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RANKING OF RISK FACTORS THAT COULD ACCENTUATE INFECTIOUS DISEASE OUTBREAK IN ADAMAWA STATE, USING ANALYTIC HIERARCHICAL PROCESS

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ABSTRACT

Disease outbreaks have increased in frequency and scope during the past few decades. The responses to these epidemics have been political and burdensome for disadvantaged groups. Using the Analytic Hierarchy Process (AHP) model, this study is conducted to establish weights to prioritize risk factors that contribute to infectious disease outbreaks in Adamawa State, Nigeria. The following criteria were identified: health policy, finance availability, government commitment to health care, and religious belief. Likewise, potential risk factors were identified as insecurity, poor health infrastructure, permeable borders, access to water, sanitation, and hygiene, poor access to the health care system, illiteracy, local and religious beliefs and poverty. Data collected was analyzed using an AHP model. Poor health infrastructures were placed first, with a weight of 0.1702. A weight of 0.1462 placed illiteracy in second place, indicating that the level of illiteracy ought to be reduced drastically to have a healthy society. With a weight of 0.1445, water, sanitation, and hygiene campaigns should be maintained. Additionally, the spread of infectious diseases was also found to be greatly impacted by insecurity, rated fourth after assessment with 0.1259 weights. Poverty was ranked fifth using the AHP model and was assigned a weight of 0.1115. Poor access to the health care system is ranked sixth with a weight of 0.1072 and religious belief is ranked eighth with a weight of 0.0952. We advised that serious, efficient, and effective action be taken to establish literate citizens.

Keywords: Analytic Hierarchy Process, Risk Factors, Infectious Diseases, Outbreak of Disease

INTRODUCTION

SARS-CoV-2, which causes COVID-19, is a unique virus that has recently caused an outbreak around the world, unlike anything that has happened since the Spanish flu outbreak of 1918 in terms of nature and scope. This pandemic differs from others in that it primarily affects older people and people with preexisting medical issues, though not solely (Douglas *et al*., 2020).

Even though the COVID-19 outbreak seems to be the current focus of public health interventions, the nature, context, and duration of the outbreak period, along with the health protection measures in place, are likely to impact non-communicable health outcomes and their wider socio-ecological determinants (Douglas *et al*., 2020).

According to Rod, Oviedo-Trespalacios, and Cortes-Ramirez (2020), additional infectious disease outbreaks, while not the same size as COVID-19 (at least since the Spanish flu), have been documented and may have had similar direct and indirect effects on health, society, and the economy. These outbreaks include severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and pandemic flu (H1N1).

Disease outbreaks have increased in frequency and scope during the past few decades. These outbreaks' epicentres have varied and may be related to various economic environments. The responses to these epidemics have been political, which has made them burdensome for disadvantaged groups (Kapiriri & Ross, 2018).

The cornerstone of controlling a communicable disease is the early detection of approaching outbreaks, followed by a swift reaction, which emphasizes the significance of gathering real-time, complete, and accurate data with analysis and prompt distribution (Kumur, Siya, Adamu, Reuben, & Dahiru, 2017). Infectious disease control at the community level is a persistent challenge for African public health systems. To detect, isolate, and treat those infected and lessen the burden on society. A public health system's capability to conduct tests for COVID-19 is crucial, especially in heavily populated areas. Weak public health systems will likely deal with the virus's spread without extensive testing or disease tracking, resulting in increased transmission and underreporting (Africa Center for Strategic Studies, 2020). Therefore, it is necessary to identify and assess relevant risk factors that can obstruct the infection control approach in Adamawa State, Nigeria.

MATERIALS AND METHODS

The data was subsequently analysed using Saaty's Analytic Hierarchy Process (AHP).

The decision maker's preference for the various selected criteria was assessed and scored using the absolute scale of relative importance proposed by Saaty (2008) as a basis.

Table 1: Saaty's AHP Nine-Point Scale for Pairwise Comparison of Relative Importance

S/N	Verbal Judgments	Numerical Rating
1	Extremely Preferred	9
2	Very strongly to extremely preferred	8
3	Very strongly preferred	7
4	Strongly to very strongly preferred	6
5	Strongly Preferred	5
6	Moderately to strongly preferred	4
7	Moderately preferred	3
8	Equally to moderately Preferred	2
9	Equally Preferred	1

The selected criteria's pairwise comparisons were arranged into a square matrix. Two separate pairwise comparisons were performed. In the Analytic hierarchy process analysis, The first pairwise assessment was between pairs of criteria and was used to demonstrate the decision maker's priorities. The second type of pairwise evaluation was between pairs of alternative risk factors and was used to weigh the relative advantages of each pair (Adamcsek, 2008).

Every stage of the selection procedure was checked. The consistency ratio (CR), the random consistency index (RI), and the consistency index (CI) were employed as benchmarks to evaluate the results' dependability. The weights obtained were compared to a reference value of 0.10.

A Consistency Index (CI), which measures the inconsistencies of pairwise comparisons, is given as $CI = \frac{(\lambda_{max} - n)}{n-1}$ (1)

Where λ_{max} is the average to the sum of the ratio of weighted sum by its corresponding weight.

n is the order of the matrix. The CR is determined by taking the ratio of the CI and the random index (RI) denoted as $CR = \frac{CI}{RI}$ (2)

By comparing the relevant RI to the value of n in the pairwise comparison matrix, as given in

Table 2: The Random Index (RI) number.

n	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.52	1.54	1.56	1.58	1.59

If CI is small enough, the comparisons made by the decision-makers are likely consistent enough to provide accurate estimates of the weights for the objective function. Inconsistencies could arise, and the AHP might not produce useful findings if the degree of consistency is less than 0.10, which is considered a reasonable level of consistency. Repeating the evaluation process will increase consistency. The consistency metric can be used to assess a decision-judgment maker's coherence and all hierarchy levels' coherence.

In this study, we identified and considered four criteria

i. Health policy (HP)
ii. Availability of finance (AF)
iii. Government disposition to health care (GDHC)
iv. Religious belief (RB)

To have a reliable result, we identified and considered eight (8) risk factors for the study;

i. Insecurity (I)
ii. Poor health infrastructure (PHI)
iii. Porous border (PB)
iv. Water, Sanitation and Hygiene (WASH)
v. Poor access to health care system (PAHCS)
vi. Illiteracy (I)
vii. Local and religious belief (LRB)
viii. Poverty (P)

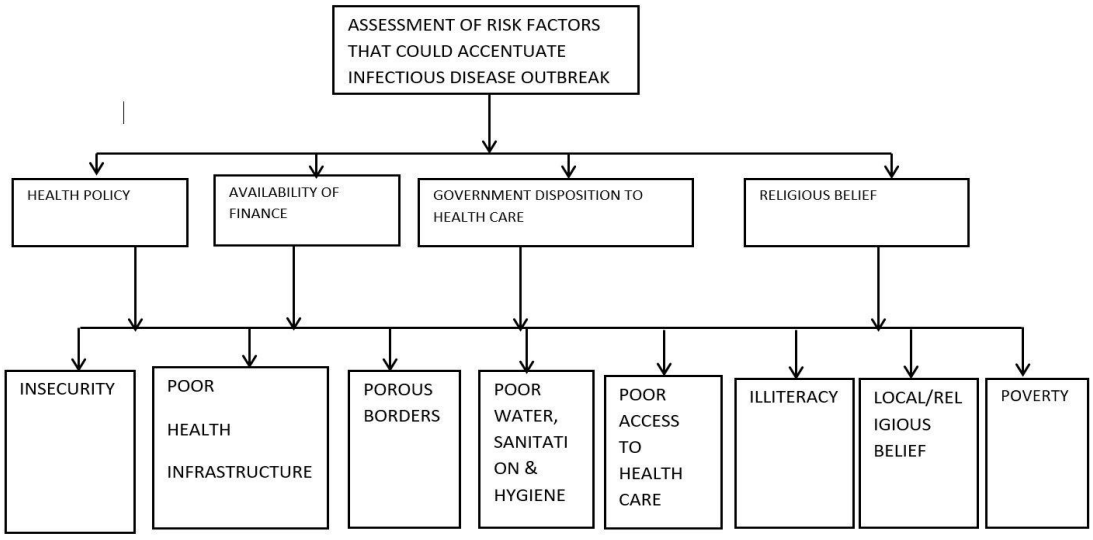

Figure 1: AHP Model for Assessing Risk Factors to Curtail the Spread of Infectious Disease Outbreak

RESULTS AND DISCUSSION

	HP	AF	GDHC	RB
HP	1	3	3	6
AF	⅓	1	½	5
GDHC	⅓	2	1	3
RB	⅙	⅕	⅓	1

Matrix 1: Criteria

	I	PHI	PB	WASH	PAHC	I	LRB	P
I	1	1	1	½	1	1	2	1
PH	1	1	3	1	3	2	2	3
PB	1	⅓	1	½	½	½	3	3
WASH	2	⅓	2	1	1	1	2	3
PAHC	1	⅓	2	1	1	½	½	½
I	1	½	2	1	2	1	3	1
LRB	½	½	⅓	½	2	⅓	1	⅓
P	1	⅓	⅓	⅓	2	1	3	1

Matrix 2: Risk factor pairwise comparison matrix with respect to Health Policy

	I	PHI	BP	WASH	PAHC	I	LRB	P
I	1	2	2	3	2	½	2	1
PHI	½	1	3	2	2	1	2	3
PB	½	⅓	1	2	½	½	½	½
WASH	⅓	½	½	1	2	½	⅓	⅓
PAHC	½	½	2	½	1	⅓	3	1
I	1	1	2	2	3	1	1	1
LRB	½	½	2	3	⅓	1	1	2
P	1	⅓	2	3	1	1	½	1

Matrix 3: Risk factor pairwise comparison matrix with respect to Availability of Finance

	I	PHI	BP	WASH	PAHC	I	LRB	P
I	1	3	1	⅓	1	½	½	1
PHI	⅓	1	⅓	½	⅓	⅓	2	2
PB	1	3	1	½	½	1	1	1
WASH	3	2	2	1	2	1	1	2
PAHC	1	⅓	2	½	1	1	3	1
I	2	3	1	1	1	1	1	1
LRB	2	½	1	1	⅓	1	1	1
P	1	½	1	⅓3	1	1	1	1

Matrix 4: Risk factor pairwise comparison matrix with respect to Government disposition to Health care system

	I	PHI	BP	WASH	PAHC	I	LRB	P
I	1	2	1	½	2	1	1	1
PHI	½	1	1	2	2	⅓	2	2
PB	1	1	1	½	½	2	⅓	1
WASH	2	½	2	1	1	1	1	1
PAHC	½	½	2	1	1	⅓	1	1
I	1	3	½	1	3	1	1	1
LRB	1	½	3	1	1	1	1	1
P	1	½	1	1	1	1	1	1

Matrix 5: Risk factor pairwise comparison matrix concerning Religious Belief

Table 3: Criteria Prioritized Weights

Criteria	Priority
Health Policy	0.5125
Availability of Finance	0.1950
Government disposition to Health care system	0.2278
Religious Belief	0.0647

The criteria ranking results demonstrate the importance of a firm, feasible health policy in preventing the development of infectious disease outbreaks, as demonstrated by health policies with a rating of 0.5125. The government's attitude toward the healthcare system is another crucial factor; it obtained a grade of 0.2278, meaning that even with a sound and dependable healthcare policy, the government should have a strong willingness to administer an effective and efficient healthcare system. The influence of finance cannot be understated when all of these things are taken into account. With a rating of 0.1949 for financial accessibility, it is recommended that money be made available to support a strong healthcare system and effective health policies.

AHP provides a consistency metric for pairwise comparisons (CR) by calculating a consistency ratio. Each column of the pairwise comparison matrix was divided by the priority vector of either criterion, enabling the CR to be computed.
An appropriate consistency ratio is one of less than 0.10. The degree of consistency in the pairwise comparisons is adequate, and since the CR value for the decision-maker criteria is 0.0706, we can conclude that expert verbal judgments are acceptable.

Calculating the Risk Factor Priorities and Consistency Ratio

In assessing the effect of possible risk factors that could cause the spread of infectious disease outbreaks, we considered the effect each of the criteria could have on the risk factors.

Table 4: risk factors prioritize weights with respect to Health Policy

Risk factors	Priority	Rank
Insecurity	0.1169	4
Poor Health Infrastructures	0.2056	1
Porous Border	0.1112	5
Water, Sanitation, and Hygiene	0.1533	2
Poor access to healthcare	0.0944	7
Illiteracy	0.1415	3
Local/Religious Belief	0.0726	8
Poverty	0.1045	6

Possible risk variables are identified to evaluate how well a health strategy reduces the rate infectious diseases could spread. The result depicts that poor health infrastructure, given a weight of 0.2056, ranked top as a potential entry point for an infectious disease outbreak. WASH was rated second with a weight of 0.1533. From the study, illiteracy, having been assigned a weight of 0.1415, was ranked third in the cadre of possible reasons infectious diseases could break out in the community. Failure to maintain clean water, sanitation, and hygiene (WASH) will give room for disease outbreaks.
With a weight of 0.1169, insecurity came in at number four among the causes of infectious disease epidemics. The fear of not feeling safe in the community may keep afflicted persons from obtaining the proper medical attention, which could help diseases spread to caregivers and neighbours. Additionally, insecurity will make it more difficult for medical professionals to visit appropriate medical facilities and do their jobs as required. The porous border, which weighed 0.1112, placed fifth. As a result, having a porous border could raise the likelihood of infectious diseases easily crossing it, endangering the nation's health.
The consistency ratio of the decision maker's assessment of the risk factor in line with health policy was computed as follows: An appropriate consistency ratio is less than 0.10. Given that CR = 0.0813 for the paired comparison of the decision-maker criteria, we can assert that the level of consistency in the pairwise comparisons is adequate. As a result, expert verbal judgments are acceptable.

Table 5: Risk factors prioritize weights concerning the availability of finance

Risk factors	Priority	Ranks
Insecurity	0.1727	2
Poor Health Infrastructures	0.1779	1
Porous Border	0.0706	7
Water, Sanitation, and Hygiene	0.0699	8
Poor access to healthcare	0.1096	6
Illiteracy	0.1540	3
Local/Religious Belief	0.1243	4
Poverty	0.1209	5

Possible risk factors were found when analyzing the impact of financial accessibility on lowering the potential spread rate of infectious diseases. We were able to infer from the model that a lack of adequate health infrastructure, which was given a weight of 0.1779, came in the first place as a potential entry point for preventing the spread of infectious disease epidemics. People must have the flexibility to move around to access essential medical care for their health issues. Consequently, addressing insecurity was given a weight of 0.1727 and placed second. This study revealed that the spread of infectious disease outbreaks in the neighborhood could be halted if the illiteracy level in the abode community is reduced.
Getting the correct information on how to maintain a healthy society will always be encouraged because a highly literate society will be more aware of its health state. With a weight of 0.1243, local/religious belief came in fourth place on the list of strategies to stop the spread of infectious disease outbreaks. This strategy addressed the long-held urban legend regarding local causes of death and pushed for religious organizations to inform their followers of the best methods for stopping disease outbreaks.
The consistency ratio of the decision maker's assessment of the risk factor in line with the availability of finance was computed as follows:
A consistency ratio of 0.10 or less is regarded as satisfactory. As the pairwise comparison for the decision-maker criteria indicates CR = 0.0865, we can conclude that the level of consistency in the pairwise comparisons is adequate, and as a result, expert verbal judgments are acceptable.

Table 6: Risk factors prioritize weights concerning Government disposition to Health care system

Risk factors	Priority	Ranks
Insecurity	0.1054	7
Poor Health Infrastructures	0.0900	8
Porous Border	0.1157	5
Water, Sanitation, and Hygiene	0.1921	1
Poor access to healthcare	0.1366	3
Illiteracy	0.1472	2
Local/Religious Belief	0.1121	6
Poverty	0.1209	4

While analyzing how government policies on the healthcare system affected the ability to halt the spread of infectious diseases, potential risk factors were discovered.

From the AHP model, we could infer that ongoing public education on the availability, upkeep, and usage of clean water, sanitation, and hygiene (WASH) will significantly help prevent disease outbreaks since WASH was placed first with a weight of 0.1921. With a weight of 0.1472, eradicating or reducing illiteracy was ranked second as a potential way to stop disease outbreaks. Third place, with 0.1366 in weight, is occupied by expanding access to healthcare. Furthermore, lowering or eliminating the poverty rate, which came in fourth with a weight of 0.1209, will significantly help control disease outbreaks.

Checkmating and monitoring porous borders will significantly lower the likelihood of an infectious disease outbreak crossing the border. Porous borders also placed fifth with a weight of 0.1607.

Additionally, insecurity will make it more difficult for medical professionals to visit appropriate medical facilities and do their jobs as required. The porous border as a risk factor weighed 0.1112 and placed fifth. Thus, having a porous border could raise the likelihood of infectious diseases easily crossing it, endangering the general public's health in the nation. A consistency ratio of 0.10 or less is regarded as satisfactory. As the pairwise comparison for the decision maker criteria indicates CR = 0.0680, we can conclude that the level of consistency in the pairwise comparisons is adequate, and as a result, expert verbal judgments are acceptable.

Table 7: Risk factors prioritize weights concerning Religious Belief

Risk factors	Priority	Ranks
Insecurity	0.1290	4
Poor Health Infrastructures	0.1488	2
Porous Border	0.1051	6.5
Water, Sanitation, and Hygiene	0.1316	3
Poor access to healthcare	0.0973	8
Illiteracy	0.1562	1
Local/Religious Belief	0.1269	5
Poverty	0.1051	6.5

Assessing how religious belief affects the rate of infectious disease spread could help identify and minimize potential risk factors. We concluded that the presence of poor health infrastructure, given a weight of 0.2056, ranked top as a potential entry point for an infectious disease outbreak. WASH was rated second with a weight of 0.1533, and this research also acknowledges that illiteracy, with a weight of 0.1415, was ranked third in the cadre of possible reasons infectious diseases could break out in the community. Failure to maintain clean water, sanitation, and hygiene (WASH) will give room for disease outbreaks. With a weight of 0.1169, insecurity came in at number four among the causes of infectious disease epidemics.

Infected individuals may put off getting the right medical attention out of concern for their safety in the neighbourhood, which could help diseases spread to nearby neighbours and caregivers. Insecurity will also make it more difficult for medical professionals to get to the right clinics and do their tasks as required. With a weight of 0.1112, Porous Border placed fifth. It follows that having a porous border could enhance the likelihood that contagious diseases will spread easily across it, endangering the general public's health.

A consistency ratio of 0.10 or less is regarded as satisfactory. As the pairwise comparison for the decision-maker criteria indicates CR = 0.0961, we can conclude that the level of consistency in the pairwise comparisons is adequate. As a result, expert verbal judgments are acceptable.

Establishing a global ranking for the decision options

The values in the reference vector for the criterion are multiplied by the priority vector matrix for the following risk factor possibilities, and the products are summed to obtain an overall score for each potential risk factor:

When the entire impact of the criteria identified and taken into account in this research on potential risk factors was computed, it was discovered that poor health infrastructures, with a weight of 0.1702, ranked first and thus constituted a serious threat to the health status of the inhabitants. As a result, to keep up with the country's present demand for health services, substantial consideration should be given to updating and maintaining our current health infrastructures. With a weight of 0.1462, illiteracy came in second, indicating that it must be significantly reduced if society is to be healthy. As it is ranked third with a weight of 0.1445 utilizing the Global Goals, the campaign for water, sanitation, and hygiene should be maintained and expanded. Therefore, a clean atmosphere is made possible by sustaining a healthy lifestyle and lowering the spread of infectious diseases

Regarding urgency, insecurity came in at number four with a weight of 0.1259. Health professionals are being abducted, hospitals are being raided often, and patients are being

targeted because various types of insecurity are on the rise. As access to the available health facilities becomes more perilous due to rising insecurity, society's health will decline.
Therefore, the government or decision-making bodies must take severe action as affected people may not get health care, raising the risk that their neighbours will contract the disease.
Poverty was rated fifth in the AHP model with a weight of 0.1115 and serves as both a risk factor for infectious diseases and an agent that promotes them. Poor access to the health care system will be rated sixth with a weight of 0.1072, local and religious beliefs will be ranked eighth with a weight of 0.0952, and poverty will be listed as one of the contributing factors to the spread of infectious illnesses. Because they operate as the foundation for potential risk factors for spreading infectious diseases, the results indicated that the nation's poor health infrastructures should be given more attention.
A substantial risk factor for the spread of infectious diseases has also been found as illiteracy.
The third most likely threat to the spread of infectious diseases was the failure to maintain clean water, decent sanitation, and proper hygiene.
Insecurity was also mentioned on the list of potential risk factors that can contribute to the spread of infectious illnesses, although the findings suggest that the country's inadequate health infrastructures should be given higher emphasis because they operate as a foundation for potential risk factors for the development of infectious diseases.
The spread of infectious diseases has also been linked significantly to illiteracy.
Third on the list of conceivable potential hazards to the spread of infectious diseases was the failure to maintain clean water, decent sanitation, and proper hygiene.
Even though it was mentioned on the list of potential risk factors that can encourage the spread of infectious illnesses, insecurity remains a significant concern.

CONCLUSION

An Analytic hierarchical process of ranking risk factors that could promote disease outbreaks has been presented. The influencing criteria and alternative risk factors identified were derived from thorough consultation with an expert from the hector of Adamawa State. The study has shown that a poor health infrastructure can aggravate disease outbreaks. This also points out that illiteracy, which is on the increase in the state, significantly contributes to the maintenance of health facilities.
Effecitve action should be taken to establish sound healthcare infrastructures and provide sound, high-quality services. Additionally, the education system needs to be reexamined so that all citizens can receive a proper education, as an educated citizen is potentially healthy.

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