 and 2016 rainy season rainfall

levels were down by 50% and dam levels in Swaziland were as low as five percent capacity. The county experienced a significant reduction in production of the two major crops, maize and sugarcane, down 80 and 64% compared to the previous year, respectively. Additionally, health care facilities were noted to underprepared to respond to drought effects and noted an increase in drought-related conditions such as diarrhea, skin conditions, and malnutrition [7].

Recent focus on the development of emergency care systems in LMIC countries is the result of increasing rates of death and disability from trauma and acute illnesses, the majority of which occur prior to arrival to a hospital. Development of these systems in LMIC settings has demonstrated improvements in patient outcomes from trauma [9-12]. However, information on how well these systems can adapt to respond to prolonged natural disasters in these countries is lacking. Emergency call data from these systems can also be utilized to determine key conditions and target specific areas of need for further public health assistance and planning.

In 2008, the Ministry of Health (MOH) in Swaziland created the Department for Emergency Preparedness and Response with primary responsibilities of coordinating and leading health emergencies and disasters and also tasked with the provision of prehospital care through a formalized national EMS system [13-15]. The prehospital personnel are trained by South African standards, with three levels of training: Basic Ambulance Attendant (BAA) - a Basic Life Support certification, Ambulance Emergency Assistant (AEA) - an International Life Support certification, and Critical Care Assistant (CCA) -

and Advanced Life Support certification. The service runs 24-hours per day and seven days per week with approximately 32 ambulances stationed at 16 bases throughout the country. Ambulances respond to calls placed by citizens through the country's dedicated free national emergency number, 9-7-7, in addition to calls from more rural hospitals and clinics for interfacility transports. Since implementation of the service, the utilization of the service has grown steadily and is widely recognized and accepted throughout Swaziland.

Evaluation of key conditions during drought and non-drought periods is important in order to improve integration of EMS services within the context of future disaster planning, public health interventions and response. It is unclear how the impact of the drought has affected prehospital services in the country. To address this, we aimed to assess the impact of the 2014-2016 droughts in Swaziland on EMS response times, call frequency and types of call complaints.

METHODS

Population and Setting

The national EMS system in Swaziland is utilized for both inter-facility and on-scene transports throughout the entire country by calling a free national emergency number, 977. Ambulances are based at 16 different dispatch centers throughout the country. The only call center in the country is housed at the Swaziland EMS headquarters in the capital Mbabane.

Since the implementation of the EMS service in 2008, all calls to 9-7-7 have been recorded. Call records were initially on paper, but in January 2014 electronic forms were implemented. This data is entered into an electronic database by MOH personnel. Chief complaints are entered into the electronic database as free-text. Standardized patient care reports filed by field paramedics are still in paper form. The call center is staffed by up to 8 personnel during peak hours to answer 9-7-7 calls. A single dispatcher is on shift at any time. Dispatchers work either day shift or night shift, with day shift workers staffing the center from 8:00 AM to 5:00 PM and night shift dispatchers working from 5:00 PM to 8:00 AM. All dispatch and call center agents are trained at least to the BAA level. No formal triage system is utilized to dispatch ambulances to priority calls, however dispatchers are trained to preferentially dispatch ambulances to road traffic accidents.

Institutional Review Board

This study was approved by the Swaziland Ministry of Health Ethics Committee, and by the Institutional Review Board at Emory University (IRB # 00094951).

Statistical Analyses

We reviewed all emergency calls placed to the Swaziland EMS call center from 1/28/2014 to 7/11/2017. The drought period was determined to be from October 2014 to November 2016 based on data and information from the Swaziland Ministry of Health. Chief complaints were placed into the following 10 categories: respiratory complaints, HIV, tuberculosis (TB), malnutrition, hypertension, seizures, diabetes, gastrointestinal illnesses (GI), obstetric-gynecologic emergencies (OBG), and injuries. Categories were

chosen prior to analysis on the basis of common complaints and hypothesis and were categorized based on algorithms using keywords identified in the text field.

Three different categories of response times were studied. Call-to-Dispatch time indicates time from the initial 9-7-7 call to the call center to the time that the dispatcher located an available unit and dispatched the unit to the scene. Dispatch-to-scene time is the time from initial ambulance dispatch to arrival on scene. Scene-to-Destination time indicates time from the ambulance arrival on scene to completion of transport to a health care facility.

Descriptive Statistics: Categorical variables (e.g. Types of Complaint) were described using percentages and 95% confidence intervals. Confidence intervals were computed using an intercept-only mixed-effects/multilevel logistic regression because patients were clustered within administrative region. Continuous variables (e.g. Response Times) were described using medians and 95% confidence intervals. Confidence intervals were computed using an intercept-only mixed-effects/multilevel quantile regression because patients were clustered within administrative region and ambulance team.

Multivariate Analyses: Call-to-Dispatch, Dispatch-to-scene, and Scene-to-Facility times were analyzed using a mixed-effects/multilevel quantile regression. In order to explore the impact of the drought on response times, three quantiles were examined: the 50th percentile/median, the 70th percentile, and the 90th percentile. 95% confidence intervals and p-values were used to evaluate the effect of the drought. The following

covariates/confounders were included in the regression: gender of the caller, age of the caller, type of complaint, day vs night shift, administrative region, ambulance team, and time since the beginning of data collection.

To examine the effect of the drought on Type of Complaint, initial attempts were made to conduct mixed-effects/multilevel logistic regressions. However, model estimation failed due to small cell counts. Instead, gender of the caller, age of the caller, day vs night shift, administrative region, ambulance team, and time since the beginning of data collection were used to computed propensity scores. Callers were then stratified into 5 strata on the basis of the propensity scores and the effects of the drought were examined using the Mantel-Haenszel risk ratio.

RESULTS

A total of 136,540 calls were reviewed, 90,532 (66.3%) of these calls occurred during the drought period. During the non-drought period, there was an average of 6.96 calls per day (95% CI: 6.61 - 7.73), compared to 14.11 calls per day on average during the drought period (95% CI 13.69 - 14.58). Drought periods were associated with a 2.03 times increase in the average number of calls per day (95% CI: 1.92 - 2.14). Females accounted for 58.8% of patients and the median age of patients was 29 years. The Hhohho region accounted for the largest number of calls at 37.9%, followed by Manzini at 32.3% and Lubombo and Shiselweni at 15% or less. The distribution of calls between night and day shifts was fairly equivalent, with 49% of calls occurring during the day and 51% of calls at night.

The median call-to-dispatch time, dispatch-to-scene time, and scene-to-facility time were 29 minutes, 27 minutes, and 39 minutes, respectively. Calls for GI illnesses, injury-related calls, and OBG emergencies comprised the largest percentages of overall calls at 25.93%, 23.72% and 22.48%, respectively. Diabetes-related calls, TB, malnutrition and seizure-related calls were the lowest frequency calls, all less than 4%.

Call-to-dispatch time increased during the drought period, with an increase of 12.79 minutes (95% CI: 10.05-15.48) at the 50th percentile, an increase of 31.99 minutes (95%CI: 27.24-36.74) at the 70th percentile, and 67.46 minutes (95% CI: 56.81-78.11) at the 90th percentile. There were no statistically significant changes with the drought for the other response times.

Hypertension-related calls increased during the drought period (RR = 1.17; 95% CI: 1.08-1.28). We found a reduction in calls during the drought period for the following categories: GI (RR = 0.97; 95% CI: 0.94-0.99), HIV (RR = 0.84; 95% CI: 0.79-0.89) malnutrition (RR = 0.78; 95% CI: 0.66-0.93), seizures (RR = 0.91; 95% CI: 0.83-0.99), and injuries (RR = 0.94; 95% CI: 0.91-0.96). There was no significant association between the drought and calls related to respiration, TB, diabetes, or OBG.

DISCUSSION

Prehospital medicine in many parts of Africa is still a nascent field. Although EMS services in the Kingdom of Swaziland have been available to the public for a decade at

this point, this is the first detailed analysis of available call center data, and the only analysis of the impact of drought on prehospital services. With projected future increases in drought frequency in many parts of Africa, our findings demonstrate data that may be beneficial to Swaziland and surrounding countries in planning and resource allocation for EMS services during prolonged emergencies such as droughts. This data may also be beneficial in identifying public health needs for preventive measures during drought conditions.

During the drought period, we found increased delays from the time of the initial call to dispatch of the ambulance despite no statistically significant change in ambulance dispatch to scene times or scene to facility times. Given that there were twice as many daily calls on average during the drought period, this suggests that an increase in demand led to a shortage of available ambulances and/or personnel to respond to distress calls. Data on available ambulances and personnel during drought conditions is not accounted for in this analysis.

We found an increase in hypertension-related calls during the drought. The reason for this increase is not clear, particularly given the decrease in HIV and TB-related illnesses. Whether this was the result of inability to access medications for non-communicable diseases or lack of public health focus could be further clarified by investigating hospital records.

Increased respiratory complaints during drought conditions would be expected with what is previously known. Drought is associated with reduction in air quality, from dust, wildfires, and increased particulates in the air and has been linked with increased incidence of respiratory illnesses [16-18]. However, there we found no significant change in the number of respiratory illnesses during drought conditions.

Contrary to reports from the Ministry of Health on the effect of drought on health care centers, we noted a decreased in the number of malnutrition calls. We must note that our data is looking at an EMS service only during the acute phase of the drought. Malnutrition is rarely considered an emergent or acute condition and we do not have data from patients who may have sought aid in clinics or presented to the hospital via alternative transportation. There was also a significant response to the drought by the World Food Program and other non-profits in the delivery of food to people living in rural areas, therefore, fewer people may have called during the acute drought phase and possibly more may have called after the drought was over, after food assistance programs ended. Finally, given the nature of the free-text field for call complaints, it is challenging to identify complaints that are primarily malnutrition or hunger-related, as the caller may not use specific language to relay these conditions.

Despite information from the Ministry of Health regarding an increased number of patients with GI complaints presenting to healthcare facilities, we found a reduction in the number of GI complaints when evaluating call data. GI calls represent a large percentage of overall 9-7-7 calls, with just over 27% of all calls related to a GI complaint.

Given information from the Ministry of Health, it appears that patients with GI illnesses are less likely to call 9-7-7 during the drought.

Limitations

This study has multiple limitations. First, this is a retrospective study design using a database in which chief complaints are entered into a free text field in a database by the call center agent at the time of the call. There is a strong likelihood of misclassification bias, for example, if key information was not entered into chief complaint field by the call-taker at the time of the call, if there were spelling errors or alternate language, or if the algorithm was not fully inclusive.

Drought months were determined using information from the Ministry of Health, including a declaration of a state of disaster, and based on the typical rainy season in Swaziland. These dates may be imprecise due to lack of specific rainfall data in the country. The authors believe the dates to be as accurate as possible given the available information.

Finally, many of the effects of droughts are long-term in nature, such as malnutrition, and may not manifest in the immediate or acute phase. It is challenging to determine when the economic and health effects of a drought are over, as they can linger for several years. The purpose of this study was to determine the effects of an active drought situation on EMS service provision and need.

CONCLUSION

During the acute drought period, Swaziland EMS saw an increase in the number of daily calls and an increase in call to dispatch times, suggesting a strain on resources due to higher call volume. Acute drought conditions were associated with an increase in hypertension-related emergency calls. Future efforts could be focused increasing personnel and vehicles during acute drought conditions and ensuring distribution of medications for non-communicable disease during acute drought conditions.

A standardized chief complaint list and standardization of EMS records would be beneficial in future data collection. Data on addresses or neighborhoods could be analyzed with geographic information systems to determine hotspots for specific presentations and therefore target focused public health interventions to these areas, both during drought and drought-free periods.

Acknowledgements

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Tables and Figures

Table 1. Demographic Characteristics

Characteristic	Count or Median	% or IQR
Calls during the Drought	90,532	66.3%
Sex		
Male	56,195	41.2%
Female	80,344	58.8%
Administrative Region		
Hhohho	51,733	37.9%
Lubombo	20,420	15.0%
Manzini	44,149	32.3%
Shiselweni	20,237	14.8%
Age (years)	29	18 - 42
Shift		
Day	66,852	49.0
Night	69,687	51.0

Note. IQR - Inter-Quartile Range

Table 2. Descriptive Statistics for Type and Complaint and Response Times

Variable	% or Median	95% CI
Respiratory (%)	11.00	10.18; 11.89
HIV (%)	7.92	7.05; 8.88
TB (%)	2.47	2.10; 2.91
Malnutrition (%)	3.26	3.14; 3.38
Hypertension (%)	5.48	3.29; 9.09
Seizure (%)	3.57	3.10; 4.12
Diabetes (%)	3.10	2.82; 3.38
GI (%)	27.35	26.29; 28.44
OBG (%)	22.84	20.88; 24.91
Injury (%)	25.13	23.52; 26.81
Call to Dispatch Time (M)	29.0	28.0; 29.0
Dispatch to Scene Time (M)	27.0	26.0; 28.0
Return from Scene Time (M)	39.0	39.0; 40.0

Table 3. Association Between Drought and Response Times (Quantile Regression: 50th, 70th, and 90th percentiles)

Quantile	Effect	95% CI	p
Call to Dispatch Time			
50th	12.76	10.05; 15.48	<.001
70th	31.99	27.24; 36.74	<.001
90th	67.46	56.81; 78.11	<.001
Dispatch to Scene Time			
50th	2.52	-0.7; 5.73	0.13
70th	0.39	-3.06; 3.84	0.83
90th	-15.33	-174.42; 143.77	0.85
Scene to Facility Time			
50th	1.49	-1.42; 4.41	0.32
70th	1.11	-4.07; 6.29	0.67
90th	-2.48	-11.37; 6.41	0.59

Table 4. Association Between the Drought and Type of Complaint (Mantel-Haenszel Risk Ratio)

Type of Complaint	RR	95% CI	p
Respiratory	1.04	0.99; 1.10	.15
HIV	0.84	0.79; 0.89	<.001
TB	0.99	0.90; 1.11	.95
Malnutrition	0.78	0.66; 0.93	.01
Hypertension	1.17	1.08; 1.28	<.001
Seizure	0.91	0.83; 0.99	.03
Diabetes	1.10	0.99; 1.22	.06
GI	0.97	0.94; 0.99	.02
OBG	1.01	0.98; 1.05	.38
Injury	0.94	0.91; 0.96	<.001

Table 5: Calls per Day by Region

Region	Calls per Day	95% CI
Hhohho	15.99	15.21; 16.82
Lubombo	6.29	5.98; 6.62
Manzini	13.64	12.97; 14.36
Shiselweni	6.22	5.91; 6.55