



# Outbreak Detection and Response: A Country Prioritization Model for West Africa

**Laurie Wallis, MPH**

# Introduction



Large-scale outbreaks are a major threat to global health security.

Outbreak prediction modeling attempts to determine when and where outbreaks may occur, but rarely consider consequences of outbreaks when they emerge.

# Introduction



**Global Health Security Agenda (GHSA) and global outbreak preparedness funding has been in decline, revealing a need for:**

- Analysis to prioritize where and how to engage on global health security issues.**
- Initiatives need metrics to measure effectiveness and prove return on investment.**

# Practicum Research



Literature review following recent large outbreaks reveal a trend in factors that contribute to scale of the outbreak.

- Ebola in West Africa (2014-2015)
- MERS-CoV (2012)
- Swine Flu – H1N1 (2009)
- SARS in Asia (2003)



# Practicum Research



Trends emerged showing the primary factors contributing to outbreak scale are:

- Disease burden in the country (endemic and outbreak disease status)
- Ability of the healthcare system to detect and respond to the outbreak
- Effectiveness of the government and engaging partnerships to control outbreaks.

# Practicum Research



Evaluating countries by quantitative analysis of these three primary factors can be useful for:

- Indicate which countries may be at risk uncontrolled outbreak may take place
- What ways the country could benefit from investment
- Measure effectiveness of engagements to improve these areas.

# Multi-Criteria Decision Analysis



Indicators of factors

Subject Matter Expert Opinion

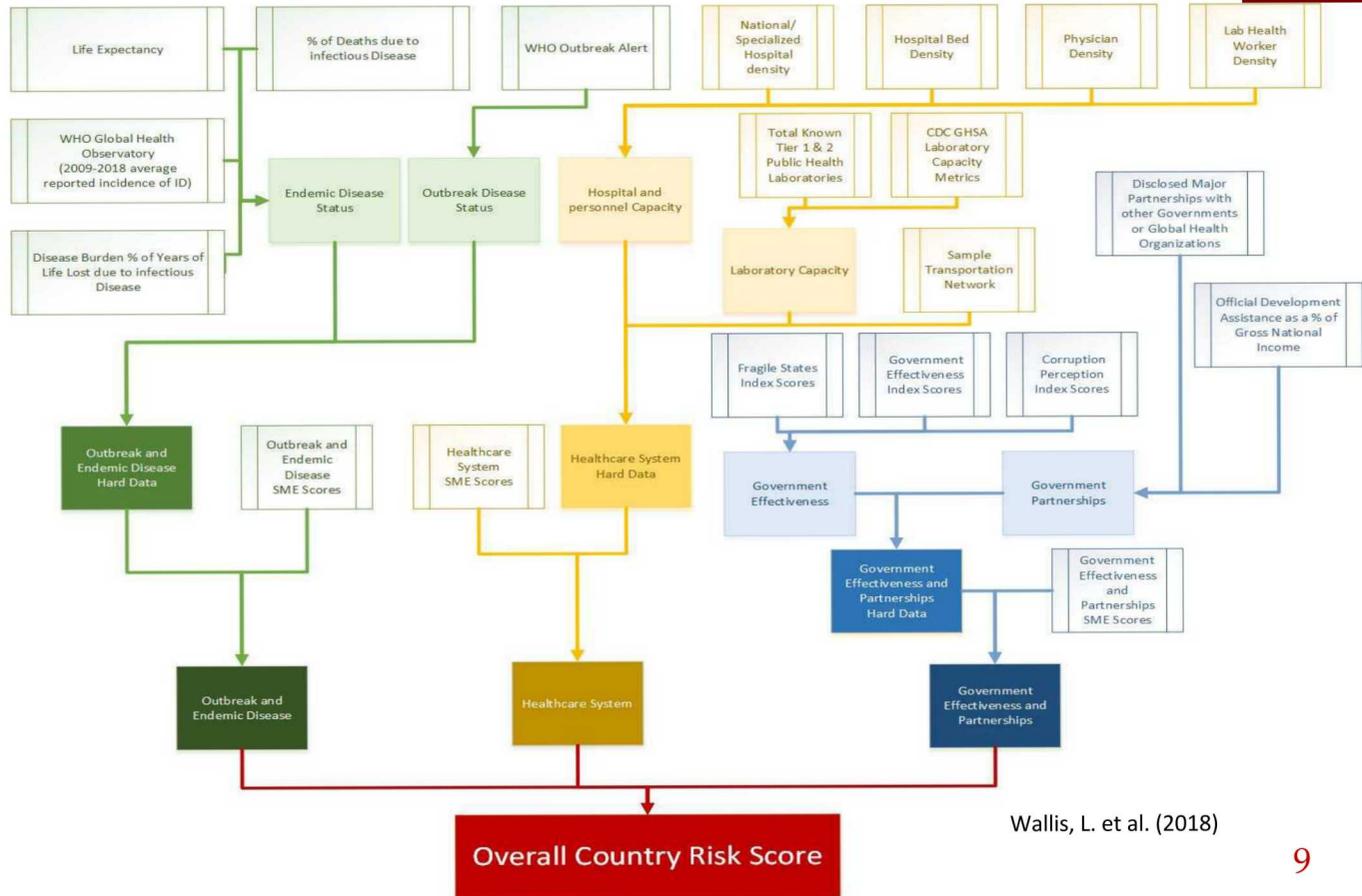
Simple Additive Weights (SAW)

Pilot region

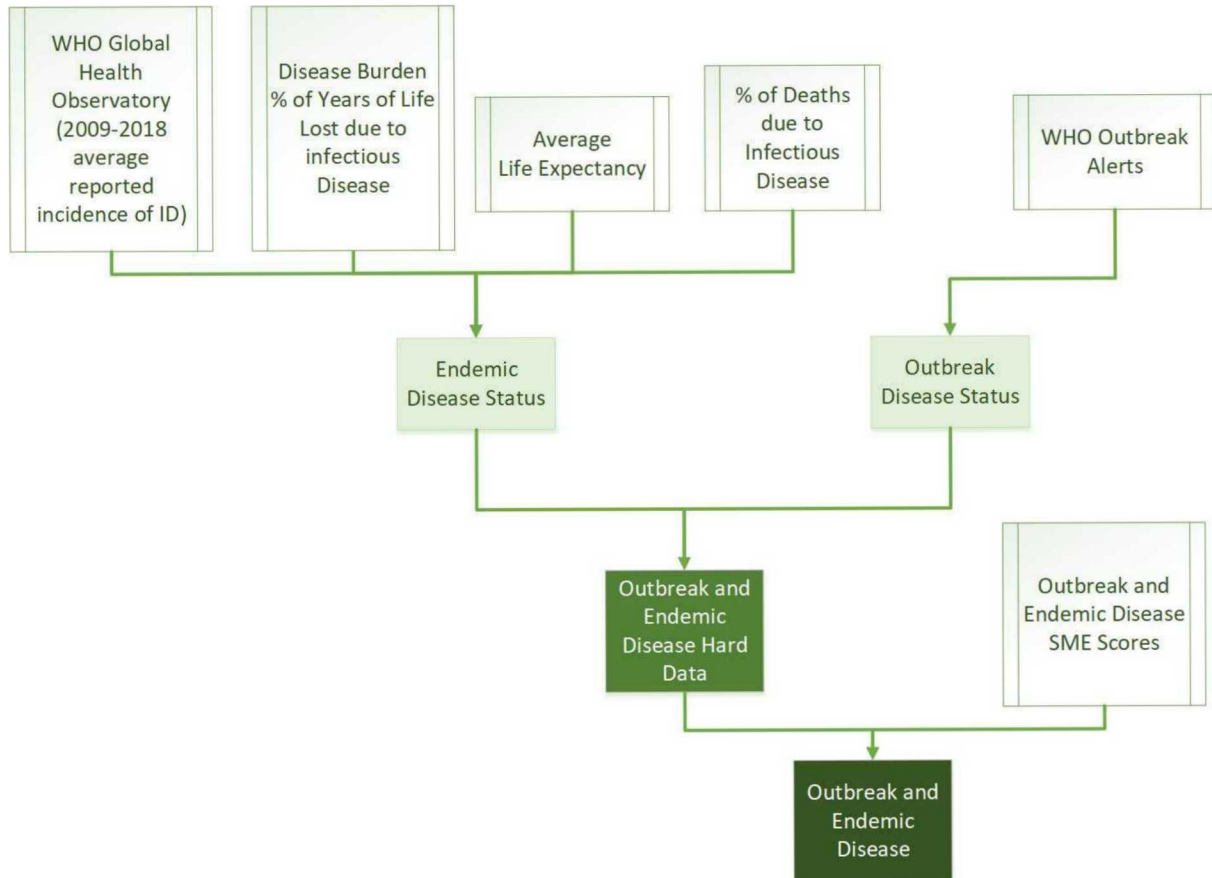




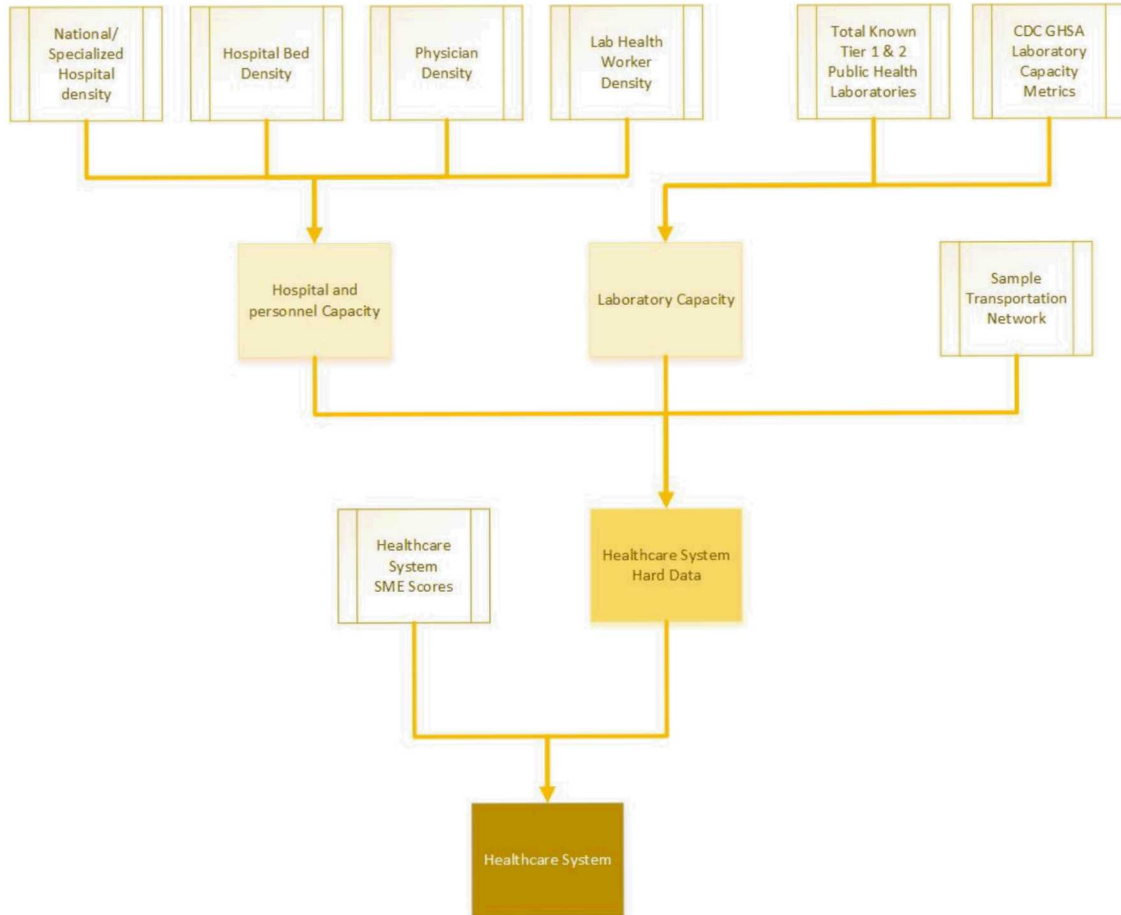
# Methods – Model Architecture



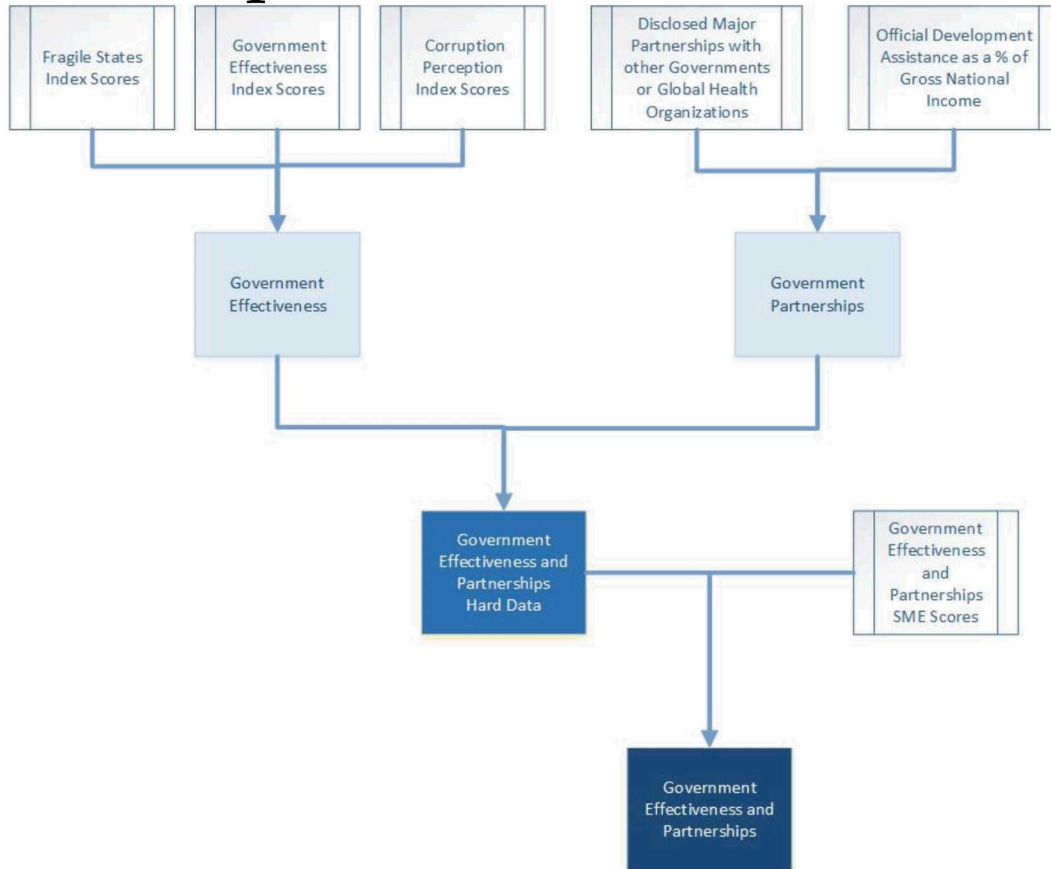
# Outbreak and Endemic Disease



# Healthcare System



# Government Effectiveness and Partnerships



# Results



## West Africa Risk of Uncontrolled Outbreak

Overall  
Risk Scores



Cape Verde  
0.409

The Gambia  
0.480

Senegal  
0.439

Guinea-Bissau  
0.665

Guinea  
0.700

Sierra Leone  
0.627

Liberia  
0.627

Ivory Coast  
0.470

Mali  
0.517

Burkina Faso  
0.527

Ghana  
0.510

Togo  
0.499

Benin  
0.574

Niger  
0.581

Nigeria  
0.565

Wallis, L. et al. (2018)

# Results



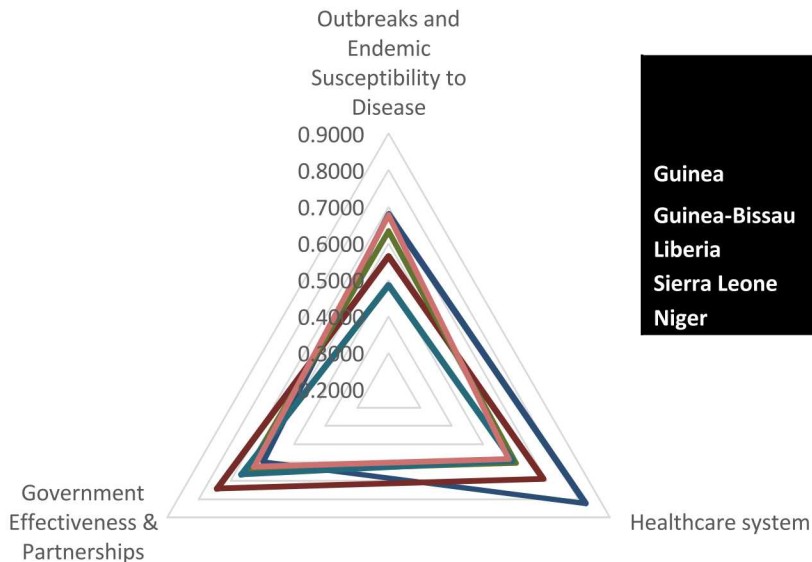
	Outbreaks and Endemic Disease	Healthcare System	Govt. Effectiveness & Partnerships	Overall Country Risk Scores	Rank
Guinea	0.680	<b>0.823</b>	0.597	0.700	1
Guinea-Bissau	0.564	0.688	<b>0.741</b>	0.665	2
Liberia	0.632	0.601	<b>0.647</b>	0.627	3
Sierra Leone	<b>0.677</b>	0.579	0.624	0.627	4
Niger	0.486	0.593	<b>0.664</b>	0.581	5
Benin	0.631	<b>0.703</b>	0.389	0.574	6
Nigeria	<b>0.754</b>	0.472	0.468	0.565	7
Burkina Faso	0.479	<b>0.595</b>	0.506	0.527	8
Mali	0.481	<b>0.547</b>	0.523	0.517	9
Ghana	<b>0.657</b>	0.493	0.381	0.510	10
Togo	0.424	0.533	<b>0.538</b>	0.499	11
Côte d'Ivoire	0.435	0.486	<b>0.489</b>	0.470	12
The Gambia	0.297	0.532	<b>0.611</b>	0.480	13
Senegal	0.412	0.431	<b>0.474</b>	0.439	14
Cape Verde	0.292	<b>0.481</b>	0.454	0.409	15

# Results



## Top Five Highest Risk Countries

Guinea Guinea-Bissau Liberia Niger Sierra Leone



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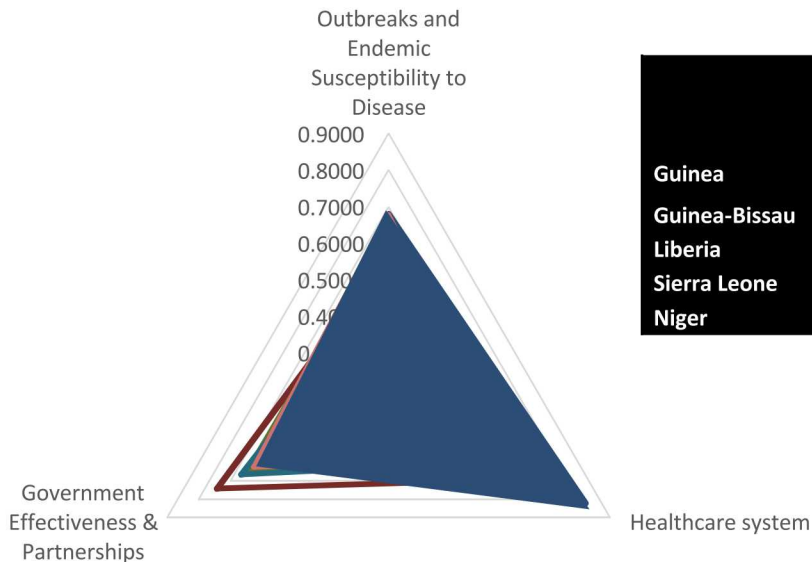
Wallis, L. et al. (2018)

# Results



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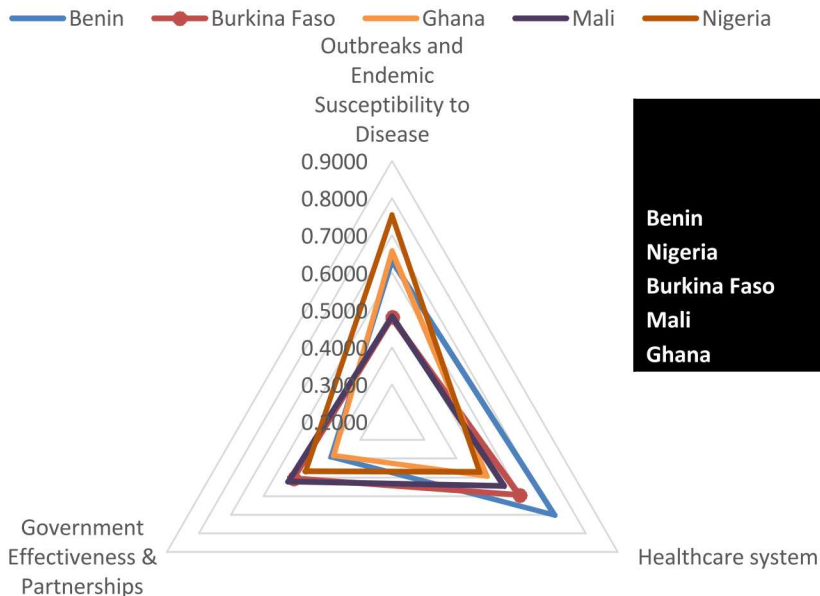
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# Results



## Middle Five Moderate Risk Countries



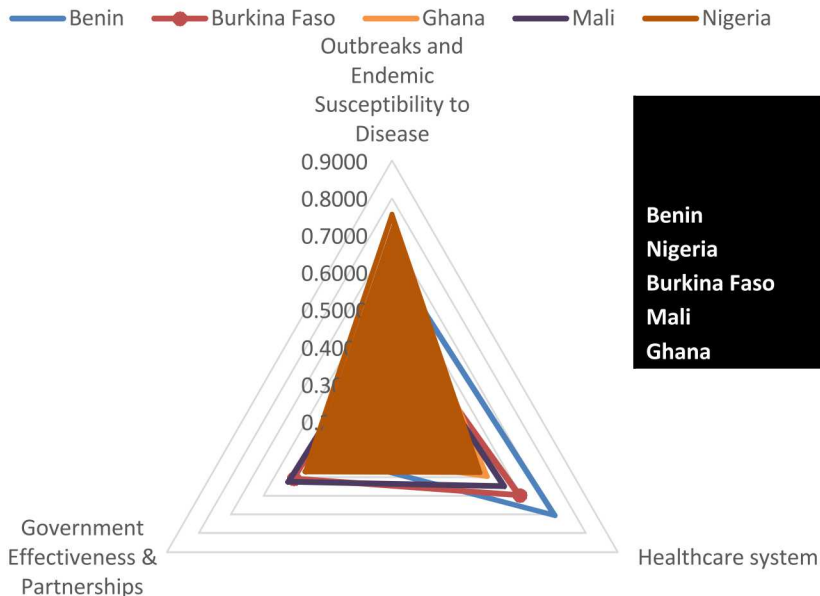
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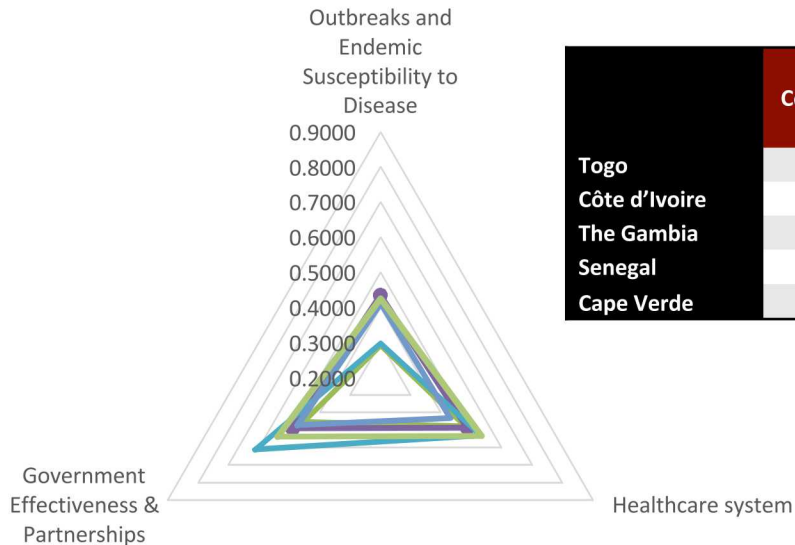
Wallis, L. et al. (2018)

# Results



## Bottom Five Lowest Risk Countries

— Cape Verde 
 —●— Cote d'Ivoire 
 — The Gambia 
 — Senegal 
 — Togo



	Overall Country Risk Scores	Rank
<b>Togo</b>	0.499	11
<b>Côte d'Ivoire</b>	0.470	12
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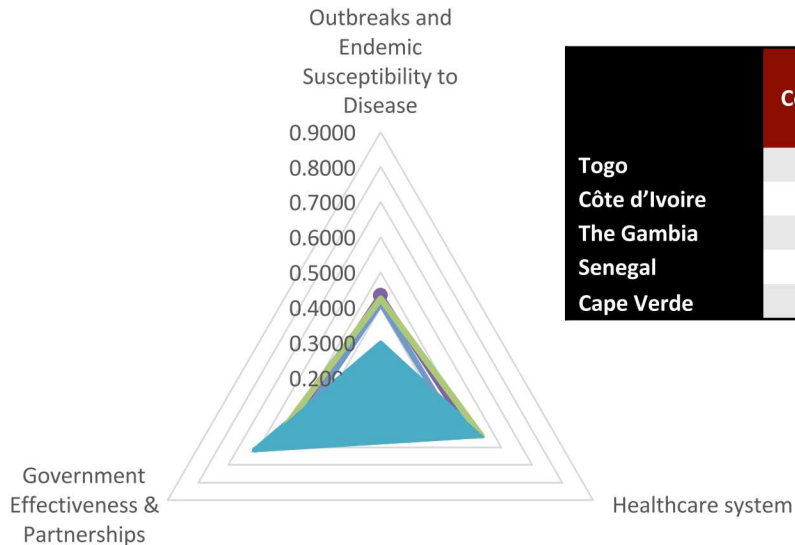
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# Discussion



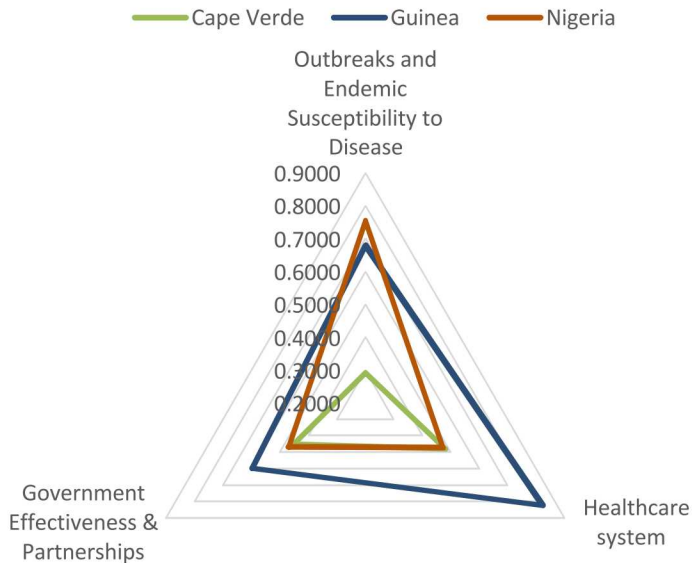
**Cape Verde is an island nation with small population and limited reporting to WHO, this may bring questions about ranking as lowest risk country.**

**Nigeria is very high population with a lot of imported disease for patients in the region seeking better healthcare, so results may be misrepresented in disease burden criteria.**

# Results



## Discussion of Three Countries



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# Future Direction



Application to other countries and regions could serve as a predictive measure for areas where outbreaks could become uncontrolled.

Repeated analysis could give a measurable performance indicator for global health security engagements at baseline and after engagement.



# Acknowledgements



## **US Centers of Disease Control and Prevention – EISLB**

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Laboratories**

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- International Biological and Chemical Threat Reduction Program



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- Faculty Advisor: Dr. Mellissa Withers, Global Health Leadership track



**ABSA  
INTERNATIONAL**  
*The Association for Biosafety and Biosecurity*

## **ABSA International**

- Robert I. Gross Student Award



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# Questions

