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KIDNEY FAILURE (KF) MODEL: WHY ARE KF CASES GETTING YOUNGER?

Jezyl T. Cempron-Cutamora*, Jillian Bejoc

Faculty Member at College of Nursing, Cebu Normal University, Philippines

**Corresponding Author Email: cutamoraj@cnu.edu.ph*

ABSTRACT

The intent of determining the occurrence of renal failure among the younger population prodded the researchers to develop a predictive model that will aid healthcare providers. The purpose of this paper is to analyze the characteristics of the younger population of the present in relation to its increasing vulnerability in developing kidney failure such as, intake of power/energy drink (PD), body mass index (BMI), family history (FH) and presence of other pre-existing condition (PC). In establishing the extent by which these identified independent variables really contributed to the development of KF among the young ones, we did a simulation run with 1000 generated random data in the minitab version 15 based on real behaviors. We formulated and tested the first linear model: $Y_1 = \beta_0 + \beta_1 PD + \beta_2 BMI + \beta_3 PC + \beta_4 FH$ and the results showed that RF (Y_1) = 28.9 - 4.02 PD - 0.0028 PC + 0.0459 FH. Notice that BMI has been removed from the equation because it is highly correlated with other independent variables. At this point, we could not say yet that this is a good model. So, we noted that the sum of square residual error (SSE) is 251. Knowing that the higher is the SSE, the larger is the degree of error of the theory and thus, there is a need for us to generate a new, better model. At this point, we constructed a reciprocal model: $Y_2 = \beta_0 + \beta_1(1/PD) + \beta_2(1/BMI) + \beta_3 PC + \beta_4 FH$. The simulation run revealed that RF (Y) = 0.000000 + 50.0 + 0.000000 PC - 0.000000 FH. Consistent with the result of the first trial, BMI is still omitted because it is highly correlated with other independent variables. As you can see, of the three (3) remaining variables, only PD was found to be a determinant of KF development i.e., KF = 50/PD. This means that our unknown is 50 and so to illustrate, if a teenager consumes 5 bottles of PD per day, then he can develop renal failure at the age of 10 (50/5). We can say that this is a better model compared with the first one because the SSE is 0. This implies that the model is very accurate. This result illustrates the real behavior because the younger population before did not as a lot of PD while the rest of the identified independent variables already existed even then. As the proponents were just utilizing a hypothetical data, we are interested in applying the generated model in actual data. After analyzing the gathered data, the intake of power drinks was the only determinant of kidney failure development.

Keywords: Kidney failure model, Prediction, Simulation, Power drinks, BMI, Pre-existing conditions and family history

INTRODUCTION

Over the past decades, kidney failure has been observed to significantly affect elderly population in the Philippines and even globally (Lee *et al.*, 2011). Renal failure or kidney failure is a widespread medical condition in which the kidneys fail to adequately filter toxins and wastes products from the blood.

Recently however, it is very noticeable that this condition is already involving the young ones. This observation is supported by United States Renal Data System (USRDS, 2003) reporting that there was a significant increase of incidence in 2001 in 0-19 years with the mean age of 13.3 years.

It is quite unexpected that the rise of renal failure incidence is affecting the younger populace. In the medical context, this situation is very alarming. This is actually a call for the health care providers to develop or enhance the treatment regimen suited for younger patients. Furthermore, there is a need to compare the characteristics of the younger population from then and now.

The intent of determining the occurrence of renal failure among the younger population prodded the researchers to develop a model that will aid healthcare providers to predict the prevalence of such condition. Through this, health education on the prevention of this condition, the next generation will be reinforced and be given much emphasis. The purpose of this paper is to analyze the characteristics of the younger population of the present in relation to its increasing vulnerability in developing kidney failure such as gender, intake of power drinks, body mass index (BMI), family history and presence of other pre-existing condition.

LITERATURE REVIEW

The adult and the elderly are the ones that come into our minds when we hear the word renal failure. It is a condition that is commonly evident in the older population of many countries. However, the occurrence of such made a great change, as the individuals of the younger population now paved its way to be a part of the already existing groups of adults with renal failure. Several factors are to be considered to better understand its rate in the recent times. Age, gender, intake of powered drinks, body mass index, family history and presence of other conditions can be associated with the increasing incidence.

According to the NNHeS Renal Report of 2003-2004, a prevalence rate of 2.6% was gathered, which means that 1,212,306 adult Filipinos have chronic kidney disease. However, according to USRDS, 2003, there was significant increase of incidence in 2001 in 0 - 19 years with the mean age of 13.3 years. On a report of the National Statistics Office (2011), Kidney diseases ranked number 10 cause of mortality in the Philippines (Philippine College of Physicians, 2011).

The Kidney Failure Model

The kidney failure model is derived based on the following assumptions:

Assumptions:

1. Kidney failure is recently affecting the younger populace;
2. Younger people today have distinguishable characteristics as compared to the young ones decades ago;
3. The characteristics that should be examined include intake of power drinks, body mass index (BMI), family history and presence of other pre-existing condition;
4. Adolescents of today are noticeably good consumers of power drinks. The risk of acquiring renal disease starts to elevate when a person is constantly drinking at least 3 bottles of power drinks per day. As the number of power drinks reaches 10, the incidence rate will peak and remain invariable even when a person drinks 30 bottles or more;
5. There is higher probability of acquiring KF if the BMI reaches more than 23;
6. There is a higher risk of renal failure if the person has a family history/genetic predisposition and if there is/are pre-existing disorders.

Based on the assumptions:

At first, we validated the observation that kidney failure was indeed affecting the younger population. Knowing this, we are interested in looking at the characteristics of this age group and compare those characteristics to the young ones before. These characteristics include intake of power/energy drinks (PD), body mass index (BMI), presence of pre-existing conditions (PC) and presence of family history (FH).

In determining the extent by which these identified independent variables really contributed to the development of KF among the young ones, we did a simulation which run with 1000 generated random data based on real behaviors. Results of the simulation are attached in the appendices.

We formulated and tested the first linear model:

$$Y_1 = \beta_0 + \beta_1 PD + \beta_2 BMI + \beta_3 PC + \beta_4 FH$$

The result showed that **RF(Y) = 28.9 - 4.02 PD - 0.0028 PC + 0.0459 FH**. Notice that BMI has been removed from the equation because it is highly correlated with other independent variables such as the intake of PD, FH and PC. At this point, we could not say yet that this is a good model. And so, we should note that the sum of square residual error (SSE) is 251. Knowing that the higher is the SSE, the larger is the degree of error of the theory and thus, there is a need for us to generate a new, better model.

At this point, we constructed a reciprocal model:

$$Y_2 = \beta_0 + \beta_1(1/PD) + \beta_2(1/BMI) + \beta_3 PC + \beta_4 FH$$

The simulation run revealed that **RF(Y) = 0.000000 + 50.0 + 0.000000 PC - 0.000000 FH**. Consistent with the result of the first trial, BMI is still omitted because it is highly correlated with other independent variables such as the intake of PD, FH and PC. As you can see, among the three (3) remaining variables, only PD was found to be a determinant of KF development. That is, **KF = 50/PD.**

We can say that this is a better model compared with the first one because the SSE is 0. This implies that the model is very accurate. This result illustrates the real behavior because earlier the younger population did not consume a lot of PD while the rest of the identified independent variables already existed even then and because the proponents were just utilizing a hypothetical data, we are interested in applying the generated model in actual data.

METHODOLOGY

The researchers used an advanced mathematical modeling in testing and validating the function which was being formulated. Actual data from patients with renal failure aging 30 years old or younger were gathered. Data include gender, intake of power/energy drinks per day, actual BMI, presence of pre-existing conditions and presence of family history of renal failure. Data were gathered in the community or hospital settings anywhere in the region through personal interview. The proponents proposed to have at least 400 respondents however, after six months of data gathering, the proponents only had 18 respondents who qualified. Data were processed and analyzed utilizing minitab version 15 following the steps done in the simulation phase.

RESULTS AND DISCUSSIONS

After processing the actual data gathered, the regression analysis results of renal failure versus BMI, Intake of power/energy drinks, family history and pre-existing condition were revealed.

The presence/absence of pre-existing condition variable is highly correlated with the other identified variables (such as intake of power drinks, BMI, family history and pre-existing condition) and hence, it has been removed from the regression equation. The regression equation is:

Kidney Failure *(KF) =*
5.75 + 0.750 BMI + 2.63 PD - 1.00 FH

Predictor	Coef	SE Coef	T	P
Constant	-0.800	1.724	-0.46	0.650
BMI	-0.00356	0.05771	-0.06	0.952
Intake of PDs	-0.3921	0.3236	-1.21	0.246
Fam Hx	0.3916	0.4727	0.83	0.421

S = 0   R-Sq = 100.0%   R-Sq(adj) = 100.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	4	0.2890	0.0723	0.45	0.769
Residual Error	14	2.2377	0.1598		
Total	18	2.5267			

Source	DF	Seq SS
BMI	1	0.0012
Intake of PDs	1	0.1780
Fam Hx	1	0.1097

It can be gleaned from the result above that one (1) of the four (4) remaining variables predict the occurrence of renal failure and that is the intake of power drinks. The intake of power drinks was the only determinant of kidney failure development. That is, **KF = 2.63 / PD**. This means that our unknown is 2.63 and so to illustrate, if a teenager consumes 2 bottles of PD per day, then he can develop renal failure after 1.3 years (2.63/2).

The result is consistent with the prior simulation tests done. Furthermore, this illustrates the real behavior because the younger population before did not consume a lot of energy drinks while the rest of the identified independent variables already existed even then.

According to Suliman *et al.*, (2002), kidney failure can develop because of taurine component in the energy drinks which may accumulate in the kidneys. Furthermore, Hanly (2014) said that moderate intake is unlikely to have any ongoing effect on your body, but exceeding the recommended dosage increases your risk to kidney diseases, particularly when mixing energy drinks with alcohol or taken after exercise.

CONCLUSION

After analyzing the characteristics of the younger population of the present in relation to its increasing vulnerability in developing kidney failure, only the intake of energy drinks is a significant predictor.

Appendix A

Minitab Simulation Results

TRIAL 1

Regression Analysis: RF(Y) versus PD(X1), BMI(X2), PC(X3), FH(x4)

* BMI(X2) is highly correlated with other X variables
* BMI(X2) has been removed from the equation

The regression equation is

RF(Y) = 28.9 - 4.02 PD(X1) - 0.0028 PC(X3)+ 0.0459 FH(x4)

Predictor	Coef	SE Coef	T	P
Constant	28.8966	0.0987	292.79	0.000
PD(X1)	-4.01838	0.02268	-177.21	0.000
PC(X3)	-0.00280	0.05406	-0.05	0.959
FH(x4)	0.04593	0.03231	1.42	0.156

S = 0.5022 R-Sq = 96.9% R-Sq(adj) = 96.9%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	7964.7	2654.9	10527.20	0.000
Residual Error	996	**251.2**	0.3		
Total	999	8215.9			

Source	DF	Seq SS
PD(X1)	1	7964.2
PC(X3)	1	0.0
FH(x4)	1	0.5

TRIAL 2

Regression Analysis: RF(Y) versus 1/PD, 1/BMI, PC(X3), FH(x4)

* 1/BMI is highly correlated with other X variables

* 1/BMI has been removed from the equation

The regression equation is

RF(Y) =0.000000 + 50.0 1/PD +0.000000 PC(X3) -0.000000 FH(x4)

Predictor	Coef	SE Coef	T	P
Constant	0.00000000	0.00000000	*	*
1/PD	50.0000	0.0000	*	*
PC(X3)	0.00000000	0.00000000	*	*
FH(x4)	-0.00000000	0.00000000	*	*

S = 0 R-Sq = 100.0% R-Sq(adj) = 100.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	8215.9	2738.6	*	*
Residual Error	**996**	**0.0**	0.0		
Total	999	8215.9			

Source	DF	Seq SS
1/PD	1	8215.9
PC(X3)	1	0.0
FH(x4)	1	0.0

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