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Examining Potential Risk Factors to Acute Pancreatitis Disease: A Comparison of Loglinear Models in a Malaysian Case Study

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Acute pancreatitis is not a new disease in Malaysia and the occurrence of the disease has increased from year to year. Death from the infection of acute pancreatitis is also on the rise. This is worrying situation for all Malaysians and medical institution. Therefore, this study aims to identify the strength and significant predisposing factors to acute pancreatitis based on the most suitable and parsimonious model. This study used patient's data records between 2005 and February 2012 obtained from Universiti Kebangsaan Malaysia Medical Centre (UKMMC). The Chi-Square test and Mantel-Haenszel test of homogeneity was used to determine the association among potential risk factors to acute pancreatitis and the confounding variables in this study, respectively. Loglinear modeling methods was performed to find the most suitable and parsimonious model. Parameter estimates and odds ratios were used in testing the effect of risk factors in acute pancreatitis. Results show that alcohol, diabetes, gallstone and smoking are significantly associated with acute pancreatitis. In the loglinear analysis, it was found that homogeneous model is the most parsimonious model in explaining the potential risk factors to acute pancreatitis. Findings from test of effect sizes indicate that age and race are significantly associated between potential risk factor (diabetes, gallstone and smoking) and acute pancreatitis.

Key words: Risk factors, acute pancreatitis, homogeneous loglinear, independenc loglinear, odds ratio

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INTRODUCTION

Numerous studies have been conducted to identify predisposing factors to acute pancreatitis, characteristics of acute pancreatitis, complications from acute pancreatitis and its prevention. According to Sun *et al.* (2003), 80% of mortality in severe acute pancreatitis are caused by infection. Biliogenic pancreatitis is a high risk factor that can be exposed to this infection. They also found that bloody ascites, paralytic ileus greater than 5 days, ranson scores more than 5 point, hematocrit higher than 45% and CT Balthazar score greater than 7 points are the predisposing factors to secondary pancreatic infection.

Previous research have revealed many factors predisposing to acute pancreatitis. Based on Kelly (1984), gallstone is the local predisposing factors to acute pancreatitis. The study clearly shows that there were more stones and smaller faceted stones in the gallbladder and common bile ducts of patients who experienced acute pancreatitis compared with patients without pancreatitis. McMahon *et al.* (1981) also found that multiple small-faceted stones were seen more often on radiographs from patients with cholelithiasis and pancreatitis. Kelly (1984) proposed that bile reflux into the pancreatic duct was the cause of acute pancreatitis associated with cholelithiasis. Kelly (1976) also reported that there is at least three condition in which gallstones predispose a patient to gallstone pancreatitis. Firstly, complete obstruction of the ampulla of Vater by a small stone that permits reflux of bile behind the stone into the pancreatic duct. Secondly, partial obstruction of the ampulla of Vater permitting duodenal reflux into the pancreatic duct and lastly duodenopancreatic duct reflux after the passage of a gallstone into the duodenum.

Other than that, type 2 diabetes and antidiabetic drugs have also been associated with acute pancreatitis (Gonzalez-Perez *et al.*, 2010). Antonio reported that patients with type 2 diabetes have excess risk of acute pancreatitis. In fact, in United Sates the cohort analyses yielded a statistically significant 77% increased risk of acute pancreatitis associated with prior history of diabetes. This study also found that use of insulin and long-term use of metformin in type 2 diabetes might be associated with a reduced risk of pancreatitis as opposed to long-term use of sulfonylureas, which seem to increase the risk. This study also indicates that acute pancreatitis rises with increasing age and tends to be higher in men than women. Among other risk factors, smoking, alcohol use and use of ACE inhibitors are also predisposing factors to pancreatitis.

Thamilselvam *et al.* (2008) found that there is a striking difference in the etiological factors for acute pancreatitis between two different ethnic groups in Malaysia, namely Malay and Indian. This is most likely due to the difference in alcohol consumption between the ethnic groups. This study also found that clinical features and complications were more severe in the Malay than Indian ethnic groups.

Kandasami *et al.* (2002) described that acute pancreatitis are significantly influenced by ethnic differences and etiological factors. They found that alcohol consumption and gallstone are most important etiologic factors associated with acute pancreatitis. The study revealed that alcohol dependence is higher among Indians as compared to other races. This is due to their lifestyle as being in the low social class where many of them were labourers in the plantations. Kandasami *et al.* (2002) also stated that alcohol association with acute pancreatitis has significantly increased in the men while gallstone pancreatitis is more associated with women.

In another study, Zuo *et al.* (2012) indicated that there is an association between Mean Glucose Level (MGL) and severe acute pancreatitis. They also found that GLI is a significant contributor of mortality in patients with SAP. On the other hand, Lowenfels and Maisonneuve (2011) revealed that smoking provides strong evidence that lead to a risk of acute pancreatitis. They also found that alcohol consumption can cause acute and eventually chronic pancreatitis. Barclay (2009) found that among Danish men and women, smoking was significantly related with increased risk of pancreatitis.

Based on geographic location, Gardner *et al.* (2006) found that more patients in Europe and Hong Kong have gallstone pancreatitis. On the other hand, pancreatitis is more common among the high alcohol comsumers in the United States. According to Thamilselvam *et al.* (2008), alcohol and gallstones are equally important in Malaysia because of its multi-ethnic population. Besides that, Raj *et al.* (1995) found a striking difference between demographic and etiological pattern of acute pancreatitis in Kelantan. They found that acute pancreatitis is related to gallstone but there was a low incidence of alcoholic pancreatitis among the Muslim community.

Buscaglia *et al.* (2009) summarized that male patients with age greater than 65 years that have low income are strongly associated with inpatient mortality from pancreatitis. However, there is no single characteristic can reliably and accurately predict mortality but rather a combination of factors both patient-related and hospital course-related.

SELECTED STUDIES ON ACUTE PANCREATITIS

The term "pancreas" is derived from the Greek which are, Pan-all and Kreas-flash. Any inflammation of the pancreas is known as acute pancreatitis. According to Nadesan *et al*. (1999), any inflammation of the pancreas is known as acute pancreatitis. De Beaux *et al*. (1995) stated that development of organ dysfunction in acute pancreatitis is a major cause that lead to morbidity and mortality.

Mostly, acute pancreatitis will affect patients at a similar frequency among various age group, but it will vary in the cause of the condition and the likelihood of death depending on the age, sex, race, body-mass index and other factors. Steinberg and Tenner (1994) found that acute pancreatitis is a multifaceted disease with multiple etiologies and there is a wide variability in the presentation and clinical course of the disease. Most of the previous study described that the two common causes of acute pancreatitis are alcohol abuse and gallstones.

Acute pancreatitis is not a new disease in Malaysia. However, the occurrence of the disease has increased from year to year. This is a worrying situation in Malaysia and a cause for concern among the medical practitioners. Based on the researcher's conversation with a medical doctor at UKMMC, acute pancreatitis will lead to mortality, however, the situation is less common in Malaysia. Nowadays, death from the infection of acute pancreatitis is on the rise. Sun *et al*. (2003) have revealed the evaluation and the prevention of the disease. However, no attempt has been made yet to investigate the significant effect of the potential risk factors to acute pancreatitis in Malaysia. Therefore, this study was carried out to determine the effect of the potential risk factors to acute pancreatitis using loglinear modeling approach. This study is expected to provide benefits to the health sciences and medical fields in contributing additional information regarding the effect of potential risk factors to acute pancreatitis. This study is also expected to increase the awareness of public on health risk issues related to acute pancreatitis.

RELATED MEDICAL STUDIES USING LOGLINEAR MODELS

According to Chan (2005), loglinear models can be applied in multiway contingency tables that have three or more categorical variables in determining whether or not there are significant relationship between the variables. Loglinear also can be used to identify whether the distribution of the counts among the cells of a table can be explained by a simpler, underlying structure model also known as restricted model. Loglinear models is used to describe the strength of association among the response variables. Previous study from different fields have applied loglinear approach in determining the associated factors between their interested categorical variables such as medical, forecasting and social science.

A research that was conducted by Tiensuwan *et al.* (2005) have applied loglinear models to identify the associated factors between personal and cancer/clinical variables of the cancer patients at the National Cancer Institute. Two and three-dimensional loglinear models have been constructed to determine the relationship between variables. The variables involve in the model for the personal data include race, religion, marital status, age and region while in cancer/clinical data, variables includes diagnostic evidence, site of cancer, stage of diagnosis, treatment and status of lost contact. In another study, loglinear approach was used in case-parent triad data to investigate maternal genetic polymorphisms in relation to offspring disease risk (Starr *et al*., 2005). Then, Tanaka *et al.* (2003) used hierarchical loglinear model to assess interaction between genotype and age in a case-control study of the apolipoprotein E gene in Alzheimer's disease.

Alaya (2010) used logistic regression and loglinear models to investigate factors that affects heart disease. He used three way and higher interaction in assessing the model interactions. The dependent variables included in this study were fatty diet, hypertension, diabetes, gender, smoking, family history of heart disease and overweight in patients data of Jordanian hospitals. In contrast, Zhu *et al*. (2006) compared two approaches in determinants of caregivers' health, a structural equation modeling and loglinear models. In the Caregiver study, there is no clear distinction between response and explanatory variables. Therefore, a loglinear model is applied in order to describe the association and interaction patterns between the variables.

BRIEF OVERVIEW OF LOGLINEAR MODELS

Loglinear model is used to model the cell counts in contingency tables (Agresti, 2007) where, it estimate parameters that describe the relationship between categorical variables. In loglinear model, all the variables have been treated as response variables by modeling the cell counts for all combinations of the levels of the categorical variables included in the model. Two loglinear models, namely homogenous and conditional independence are compared against the saturated loglinear model.

Saturated model is the most complex model that can be fitted to any contingency table where it includes all main effects, two-way and three-way interactions. Homogeneous model contains all two-way interactions and main effects but not three-way interaction. It implies that at each level of third variable, the conditional odds ratio between any two variables are the same while conditional contains the main effects and some two-way interactions. Saturated, homogenous and conditional independence models can be represented as in Eq. 1-3, respectively (Agresti, 2007):

$$\log(\mu_{ijk}) = \lambda + \lambda_i^x + \lambda_j^y + \lambda_k^z + \lambda_{ij}^{xy} + \lambda_{ik}^{xz} + \lambda_{jk}^{yz} + \lambda_{ijk}^{xyz} \quad (1)$$

$$\log(\mu_{ijk}) = \lambda + \lambda_i^x + \lambda_j^y + \lambda_k^z + \lambda_{ij}^{xy} + \lambda_{ik}^{xz} + \lambda_{jk}^{yz} \quad (2)$$

$$\log(\mu_{ijk}) = \lambda + \lambda_i^x + \lambda_j^y + \lambda_k^z + \lambda_{ik}^{xz} + \lambda_{jk}^{yz} \quad (3)$$

where, log (μ_{ijk}) is log of the expected cell frequency of the cases for cell i, j and k in the contingency table:

- λ is the overall mean of the natural log of the expected frequencies
- $\lambda_i^x, \lambda_j^y, \lambda_k^z$ are main effects for the variables X, Y and Z
- $\lambda_{ij}^{xy}, \lambda_{ik}^{xz}, \lambda_{jk}^{yz}$ are the interaction effects for variables X and Y, X and Z and Y, Z
- λ_{ijk}^{xyz} is the interaction effect for variables X, Y and Z

MATERIALS AND METHODS

Study design: The study involved selecting 115 medical records of patients with pancreatitis disease and 73 patients without the disease. These records were gathered after obtaining a written permission from the Head of CaseMix Unit at UKMMC. These records comprised of patients records who went to Universiti Kebangsaan Malaysia Medical Centre (UKMMC) to seek treatment between 2005 and 2012. Other information collected includes patients' demographic profiles (race, gender and age) and other diseases or information that are associated with the patients such as diabetes, gallstones, alcohol consumption and smoking. There is a constraint in the amount of data collected and usually limited to between 10 and 15 cases day^{-1}. Some information are not available and could not be retrieved from the database.

Two loglinear models, namely independence and homogenous were compared against the saturated model and finally chosen for its parsimony. For each loglinear model, three categorical variables are selected with one variable identified as a confounder. Prior to the analysis of loglinear models, data are subjected to several tests of association using chi square test to ensure that significant variables are selected and can be used in the model. Based on the review of literature on factors relating to pancreatitic disease, several variables were deemed important and used in the investigation. Chi square is also used to test partial associations in the models. The partial association tests relate to testing of a specific coefficient in the model. To identify the confounder, Mantel-Haenszel test of homogeneity is used. It is used to determine whether or not confounding effect exist between two factors in the presence of a third factor. Rothman and Greenland (1998) proposed several criterias for a confounding factor such that confounding factor must be a risk factor for a disease, a confounding factor must be associated with exposure in the population at risk from which the cases are derived and confounding factor cannot be intervening variable that comes in between the exposure and the outcome.

In this study, General loglinear modeling (Genlog) is used to test the model by searching manually among a finite set of models to determine the most parsimonious one. Backward elimination procedure proposed by Goodman (1971) is used where, it attempts to remove the highest order effect, second highest order and so on and test whether the removal significantly reduced the likelihood ratio G^2 (at α = 0.05). This process continues until all effects at a level are retained or all effects have been tested and removed. According to Agresti (2007), loglinear model will be classified to have a good fit when the model has smaller likelihood ratio statistics, G^2 and smaller p-value. Analysis of residuals which reflect local differences between the observed and expected cell counts is also used to assess the fit of a model. Loglinear model that consist both positive and negative residual frequencies value with approximately the same magnitude that are distributed evenly across the cells of the table are likely to have a good fit (Christensen, 1997).

Alternative way to assess the model is to analyze the residuals. According to Agresti (2007), normally lack of fit is indicated by absolute values larger than about 2 when there are few cells or about 3 when there are many cells. This is supported by Tabachnick and Fidell (1996) who indicated models that fit poorly or display a lack of fit in a generally good fitting model can be observed by looking at the standardized residual.

In estimating the parameters or effect sizes, maximum likelihood approach is used. It may be expressed as unstandardized or standardized lambda or b coefficients. Standardized parameter estimates can be used to see which variables in the model are most or least important to the interactions in the given parsimonious model. The more positive (if significant) the parameter estimate for an effect, the more cases are predicted to be in a cell over and beyond those predicted by the constant and other effects. The more negative (if significant), the fewer cases are predicted. If the parameter estimates is non-significant, the effect is not associated with any change in cell frequencies which are predicted by the constant or other effects. The effect of parameter estimates are related to odds and odds ratios. Christensen (1997) defined odds as the ratio between the frequency of being in one category and otherwise which equivalent to the frequency of not being in that particular category. Agresti (2007) stated that if odds ratio equals 1.0, there is no association between the variables; for odds ratio value above 1.0, there is a positive association among the variables. The larger the value of odds ratio, the stronger the association will be. As for odds ratio value smaller than 1.0, this will indicate that there is negative association.

RESULTS

Demographic profiles: This section describes the demographic profile of the patients at UKMMC. Demographic variables which are considered in this study are age, gender and races. These variables are among the variables which are considered important in the investigation of pancreatitis disease and found to be significant risk factors based on literature review. From the data, there is a higher representation of patients between the age of 21-55 years old. Male records represented slightly more than 50% of the total sample compared to female. In the composition of prevalence to acute pancreatitis disease according to ethnic groups, Malay account for 3.7% of the population followed by 0.9%. Chinese. For Indian and other ethnic groups, the prevalence of acute pancreatitis is still considerably low (Table 1). Only 27% of the patients are smokers; 18% are alcoholic; 48% had gallstones infections and 37% are diabetic.

Idenifying risk factors and confounding variables: Chi-square test showed that alcoholism, diabetes and gallstone were found to be significantly associated with acute pancreatitis disease. These results are consistent with Kandasami *et al.* (2002) who studied acute pancreatitis in a multi-ethnic population. Smoking is not significantly associated with acute pancreatitis, but it has been included in the model based on the evidence from the literature review (Albert *et al.*, 2011).

Analysis of confounding found that gender, age category and race are potential confounders as shown in the Mantel-Haenszel test. The results show that the combination of Gender vs. Alcoholism vs. Acute Pancreatitis, Age vs. Alcoholism vs. Acute Pancreatitis and Race vs. Alcoholism vs. Acute Pancreatitis were found to be significantly associated. These combinations of variables are used in the analysis of loglinear models.

Analysis of loglinear models: This section discuss the analysis and results of three-way loglinear models involving combination of gender (G), alcoholism (A) and pancreatitis (P). It involves the analysis of Eq. 4:

$$\log(\mu_{ijk}) = \lambda + \lambda_i^G + \lambda_j^A + \lambda_k^P + \lambda_{ij}^{GA} + \lambda_{ik}^{GP} + \lambda_{jk}^{AP} + \lambda_{ijk}^{GAP} \quad (4)$$

Table 2 shows that 80.8% of male patients who were alcoholic are prone to have acute pancreatitis compared to 19.2% without acute pancreatitis. Among female who were alcoholic, 85.7% were diagnosed with acute pancreatitis compared to 14.3% without acute pancreatitis. Comparisons are made between the loglinear models starting with investigation on the strength of the association between patients with acute pancreatitis and alcoholism across gender group.

Table 1: Percentage of patients diagnosed with acute pancreatitis based on ethnicity

Ethnicity	Estimated population of Malaysia (%)	Patients diagnosed with acute pancreatitis (%)	Difference (%)
Malay	54.6	58.3	3.7
Chinese	24.3	25.2	0.9
Indian	7.3	7.0	-0.3
Indigenous	12.8	Nil	Nil
Other	1.0	9.5	-8.5

Table 2: Three-way table for Gender (G), Alcoholism (A), Pancreatitis (P)

		Diagnosis of acute pancreatitis		
Gender	Alcoholism	Acute pancreatitis	Non-acute pancreatitis	Total
Male	**Alcoholic**			
	Count	21.0	5.0	26
	Alcoholic (%)	80.8	19.2	
	Non-alcoholic			
	Count	41.0	26.0	67
	Non-alcoholic (%)	61.2	38.8	
Female	**Alcoholic**			
	Count	6.0	1.0	7
	Alcoholic (%)	85.7	14.3	
	Non-alcoholic			
	Count	47.0	41.0	88
	Non-alcoholic (%)	53.4	46.6	

Table 3: Comparison of fitted values between the loglinear models

		Loglinear models				
Gender	Alcoholism status	(G, A, P)	(GA, P)	(GP, AP)	(GA, GP, AP)	(GAP)
Male	**Alcoholic**					
	Acute pancreatitis	9.986	15.904	14.557	21.5	21
	Non-pancreatitis	6.339	10.096	2.548	4.5	5
	Non-alcoholic					
	Acute pancreatitis	46.903	40.984	47.443	40.5	41
	Non-pancreatitis	29.773	26.016	28.452	26.5	26
Female	**Alcoholic**					
	Acute pancreatitis	10.200	4.282	12.443	5.5	6
	Non-pancreatitis	6.475	2.718	3.452	1.5	1
	Non-alcoholic					
	Acute pancreatitis	47.911	53.830	40.557	47.5	47
	Non-pancreatitis	30.413	34.170	38.548	40.5	41

G: Gender, A: Alcoholism, P: Pancreatitis, GA: Gender×Alcoholism, GP: Gender×Pancreatitis, AP: Alcoholism×Pancreatitis, GAP: Gender×Alcoholism×Pancreatitis

Table 3 shows the model fitted values for the loglinear models. Fit model refers to a non-significant difference between expected values of the test model and the expected values for the saturated model. In this case, there is a small difference between expected values for homogeneous loglinear model (GP, AP, GA) and the saturated model (GAP). The other models are found to fit poorly due to the large discrepancies between the expected values of saturated model and the test models.

For quality of fit, Table 4 compares the likelihood ratio, G^2 statistics and p-values between the models.

From Table 4, it can be seen that homogeneous model (GA, GP, AP) fits the data adequately compared to other models with the smallest likelihood ratio statistics ($G^2 = 0.326$, $p>0.5$). This implies that the homogenous model (GA, GP, AP) fits the data well.

Residual analysis in Table 5 shows the quality of fit cell-by-cell.

There is no indication for lack of fit in homogenous model as the difference in the values between observed and expected is negligibly small. This also indicates that the model is fit. The small residuals also reflect an overall good fit. Therefore, homogeneous loglinear model is considered the most parsimonious model for the combination of Gender (G), Alcoholism (A) and Pancreatitis (P). List of other most parsimonious models for different combination of variables are presented in Eq. 5, 6 and 7 as follows:

$$\log(\mu_{ijk}) = \lambda + \lambda_i^G + \lambda_j^A + \lambda_k^P + \lambda_{ij}^{GA} + \lambda_{ik}^{GP} + \lambda_{jk}^{AP} \tag{5}$$

$$\log(\mu_{ijk}) = \lambda + \lambda_i^A + \lambda_j^L + \lambda_k^P + \lambda_{ij}^{AL} + \lambda_{ik}^{AP} + \lambda_{jk}^{LP} \tag{6}$$

$$\log(\mu_{ijk}) = \lambda + \lambda_i^R + \lambda_j^A + \lambda_k^P + \lambda_{ij}^{RA} + \lambda_{ik}^{RP} + \lambda_{jk}^{AP} \tag{7}$$

Table 4: Comparison of likelihood ratio statistics between the models

Model	G^2	df	p value
(G, A, P)	23.358	4	<0.001
(GA, P)	8.883	3	0.031
(GP, AP)	13.164	2	0.001
(GA, GP, AP)	0.326	1	0.568
(GAP)	0.000	0	

G: Gender, A: Alcoholism, P: Pancreatitis, GA: Gender×Alcoholism, GP: Gender×Pancreatitis, AP: Alcoholism×Pancreatitis, GAP: Gender×Alcoholism×Pancreatitis

Where:

G = Gender
A = Alcoholism
L = Age
P = Pancreatitis

To look at the strength of the association, test of effect sizes is performed using Z statistics. This determines which parameters estimates are significant. Odds ratio is computed either from the fitted values of the model or by using the parameter estimates in the model. The parameter estimates are based on the most parsimonious model.

For the model combination GAP in Table 6, the standardized Z for parameter estimates show the relative importance of the effects. In this model, gender alone has no effect on pancreatitis ($p>0.05$). However, patients with alcoholic history has evidence for being a significant risk factor for acute pancreatitis ($p<0.05$). The analysis also revealed that the odds of getting acute pancreatitis for patients with alcoholic history are three times higher than those without.

In the loglinear model combination of ALP (Table 7), age and alcoholism are found to be significant risk factors for acute pancreatitis ($p<0.05$). There is a also a significant relationship between age category of 55 years and below and acute pancreatitis ($p>0.05$) and between alcoholism and acute pancreatitis ($p < 0.05$). Regardless of alcoholic

Table 5: Standardized residual for homogeneous loglinear model

Gender	Alcoholism status	Observed count	Expected count	Standardized residual
Male	**Alcoholic**			
	Acute pancreatitis	21	21.5	-0.554
	Non-pancreatitis	5	4.5	0.553
	Non-alcoholic			
	Acute pancreatitis	41	40.5	0.553
	Non-pancreatitis	26	26.5	-0.554
Female	**Alcoholic**			
	Acute pancreatitis	6	5.5	0.553
	Non-pancreatitis	1	1.5	-0.554
	Non-alcoholic			
	Acute pancreatitis	47	47.5	-0.554
	Non-pancreatitis	41	40.5	0.553

Table 6: Estimated parameters for gender, alcoholism and pancreatitis

Parameter	Estimate	Z	Sig.
Constant	3.701	23.796	0.000
Gender = Male	-0.424	-1.743	0.081
Alcoholism = Yes	-3.296	-6.004	0.000*
Diagnosis = Acute pancreatitis	0.159	0.760	0.447
(Gender = Male)×(Alcoholism = Yes)	1.523	3.301	0.001*
(Gender = Male)×(Diagnosis = Acute pancreatitis)	0.265	0.843	0.399
(Alcoholism = Yes)×(Diagnosis = Acute pancreatitis)	1.140	2.319	0.020*

*Significant at 0.05 level

Table 7: Estimated parameters for alcoholism (A), age (L) and pancreatitis (P)

Parameter	Estimate	Z	Sig.
Constant	3.809	25.880	0.000
Age = 55 years and below	-0.723	-2.878	0.004*
Alcoholism = Yes	-2.747	-5.745	0.000*
Diagnosis = Acute pancreatitis	-0.148	-0.695	0.487
(Age = 55 years and below)×(Alcoholism = Yes)	0.796	1.879	0.060
(Age = 55 years and below)×(Diagnosis = Acute pancreatitis)	0.956	3.015	0.003*
(Alcoholism = Yes)×(Diagnosis = Acute pancreatitis)	1.048	2.136	0.033*

*Significant at 0.05 level

Table 8: Estimated parameters for model race (R), alcoholism (A) and pancreatitis (P) model

Parameter	Estimate	Z	Sig.
Constant	0.888	1.499	0.134
Race = Malay	2.594	4.218	0.000*
Race = Chinese	2.170	3.467	0.001*
Race = Indian	1.485	2.264	0.024*
Alcoholism = Yes	-1.453	-2.045	0.041*
Diagnosis = Acute pancreatitis	0.829	1.212	0.225
(Race = Malay)×(Alcoholism = Yes)	-1.653	-2.586	0.010*
(Race = Chinese)×(Alcoholism = Yes)	-1.067	-1.581	0.114
(Race = Indian)×(Alcoholism = Yes)	-0.105	-0.136	0.892
(Race = Malay)×(Diagnosis = Acute pancreatitis)	-0.278	-0.390	0.696
(Race = Chinese)×(Diagnosis = Acute pancreatitis)	-0.809	-1.102	0.271
(Race = Indian)×(Diagnosis = Acute pancreatitis)	-1.753	-2.128	0.033*
(Alcoholism = Yes)×(Diagnosis = Acute pancreatitis)	1.428	2.781	0.005*

*Significant at 0.05 level

history, the estimated odds of patients being diagnosed with acute pancreatitis in the age category of 55 years and above is 2.6 times more likely than those below 55 years old. In contrary, regardless of age the estimated odds of patients with alcoholic history being diagnosed with acute pancreatitis is 2.9 times more likely than those without alcoholic history.

Finally for loglinear model RAP in Table 8, patients with history of alcoholism and all categories of race have significant effects on pancreatitic disease ($p<0.05$) with Malay dominating the effects due its large representation of the sample. The analysis also show that regardless of the pancreatitic diagnosis, the estimated odds of Malay patients with history of alcoholism has significant effects on pancreatitic disease ($p = 0.01$). However, regardless of race, the odds of having acute pancreatitis for patients with history of alcoholism are 4 times more likely compared to those with no history of alcoholism.

DISCUSSION AND CONCLUSION

This study has illustrated the use of loglinear models to examine the significant risk factors of acute pancreatitis among a reasonable sample of data collected at UKMMC.

The aim is to get the most parsimonious loglinear model that can estimate small number of parameters with greater efficiency and size effects. Five loglinear models namely, saturated, mutual independence, joint independence, conditional and homogeneous association are compared but saturated or full model is taken as the reference model. Using Genlog analysis, the higher order effects are subjected to removal if found to be insignificant and the process continue until no more lower order effects are removed. This final model is known as the parsimonious model. Variables selected to be in the model are subjected to test of independence (or association) and supported by evidences from the literature. Combination of three different set of variables are subjected to the analysis of those loglinear models.

Based on the comparison of the models, homogeneous loglinear model is found to be the most parsimonious model in this study. Further diagnostic analysis found homogeneous model to be fit as the model fitted values are comparably close to the fitted value of the saturated model. Comparison of the goodness-of-fit test across all loglinear models show that homogeneous model fits the data adequately as evident of the smallest Likelihood ratio statistics (G^2) and largest p-value. This is further supported by the analysis of quality of fit where standardized residual showed only small discrepancies between the observed and expected values. This concludes that for combinations that permits all pairwise associations but assumes homogeneous association fits well in this study.

The study concludes that homogeneous loglinear model is the most parsimonious and adequate model to describe the effects of the potential risk factors of acute pancreatitis. Results show that alcoholism is a significant risk factor of acute pancreatitis compared to gallstone, diabetes and smoking. The latter variables are found to be insignificant and therefore no further analysis is pursued.

The test of effect sizes describe that patients with history of alcoholism are three times more likely to have acute pancreatitis. This result coincides with Thamilselvam *et al.* (2008) who discovered that alcohol are significantly the causative factor for producing acute pancreatitis. In the present study, males are five times more likely than females to consume alcohol which is supported by Kandasami *et al.* (2002) who found that alcohol consumption in association with acute pancreatitis significantly increases among the males.

Patients whose age is 55 years old and above are more likely to be diagnosed with acute pancreatitis compared to those below 55 years old. This result coincides with Gonzalez-Perez *et al.* (2010) that increasing age is associated with higher risk of acute pancreatitis.

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