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Modeling the Prevalence of Covid 19 Virus through the Infected, Treatment and Recovery (A Case Study of Ilorin West Local Government Area of Kwara State)

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ABSTRACT
The outbreak and spread of diseases have been studied for so many years. The ability to make predictions about diseases could enable scientists to evaluate vaccination or isolation plans and may have a significant effect on the epidemic of disease. Therefore this research 'Modeling the prevalence of corona virus through the Contact, Treatment and Recovery (a case study of Ilorin west local government)' carried out to study the rate at which people contact Corona virus, to determine the number of people a person can infect at a particular point in time, to model the deterministic processes that explain the contributions of each variable and as well determine the control measures and sensitivities to change in recovery and infectious rate. SIR model and Logistic Regression were used to analyse the data. Result of the analysis revealed that the rate at which people contact covid – 19 will be on increase. The Analysis of SIR model using R_0 (Reproductive Number) shows that R_0 is greater than 1 which shows that there will likely be epidemic on Covid – 19. Also, since $R_0 = 9.74 \approx 10$, this implies that an infected person can infect 10 people and that people should be prevent from traveling to outbreak areas of corona virus outbreak in the future. The analysis from the Logistics regression shows that the risk of getting infected with corona virus is significant, and that proactive measure should be taken to avoid the spread of covid 19. It was thereby recommend that health planner should educate people more on the control, preventive and proactive measure of covid 19.

Key Word: Modeling, rate of contact, infective rate and recovery rate

I. INTRODUCTION

Mathematical models represent the examined systems in the form of mathematical objects and their relationships, often in the form of various types of (dynamic) equations, or in the form of governing rules assembled as computer algorithms. Unfortunately, only the simplest mathematical models are analytically tractable (that is, can be completely solved using standard tools of mathematical analysis). As model complexity increases, what can usually be obtained are numerical solutions corresponding to specific initial conditions. For models of intermediate complexity, analytical tools and numerical simulations are standard combination and they complement one another. Whether formally analyzed or run as numerical simulation, mathematical models are useful experimental tools for building and testing theories, generating hypotheses, assessing quantitative conjectures, answering specific questions, determining system sensitivity to changes in parameter values and estimating key parameters from data. Models often identify behaviors that are unclear in experimental data most often because such data are hardly reproducible and the number of data points is often limited and subjected to measurement errors. From the applied perspective, models can be used to supplant experiments that we, for some reasons, cannot conduct practically, and/or to assess and compare various management actions before they are actually employed. Any model is necessarily a simplified representation of reality, one is always forced to prioritize, that is, consider only those aspects of the examined system, which are essential for its understanding and/or prediction of its behavior and neglect those aspects that seem

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marginal for the question of interest. As a result, no model can be considered the best one; there is always a basis for improvement, no matter how small/little. Infectious disease is the result of a convergence of social, political, and economic factors, whether the diseases are new, re-emerging, or becoming endemic. Societal decisions and actions, or lack of such can have unintended consequences that cause emerging infectious disease to flourish, harming local populations and potentially the global community.

1.1 STATEMENT OF THE PROBLEM

Health care in Nigeria is influenced by different local and regional factors that affect the quality or quantity present in a location. Due to the aforementioned, the health care system in Nigeria has shown spatial variations in terms of availability and quality of facilities in relation to need. However, this is largely as a result of the level of state and local government involvement and investment in health care programs and education.

Youth and young adults in Nigeria are particularly vulnerable to corona virus, with old people at higher risk than young people. Corona virus have been a treat to our national development, that is, many setbacks have occur due to the presence of Corona virus in Nigeria which kwara state is not exempted. Therefore this study aims to Model the rate of increase of Corona virus through the Contact, Treatment and Recovery, using Ilorin west Local Government of Kwara state as the case study.

II. RESEARCH METHODOLOGY

2.1. DATA COLLECTION

Use of Questionnaire was adopted as follows

- Pilot survey
- Proper Survey
- Post enumeration survey

The stage of the research project covers:

- Designing of questionnaire
- Administration of the questionnaire to people
- Data were collected, summarized and presented for analysis.
- Demographic data were classified based on age, sex, religion, educational qualification, ward of Local Government Area and State of origin.

2.2 METHOD OF DATA COLLECTION

The method of data collection refers to the method used in obtaining the information required. Before acquiring the data used for this research work, the population of Ilorin West local government was sampled out based on stratified sampling technique in which the population was grouped homogeneously by grouping them based on each political wards in Ilorin west and questionnaires were administered within this political wards and collected, in which proper analysis was carried out on the questionnaires.

III. METHOD OF DATA ANALYSIS

METHODOLOGY

The population was studied using questionnaire and interview method and descriptive statistics, Susceptible, Infective and Recovery (SIR) model and logistic regression will be used to analyze

3.1 SIR model (Epidemic) the data.

The SIR Epidemic Disease model characterized people into three classes: susceptible S, infective I and recovery R. Removed individuals are no longer susceptible nor infective for whatever reasons. They may have recovered from the disease and now immune or they may have been vaccinated or they may have been isolated from the rest of the population or perhaps they may have died as a result of the disease.

The model is.

$$I(t+\Delta_t) = I_t + \beta\Delta_t S_t I(t) - \gamma I\Delta_t$$

$$\frac{dI}{dt} = \beta SI - \gamma I \qquad ...(1)$$

$$S_{(t+\Delta_t)} = S_{(t)} - \beta\Delta_t S_{(t)} I_{(t)}$$

$$\frac{dS}{d_t} = -\beta SI \qquad ...(ii)$$

$$R_{(t+\Delta t)} = R_{(t)} + I\gamma\Delta_t$$

$$\frac{dR}{dt} = I\gamma \qquad ...(iii)$$

With the constant population S + I + R = N.

Where: S---Susceptible, I---Infective, R---Recovery with immunity, β ---Contact Rate , R_0 ----Basic Reproductive Number, N-----Total Population, S_0 ----Number of initial susceptible individual

γ -----recovery rate

$R_0 = \frac{\beta N}{\gamma}$ where Ro represent basic reproductive number

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3.2 LOGISTIC REGRESSION

Logistic regression analysis is part of a category of statistical model to analyze a dataset in which there is one or more independent variable that determine an outcome. The outcome is measured with a dichotomous variable (in which there are only two possible outcomes).

In logistics regression, the dependent variable is binary or dichotomous, i.e. it only contains data coded as 1(TRUE, success, pregnant e.t.c.). The goal of logistics regression is to find the best fitting model to describe the relationship between the dichotomous characteristics of interest of interest (dependent variable = response or outcome variable) and a set of independent (predictor or explanatory) variables.

Let X denotes the vector of predictors (X_1, X_2, X_3, ..., X_N) and let the conditional probability that the outcome is present be denoted by the equation as: P(Y $=\frac{1}{X} = \pi(X)$) The logistic regression model (Harvel, 2001) is given by: $\pi(X) = \frac{1}{1+e^{X\beta}}$ $\pi(X)$ =The success probability of value X.

$X\beta$ = Stands for $\beta_o + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots + \beta_n x_n$ .The logistic regression model has a linear form for the logit of this probability. Logit $\{\pi(X)\}$ = log $\left\{\frac{\pi(X)}{1-\pi(X)}\right\} = \beta_o + \beta_1 x_1 ++ \beta_2 x_2 + \ldots\ldots + \beta_n x_n$

Decision rule: Reject H_0 if the P-value is greater than critical value, if otherwise do not reject.

IV. DATA ANALYSIS

Frequency Table

Table 1: Shows the number of respondent according to sex

Sex					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	3055	61.3	61.3	61.3
	Female	1932	38.7	38.7	100.0
	Total	4987	100.0	100.0	

Source: Survey 2022 by Adeoye O. A., Ojo O. D. and Ayanlere F. O.

The total number of respondents (N) for this research is Four Thousand, Nine Hundred and Eighty Seven (4987). The respondents examined comprises of 3055 (61.3%) "Male" while 1932 (38.7%) were females as shown in table 1

Table 2: Shows the numbered of respondents who avoid large gatherings/long queues, such as at church or at market places with 10 or more people.

Did you still Avoided large gatherings/long queues, such as at church or at markets with 10 or more people?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3320	66.6	66.6	66.6
	No	1667	33.4	33.4	100.0
	Total	4987	100.0	100.0	

Source: Survey 2022 by Adeoye O. A., Ojo O. D. and Ayanlere F. O.

As shown in table 2, over 66.6% know that avoiding large gatherings/long queues in both market place and other places is a protective measure from COVID 19 and 33.4% did not avoid large gathering.

Table 3: Shows the number of respondent kept at least 2 adults step away from others

Did you Kept at least 2 adult steps away from others?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1176	23.6	23.6	23.6
	Yes	3811	76.4	76.4	100.0

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	Total	4987	100.0	100.0	

Source: Survey 2022 by Adeoye O. A., Ojo O. D. and Ayanlere F. O.

As shown in table 3, 76.4% kept at least 2 adult steps away from others while 23.6% did not keep any step away from others.

Table 4: Shows the number of respondent that still uses face mask

Did you Wore face masks?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1991	39.9	39.9	39.9
	Yes	2996	60.1	60.1	100.0
	Total	4987	100.0	100.0	

Source: Survey 2022 by Adeoye O. A., Ojo O. D. and Ayanlere F. O.

Table 4 shows that over 60.1% did use facemasks while 39.9% did not use facemasks for protective measure from COVID 19.

Table 5: Shows the number of respondents who attended any family gatherings with 10 or more people (holiday celebrations, baptisms, wedding, funeral, etc.)

Have you attended any family gatherings with 10 or more people (holiday celebrations, baptisms, wedding, funeral, etc.)?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	1033	20.7	20.7	20.7
	No	3954	79.3	79.3	100.0
	Total	4987	100.0	100.0	

Source: Survey 2022 by Adeoye O. A., Ojo O. D. and Ayanlere F. O.

As shown in table 5, 79.3% avoid family gatherings with 10 or more people while 20.7% attended family gatherings with 10 or more people. This indicates that only few people are not pro active on the prevention of COVID 19.

Table 6: Shows the number of respondents that have tested for covid 19 before

Did you have a test for Covid-19 before?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	467	9.4	9.4	9.4
	No	4520	90.6	90.6	100.0
	Total	4987	100.0	100.0	

Source: Survey 2022 by Adeoye O. A., Ojo O. D. and Ayanlere F. O.

From table 6 it was observed that 90.6% have not done COVID 19 test before while 9.4% have done COVID 19 test before.

Table 7: Shows the number of respondents that have any contact with patients confirmed with Corona virus disease in 2019

Did you have any contact with patients confirmed with Coronavirus disease in 2019					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	997	20.0	20.0	20.0
	No	3990	80.0	80.0	100.0

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	Total	4987	100.0	100.0	

Source: Survey 2022 by Adeoye O. A., Ojo O. D. and Ayanlere F. O.

From table 7 above, it was discovered that 20% have contact with patients confirmed with covid 19 while 80% did not have any contact with patients confirmed with COVID 19.

Table 8: Shows the number of respondents that have traveled to outbreak areas of the coronavirus disease in the last one year

Have you traveled to outbreak areas of the coronavirus disease in the last one year?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	599	12.0	12.0	12.0
	No	4388	88.0	88.0	100.0
	Total	4987	100.0	100.0	

Source: Survey 2022 by Adeoye O. A., Ojo O. D. and Ayanlere F. O.

From the table 8, 12% travelled to outbreak areas while 88% did not travelled to outbreak areas in the last one year.

USING THE SIR MODEL WITH THE USE OF MAPLE SOFTWARE

S=4987 R =0 I = 0 β = 0.0002 γ = 0.01

sol1 := dsolve([diff(K(t),t) = .2e-3*S(t)*K(t)-.1e-2*K(t), diff(R(t),t) = .1e-2*K(t), diff(S(t),t) = -.2e-3*S(t)*K(t), K(0) = 1, R(0) = 0, S(0) = 4987], numeric); plots[odeplot](sol1, 0..10, color = red);

sol1 := dsolve([diff(K(t),t) = .2e-3*S(t)*K(t)-.1e-2*K(t), diff(R(t),t) = .1e-2*K(t), diff(S(t),t) = -.2e-3*S(t)*K(t), K(0) = 1, R(0) = 0, S(0) = 4987], numeric); plots[odeplot](sol1, [t, R(t)], 0..10, color = red);

sol1 := dsolve([diff(K(t),t) = .2e-3*S(t)*K(t)-.1e-2*K(t), diff(R(t),t) = .1e-2*K(t), diff(S(t),t) = -.2e-3*S(t)*K(t), K(0) = 1, R(0) = 0, S(0) = 4987], numeric);plots[odeplot](sol1, [t, S(t)], 0..10, color = red);

sol1 := dsolve([diff(K(t),t) = .2e-3*S(t)*K(t)-.1e-2*K(t), diff(R(t),t) = .1e-2*K(t), diff(S(t),t) = -.2e-3*S(t)*K(t), K(0) = 1, R(0) = 0, S(0) = 4987], numeric); plots[odeplot](sol1, 0..10, color = red);

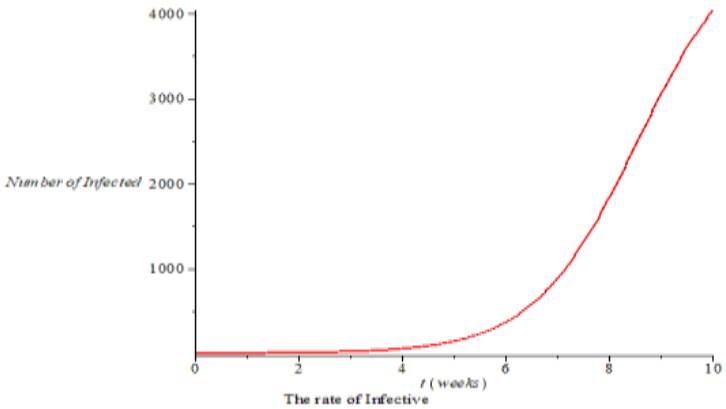

Figure 1: Chart showing the infective rate

From figure 1 above it was discovered that infective rate will be increasing

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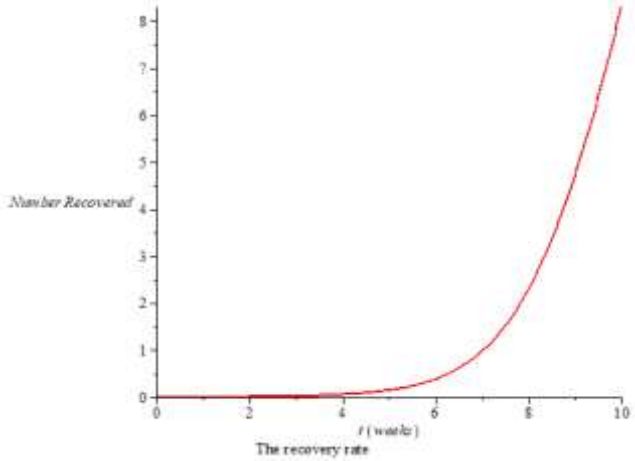

Figure 2: Showing the rate of recovery

From the figure 3 above it shows that recovery rate tends to increase also

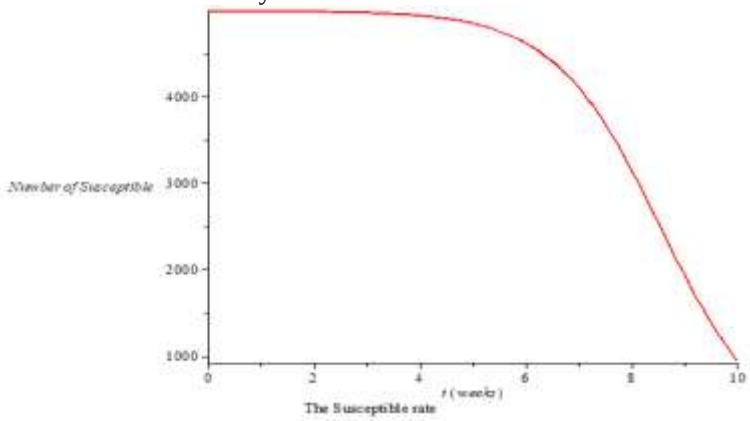

Figure 2: Showing the susceptible rate.

From figure 3 above it was discovered that susceptible was constant for years before starting to drop, this signify that the number of susceptible is reducing gradually

$R_0 = S\beta/\gamma$ the number an infected person can infect From the parameter used above R_0 = 4987x 0.0002/0.1 = 9.74 = 10 this means that an infected can infect 10 person

Logistic Regression

Table 10: Shows the analysis of covid 19 on Protective measure

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Protective measure on Covid 19: Did you Washed hands for 20 seconds or more with soap?	-1.025	.217	22.318	1	.000	.359

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	Protective measure on Covid 19: Did you still Avoided large gatherings/long queues? such as at church or at markets with 10 or more people?	-.119	.114	1.096	1	.295	.888
	Protective measure on Covid 19: Did you Kept at least 2 adult steps away from others?	-.621	.204	9.265	1	.002	.537
	Protective measure on Covid 19: Did you Avoided public transportation?	-.460	.185	6.196	1	.013	.631
	Protective measure on Covid 19: Did you Avoided shaking hands or kissing on cheeks?	-20.093	4850.064	.000	1	.997	.000
	Protective measure on Covid 19: Did you Used hand sanitizers / disinfectants?	1.431	.554	6.666	1	.010	4.184
	Protective measure on Covid 19: Did you Worn face masks?	-2.913	.091	1017.394	1	.000	.054
	Protective measure on Covid 19: Have you attended any family gatherings with 10 or more people (holiday celebrations, baptisms, wedding, funeral, etc.)?	.887	.269	10.891	1	.001	2.427
	Protective measure on Covid 19: Do you have a hand washing station with water and soap available at the household?	-.023	.236	.009	1	.924	.978

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	Protective measure on Covid 19: How much money have you spent on preventative measures per day such as soap, masks, hand sanitizer or other during covid19?	1.614	.121	177.916	1	.000	5.025
	Protective measure on Covid 19: Do you think you have risk of getting infected with corona virus?	.257	.051	25.911	1	.000	1.293
	Protective measure on Covid 19: Did you have a test for Covid-19 before?	-.154	.142	1.174	1	.279	.857
	Protective measure on Covid 19: Have you ever tested POSITIVE on a COVID-19 test?	.486	.406	1.433	1	.231	1.625
	Protective measure on Covid 19: Did you self-isolate immediately you are tested positive?	.097	.099	.961	1	.327	1.102
	Protective measure on Covid 19: Did you have any contact with patients confirmed with Coronavirus disease in the last 14 days?	1.543	.132	137.390	1	.000	4.678
	Protective measure on Covid 19: Have you travelled to outbreak areas of the coronavirus disease In the last one year?	-1.419	.396	12.810	1	.000	.242
	Constant	-3.364	.600	31.443	1	.000	.035

Source: Survey 2022 by Adeoye O. A., Ojo O. D. and Ayanlere F. O.

X_1 = Washed hands for 20 seconds or more with soap
X_2 = Avoided large gatherings/long queues, such as at church or at markets with 10 or more people
X_3 = Kept at least 2 adult steps away from others
X_4 = Avoided public transportation.
X_5 = Avoided shaking hands or kissing on cheeks
X_6 = Used hand sanitizers / disinfectants
X_7 = Did you wore face masks
X_8 = Have you attended any family gatherings with 10 or more people (holiday celebrations, baptisms, wedding, funeral, etc.)

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X_9 = washing station with water and soap available at the household
X_{10} = money have you spent on preventative measures per day such as soap, masks, hand sanitizer or other during covid 19.
X_{11} = risk of getting infected with corona virus.
X_{12} = test for Covid-19 before.
X_{13} = Have you ever tested POSITIVE on a COVID-19 test
X_{14} = self-isolate immediately you are tested positive
X_{15} = contact with patients confirmed with Coronavirus disease in the last 14 days
X_{16} = travelled to outbreak areas of the coronavirus disease in the last one year
The logistic equation is
$LOGY = -3.364-1.025X_1 -0.119X_2-0.621X_3 -0.460X_4-20.093X_5 +1.431X_6 -2.913X_7 +0.887X_8-0.023X_9 +1.614X_{10}+0.257X_{11} -0.154X_{12} +0.486X_{13}+0.097X_{14} +1.543X_{15} -1.419X_{16}$
After the test of significant the model reduced to
$LOGY = -3.364-1.025X_1 -0.621X_3 -0.460X_4-+1.431X_6 -2.913X_7 +0.887X_8-+1.614X_{10}+0.257X_{11} +1.543X_{15} -1.419X_{16}$

V. SUMMARY AND CONCLUSION

The total number of expected respondents (N) for this research were Five Thousand (5000) as Five Thousand questionnaires (5000) were administer but Four Thousand, Nine Hundred and Eighty Seven (4987) was returned. The respondents comprises of 3055 (61.3%) male and 1932 (38.7%) of females as shown in table 1. From table 2, over 66.6% know that avoiding large gatherings/long queues in both market and other places is a protective measure against COVID 19. Also, it was discovered from table 3 that about 76.4% kept at least 2 adult steps away from others with about 60.1% continuously wear facemasks while 39.9% did not wear facemasks for protective measures against COVID 19. Also 79.3% avoid family gatherings with 10 or more people while 20.7% do attend family gatherings with 10 or more people. This indicate that only few people are not pro active on the prevention of COVID 19 and it was observed that 90.6% have not done COVID 19 test before. From table 7, it was discovered that 20% have contact with patients confirmed with covid 19 while 80% did not have any form of contact with patients confirmed with COVID 19. About 12% traveled to outbreak areas of covid 19 while 88% did not travel to outbreak areas in the last one year.

Using the SIR model with the initial value of S=4987 R =0 I = 0 β = 0.0002 γ = 0.1 it was obtained that infective rate will be increasing, recovery rate will as well increase, susceptible was constant for months before it started reducing gradually and that an infected person can infect 10 person at a go.

Also from the analysis of logistic regression, it was discovered that washing hands for 20 seconds or more with soap is significant, the analysis shows that 64% of the respondent claims that washing hand for 20 second is a protective measure for covid 19. The analysis also revealed that avoiding large gatherings/long queues, such as church or market places with 10 or more people is not significant. This implies that avoiding large gatherings/long queues, such as church or markets with 10 or more people does not have any significant effect on the spread of covid 19. Also it was discovered that keeping at least 2 adult steps away from others is significant in which about 46% of the respondent claims that keeping at least 2 adult steps away from others is a substantial protective measure against covid 19 and that avoiding public transportation is significant and about 37% of the respondents claims that avoiding public transportation is an essential protective measure for covid 19.

Moreover the analysis revealed that avoiding shaking of hands or kissing on cheeks does not have any effect on the spread of the covid 19, and 100% of the respondents' claims that avoiding shaking of hands or kissing on cheeks does not have any effect on the spread of covid 19. Also it was discovered that the used of hand sanitizers/disinfectants is a significant protective measure for the spread of covid 19 and that the used of face masks is significant, the analysis shows that 95% of the respondent claims that using face masks is an essential protective measure for covid 19. It was also discovered that attending family gatherings with 10 or more people (holiday celebrations, baptisms, wedding, funeral, etc.) is significant and that having a hand washing station with water and soap available at the household is not significant and not relative to the protective measure of covid 19. The money spent on preventative measures per day such as soap, masks, hand sanitizer and others during covid 19 is relative to the spread of covid 19.

Furthermore it was discovered that risk of getting infected with corona virus is significant, the analysis shows that 29% of the respondent claims that risk of getting infected with corona virus is relative to the spread of covid 19 and 14% of the respondent claims that they have tested for Covid-19 before and the test was positive and 10% of the

respondent claims they were self-isolated immediately they were tested positive.

Generally, the analysis shows that having contact with patients confirmed with Corona virus disease is significant and relative. It was also discovered that traveling to outbreak areas of corona virus disease in the last one year is significant and this is relative to the spread of covid 19.

Recommendation

1. Health Planner should educate people more on covid 19 and its preventive measures.
2. Health Planner should create more centre where suspected covid 19 patients can be quarantine.
3. All agencies involve in educating the masses on covid 19 should be funded adequately.
4. Government at federal, states, and local levels should embark on a massive enlightenments and awareness at rural areas were 85% of the population resides.

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