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Factors Affecting Heart Diseases through Logistic Linear and Nonlinear Regression

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Abstract : **- This paper aims to investigate the effects of some factors which affect heart diseases such as fatty diet, hypertension, diabetes, gender, smoking, family history of heart disease and overweight in patients data of Jordanian hospitals.**

The data and statements were established through the medical record sheets of patients who were admitted to the hospitals in Jordan, the sample was collected from three regions of Jordan south, north and middle area.

Log-linear models analyses method has been used to analyze data, likelihood chi-square, Pearson chi-square and odds ratio to ensure the model which choose three variables in each. And logistic regression has been used to estimate the coefficients of these factors of heart disease. We have found that likelihood ratio chi – square, Pearson chi-square, odds ratio are significant, all models of 3way &higher, FT-SR are greater than 1.96 of the normal distribution, these results give assign that all of them together as the group of factors are the causes of heart disease.

Keyword : - Heart disease (C. H.D), Log-Linear, Likelihood Chi-Square, Pearson chi-square, Jordan, Jell classification: C12, C41.

Section 1. INTRODUCTION:

This paper investigates the heart diseases of Jordanian patient's hospital Admitted data to ensure whether the variables chosen in the study from their medical records . Almost 18 million people – 7% - 0f all Americans have heart disease, 50% of them are under age 65 , elder people are affected by heart disease so much greater than (American National Academy on Aging Society, 2005), whereas the ratio in Jordan was not more than 1.8% of the population, It is reasonably due to the style of life and fatty American food and the air pollution and depression on life there .

The log-linear models required Contingency tables – two-way tables which can be formed by cross-classifying categorical variables were typically analyzed by calculating chi-square values testing the hypothesis of independence .and testing them in order to determine if association and /or interactions were taking place among the variables. Since L.A Goodman published his series of researches about log-linear models, many papers appear in this field such as(Bishop, Finberg, Holland 1975, Habeman 1975), the base of work introduced of log-linear models to a wide range of variety of models that could be fitted to cross-classified data. (Agresti, 1996) .

The log-linear model is one of the specialized cases of generalized linear models for Poisson distribution data, and it is an extension of the two- way contingency table where the conditional relationship between two or more discrete categorical tables.(Chirstensen, R 1997). Also, log-linear models can be used in Multi- way contingency tables, They are commonly used to evaluate tables that involve three or more variables (Knoke,d &p.j Broke 1980).

Therefore the researcher found it's reasonable procedures to utilize of the log-linear model to analyze the data of heart disease patients in Jordan, where heart disease can be defined as a disease of a number of abnormal conditions affecting the heart and the blood vessels in the heart. Types of heart disease include many diseases such as heart attacks, Coronary artery disease. Heart disease is a type of cardiovascular disease. In addition to heart disease, the term cardiovascular disease encompasses a variety of heart conditions, such as hypertension and stroke. Coronary heart disease (CHD) is caused by a narrowing of the coronary arteries, which results in a decreased supply of blood and oxygen to the heart. CHD includes

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myocardial infarction, commonly referred to as a heart attack, and angina pectoris, or chest pain. A heart attack is caused by the sudden blockage of a coronary artery, usually by a blood clot. And chest pain occurs when the heart muscle does not receive enough blood. Another type of heart disease is a heart rhythm disorder, which includes rapid heart, heart murmurs, and other unspecified disorders.

Congestive heart failure (CHF), is often the end-stage of heart disease. Also, other types of heart disease considered such as Angina, Heart Attack, Heart failure, heart arrhythmias.

(Suleiman alKattab, et al,2011) in their study aims to shed the light on health service quality in Jordan, and compare the quality of service of public hospitals to private hospitals, in the study sample they have 250 questionnaires , results indicates that private hospital health services are superior than public hospitals, and patients seems are seems more satisfaction

Hence, the research is divided into four sections, the first section is an introduction, the second section introduces the theoretical approach, the third section presents data and methodology, section four presents a discussion of results and concluded remarks.

Section 2 . THEORETICAL APPROACH:

A) Heart Disease and Causes:

Heart disease is a number of abnormal conditions affecting the heart and the blood vessels in the heart. Types of heart disease include:

Coronary artery disease is the most common type and is the leading cause of heart attacks. When your arteries become hard and narrow, blood has a hard time getting to the heart, so the heart does not get all the blood it needs, which can lead to angina. Coronary heart disease is the term that describes what happens when your heart's blood supply is blocked, or interrupted, by a build-up of fatty substances in the coronary arteries. Over time, the walls of your arteries can become furred up with fatty deposits. This process is known as atherosclerosis, and the fatty deposits are called atheroma. If your coronary arteries become narrow, due to a build up of atheroma, the blood supply to your heart will be restricted. This can cause angina (chest pains).If a coronary artery becomes completely blocked, it can cause a heart attack. The medical term for a heart attack is the myocardial infarction.

Coronary heart disease is the biggest killer of Jordanians, one in every seven males, and one in every ten females die from the disease in Jordan, approximately not less than 5.000 people have a heart attack each year.

b)Variables of the Study:

According to the risk factors of the study explained, and that focus on these variables listed below, most people who develop heart disease have recognized risk factors which contribute to the cause of the disease. The so-called 'major risk factors' include Raised cholesterol level in the blood, Raised hypertension, Smoking.

1-Cholesterol:

A person gets coronary heart disease when cholesterol is deposited in the inner lining of the coronary arteries. These arteries supply the heart with blood. They lie on the surface of the heart and form a crown (corona) around it. As the heart beats, they twist and bend. Cholesterol is deposited where the arteries bend and divide. The higher the cholesterol levels in the blood, the greater the chance that deposits will form at these sites.

2-hypertension :

If a person has hypertension, there is more stress in the places where the arteries bend and divide. This added pressure increases the speed at which cholesterol is deposited along the walls of the arteries.

3-Smoking:

Cigarette smoke contains many chemicals, including nicotine and carbon monoxide. Some of these chemicals, along with the carbon monoxide, damage the inner layer of the arteries. Damages of arteries caused by smoking:

A) cholesterol to enter the artery walls more rapidly.

B) blood clots in the arteries which lead to heart attacks.

4)Diabetes:

Diabetes is another risk factor for heart disease. Many diabetics have a high cholesterol level and may also have raised hypertension. Other biochemical changes in diabetics may also accelerate the development of coronary heart disease.

5)Overweight:

A person's weight generally has an impact on his\ her cholesterol level. People who have overweight often have high cholesterol and raised blood pressure. Further, their blood is more likely to clot.

6)Inactivity:

People who are inactive (the 'couch potatoes') are more likely to have heart attacks, heart disease and early death than those who are generally active (moderately active seems to be enough). Inactive people are more likely to have high cholesterol, Have raised blood pressure, be overweight, be smokers.

Even without risk factors like smoking and hypertension, people who are not active still have a higher chance of heart disease. The reasons for this are not clear. It might have something to do with blood clotting and the way clots are removed from the body, but there are many other possibilities.

7)Family history:

A person's genetic inheritance forms the background for most diseases. Each person's genetic

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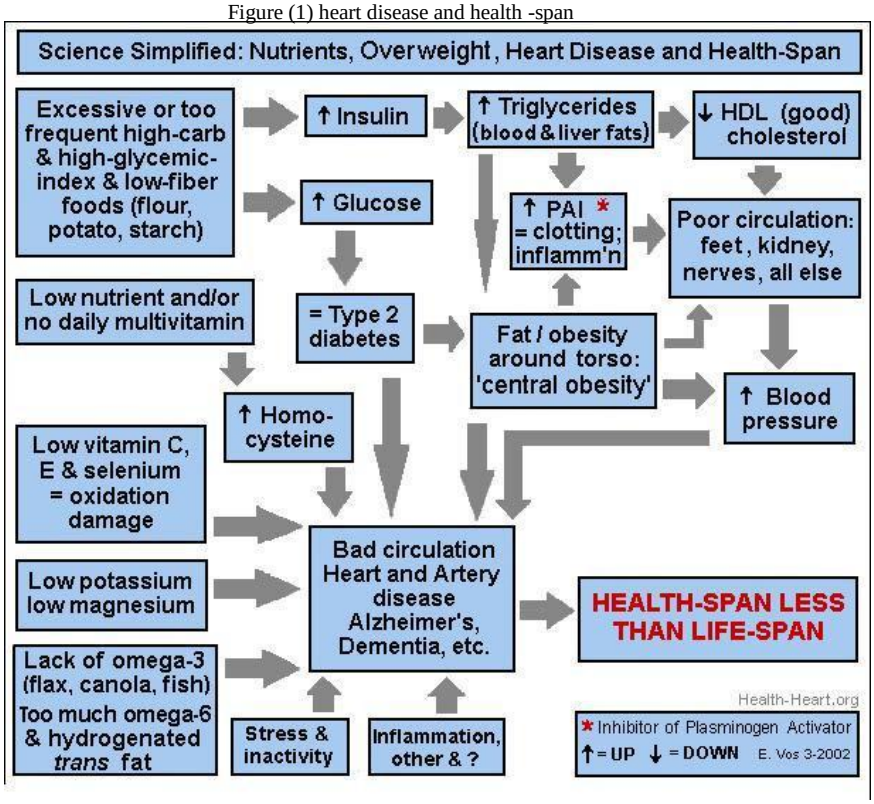
makeup is different (except in identical twins). We tend to inherit things like blood pressure levels, cholesterol, blood glucose, clotting tendencies, body build and response to stress (internal and external).

While a family history of heart disease is a strong marker of risk, you should remember that we usually inherit tendencies rather than diseases. You can overcome some inherited tendencies if you have a healthy diet and an active lifestyle. For example, if you have a family history of heart disease, you can gain enormous advantages if you limit your fat intake, don't smoke and have an active, healthy lifestyle.

8)Gender and age:

If you're male, you have a disadvantage when it comes to cholesterol levels and blood pressure. Males are more likely to develop coronary heart disease in middle age. The risk then progressively rises as they get older. The risk for females is much less, until after the menopause. Then hormonal changes, combined with higher blood pressure, cholesterol and increased weight progressively increase the risk of heart disease. We can summarize why we chose these factors in our study due to their effect on heart disease occurrence, and the effect of these factors on bad circulation heart and artery disease. Then the health span decreases life span, as the figure (1).

Figure (1) heart disease and health -span



source: Gaydos, C.A., 1996. Replication of Chlamydia pneumonia in vitro in human macrophages, endothelial cells, and aortic artery smooth muscle cells. Infect Immunity 64:1614).

Section Three:

A - Methodology and data:

The method of this paper utilizes the log-linear model which can be on forms 1- way &higher,

2- way&higher,3- way&higher, that are significant through the odds ratio, Pearson chi –square and likelihood chi-square, as the results of analyses of the model is saturated in L M model which can be writtenas :

$$Ln\ (it\ ) = \phi + \lambda_j B + \lambda JAB + \lambda_j C + \lambda_j BC + \lambda_j ABC \quad \text{……..(1)}$$

The saturated model form can be written as:

$$Y_{it} = mean + A_j + B_j + AB_{ji} + Ck + BC_jk + ABC_jk \quad \text{……(2)}$$

Where : i, j = (1,2,3,4,…..n) , A ,B,C number of models . Hierarchical models in this paper are a particular class of models in which no interaction terms specified, thus the method as:

1- when dealing with several models the relative quality of each model must be considered, the quality of the model can be measured by it good of fitness to the data, may be tested by using either of two chi-square statistics, first one is Pearson chi-square which is measured by the following equation:

$$X2=2\Sigma f_i k \ln (f_i k - m_i lk)2 / (m_i lk) \quad \text{……(3)}$$

the second is likelihood ratio chi – square statistics can be as:

$$\check{A}2 = 2\Sigma f gk \ln (f_i k) / (m_i lk) \quad \text{…….(4)}$$

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If the model goodness of fit is not significant, We can test the model for adequacy by using the chi –square test. (See, Fienberg, S, E 1979, Koehler 1986).

2- Test of marginal and partial association:

The partial association test is constructed as the first fit of the model containing all terms with the same order as the term being tested. From the partial test the second, the marginal association test is constructing by collapsing the table until the term of interest is the highest order interaction and there are no other terms of the same order.This term is the removed and the next lowest model is fit, the Ă2 value testified the marginal association among the factors in the terms.

3- Simultaneous order test, if the test of the second order models and higher is significant while the test for third order models and higher is not.

4- Step –down procedures:

The procedure begins with specified model(often the saturated models) used since it fits the data well. Then the search for the model with fewer terms that still fits well.

(Vermont, j,k 1997. Borooah v, k,2005).

5 - Analysis of residuals:

The residual analysis of log-linear models can evaluate the model fit and can point to the cells display to a lack of fit, in general good of fitness of model. This process involves standardizing the residuals for each cell by dividing the difference between frequencies observed and frequencies expected by the square root of the frequencies expected,(Tabachnick andFidell 1996).

B- Methodological difficulties:

The problems which accompanied analysis of log-linear models such as adequate sample size, we have solved by using a large sample size. Therefore the sample size and response variables are so many . (Brunkow, P.G . Collins, J, P 1996).Also, we notice that expected frequencies were encountered and cause the lowest power. This problem was solved by accepting the reduced power of testing effects association with expected frequencies. Then we have collapse categories for variables (Agresti, 1996), then we deleted some variables to reduce the number of cells with care and delete some variables that were associated with any other variable (Knoke, D. P.J Bruke 1980).

Section Four: Discussion and empirical results:

A) Logistic regression:

The response variable is fatty nutrition and the added variables are diabetes, gender, blood pressure, logistic regression used to analyze the model results are:

Fatty diet = - 161. 2017 + 36.73 diabetes + 35.7767 gender + 35.1686blood pressure. Results are appeared in Table (1).

Table (1) Logistic Regression Report

Response : fatty

Forward Variable-Selection

Action	Variable
Added	diabetes
Added	gender
Added	blood pres

Parameter Estimation Section

Variable	Regression Coefficient	Standard Error	Chi-Square Beta=0	Prob Level	Last R-Squared
Intercept	-161.2017	2399.823	0.00	0.946445	0.000002
diabetes	36.73122	618.6141	0.00	0.952652	0.000001
gender	35.7767	652.8253	0.00	0.956296	0.000001
blood pressure	35.16859	665.929	0.00	0.957882	0.000001

Model Summary Section

Model R-Squared	Model D.F.	Model Chi-Square	Model Prob
0.570583	3	3546.40	0.000000

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The chi- square statistics for the model is (3546.4) while the probability level is (0.000), which indicates that null hypothesis is not rejected but the good of fitness is accepted due to log-linear model. Also, research used logistic regression to analyze data, but the added variables - diabetes and smoking, where the response variable is fatty diet, the regression model estimated is:

Fatty diet = -10.9559 + 6.18445 diabetes + 1.3729 smoking,

In the table (2), the odds ratio for diabetes was 485.1471 and odds ratio for smoking was 3.94711 both ratios lie between the upper confidence level and lower confidence level. Where the chi- square model statistic is 2690.9 and prob level 0.00 which indicate that the model had a good of fitness.

Table (2) Logistic Regression Report

Response fatty

Forward Variable-Selection

Action	Variable
Added	diabetes
Added	smoking

Parameter Estimation Section

Variable	Regression Coefficient	Standard Error	Chi-Square Beta=0	Prob Level	Last R-Squared
Intercept	-10.9559	0.4931057	493.65	0.000000	0.156037
diabetes	6.184452	0.2060166	901.15	0.000000	0.252342
smoking	1.372983	0.2046514	45.01	0.000000	0.016578

Odds Ratio Estimation Section

Variable	Regression Coefficient	Standard Error	Odds Ratio	Lower 95% Conf. Limit	Upper 95% Conf. Limit
Intercept	-10.955900	0.493106			
diabetes	6.184452	0.206017	485.147077	323.975175	726.499140
smoking	1.372983	0.204651	3.947106	2.642891	5.894927

Model Summary Section

Model R-Squared	Model D.F.	Model Chi-Square	Model Prob
0.501950	2	2690.90	0.000000

B) Log-linear models:

The log-linear model report for the variables of analyses, smoking, blood pressure, diabetes, indicate that log likelihood ratio and Pearson chi-square allows to quickly determine the maximum order that is significant.We use preset alpha level (0.15), the value was less than some preset alpha, thus the statistic is considered one to be significant. The K- term tests indicated that all terms are significant, for One way and higher,2 -way and higher, 3-way and higher. These results appeared in likelihood ratio and Pearson chi-square. These tests indicate the significance of all terms of given orders.These results led us to conclude that three order terms will be the highest and the final models.

The other parts of table report is single – term test section represents partial and marginal association tests, we notice that even the simultaneous test of all third order terms was significant and highly significant, Therefore we can rationalize in our conclusion that ABC and higher, and the effect in model A, B, C are fairly significant. Where the results are the same when we use the factors (smoking, hypertension, and overweight) . The results of both multiple –term test and k-terms indicate that likelihood chi-square and Pearson in terms of 1-way and higher,2-way and higher, and 3-way and higher are significant. Therefore we can conclude that ABC models are fairly significant, but model AB is mildly significant prob- level was (0,0063), table(3). chi-square ratios are significant for all hierarchal models in step –down model analysis .we notice that algorithm used in a step-down

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strategy, begins with saturated model selected (the algorithm of Habermann 1972) to produce the maximum likelihood estimates.

Table (3)

Loglinear Models Report

Factors smoking, diabetes, blood pressure

Multiple-Term Test Section

K-Terms	DF	Like. Ratio Chi-Square	Prob Level	Pearson Chi-Square	Prob Level
1WAY & Higher	7	1050.32	0.0000	951.79	0.0000
2WAY & Higher	4	817.12	0.0000	715.80	0.0000
3WAY & Higher	1	64.31	0.0000	63.17	0.0000

K-Terms	DF	Like. Ratio Chi-Square	Prob Level
1WAY Only	3	233.20	0.0000
2WAY Only	3	752.82	0.0000
3WAY Only	1	64.31	0.0000

Note Simultaneous test that all interactions of order k are zero. These Chi-Squares are differences in the above table.

Single-Term Test Section

Effect	DF	Partial Chi-Square	Prob Level	Marginal Chi-Square	Prob Level
A (smoking)	1	77.71	0.0000	77.71	0.0000
B (diabetes)	1	138.84	0.0000	138.84	0.0000
C (blood pressure)	1	16.65	0.0000	16.65	0.0000
AB	1	409.16	0.0000	308.88	0.0000
AC	1	107.76	0.0000	7.48	0.0063
BC	1	436.46	0.0000	336.18	0.0000
ABC	1	64.31	0.0000	64.31	0.0000

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The differences in residual are actual and predicted. usually scanned to find cells that are not fitted well by the model, also the ratio chi-square static, and chi-square absolute values greater than 1.96 are considered larger, Therefore the model 2 2 2, Thus the factors overweight, smoking, blood pressure chi-square is (17.07) greater than 1.96 Results are available in table (4).

Table (4) Loglinear Models Report

Counts Variable count+0.5

Factors smoking, blood pressure, overweight

Multiple-Term Test Section

K-Terms	DF	Like. Ratio Chi-Square	Prob Level	Pearson Chi-Square	Prob Level
1WAY & Higher	7	975.34	0.0000	982.77	0.0000
2WAY & Higher	4	850.58	0.0000	768.98	0.0000
3WAY & Higher	1	49.44	0.0000	49.99	0.0000

K-Terms	DF	Like. Ratio Chi-Square	Prob Level
1WAY Only	3	124.76	0.0000
2WAY Only	3	801.13	0.0000
3WAY Only	1	49.44	0.0000

Single-Term Test Section

Effect	DF	Partial Chi-Square	Prob Level	Marginal Chi-Square	Prob Level
A (smoking)	1	77.71	0.0000	77.71	0.0000
B (blood pressure)	1	16.65	0.0000	16.65	0.0000
C (overweight)	1	30.40	0.0000	30.40	0.0000
AB	1	41.52	0.0000	7.48	0.0063
AC	1	62.51	0.0000	28.47	0.0000
BC	1	765.19	0.0000	731.15	0.0000
ABC	1	49.44	0.0000	49.44	0.0000

Step-Down Model-Search Section

Step No	Best No	DF	Chi-Square	Prob Level	Term Deleted	DF	Chi-Square	Prob Level	Hierarchical Model
1	1	1	49.4	0.0000	None	0	0.0	0.0000	AB,AC,BC
2	1	2	91.0	0.0000	AB	1	41.5	0.0000	AC,BC
3	1	2	112.0	0.0000	AC	1	62.5	0.0000	AB,BC
4	1	2	814.6	0.0000	BC	1	765.2	0.0000	AB, AC

DF	Like. Ratio Chi-Square	Prob Level	Pearson Chi-Square	Prob Level	Model
7	975.34	0.0000	982.77	0.0000	Mean

Parameter Estimation Section

Model Term	Number Cells	Count	Percent Count	Average Log(Count)	Effect (Lambda)	Effect Std. Error	Effect Z-Value
Mean	8	2677	100.00	5.8130	5.8130	0.0193	300.76

overweight	blood pressure	smoking	Actual	Pred	Diff	Chi	FT-SR
1	1	1	348.5	334.6	13.9	0.76	0.76
1	1	2	541.5	334.6	206.9	11.31	9.96
1	2	1	215.5	334.6	-119.1	-6.51	-7.21
1	2	2	90.5	334.6	-244.1	-13.35	-17.52
2	1	1	128.5	334.6	-206.1	-11.27	-13.88
2	1	2	214.5	334.6	-120.1	-6.57	-7.27
2	2	1	418.5	334.6	83.9	4.59	4.34
2	2	2	719.5	334.6	384.9	21.04	17.07

The results of variables hypertension, gender, and diabetes in multiple term test all likelihood chi-square ratio are significant and Pearson chi-square, thus the 3- way only and 3- way and higher are accepted due to the higher significant models, the effect due to partial chi-square association is significant , and marginal chi-square association is significant too .The step-down model test indicates that prob of chi-square is significant for all models, also FT-SR test indicates that the 2 2 2 model is greater than 1.96 the ratio is (19.72).

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Table(5) Log-linear Models Report

Factors blood pressure, gender, diabetes

Multiple-Term Test Section

K-Terms	DF	Like. Ratio Chi-Square	Prob Level	Pearson Chi-Square	Prob Level
1WAY & Higher	7	1685.73	0.0000	1587.48	0.0000
2WAY & Higher	4	1517.45	0.0000	1502.82	0.0000
3WAY & Higher	1	69.24	0.0000	74.04	0.0000
1WAY Only	3	168.28	0.0000		
2WAY Only	3	1448.21	0.0000		
3WAY Only	1	69.24	0.0000		

Effect	DF	Partial Chi-Square	Prob Level	Marginal Chi-Square	Prob Level
A (blood pressure)	1	16.65	0.0000	16.65	0.0000
B (gender)	1	12.80	0.0003	12.80	0.0003
C (diabetes)	1	138.84	0.0000	138.84	0.0000
AB	1	36.15	0.0000	45.94	0.0000
AC	1	326.38	0.0000	336.18	0.0000
BC	1	1066.09	0.0000	1075.88	0.0000
ABC	1	69.24	0.0000	69.24	0.0000

Step-Down Model-Search Section

Step No	Best No	DF	Chi-Square	Prob Level	Term Deleted	DF	Chi-Square	Prob Level	Hierarchical Model
1	1	1	69.2	0.0000	None	0	0.0	0.0000	AB,AC,BC
2	1	2	105.4	0.0000	AB	1	36.1	0.0000	AC,BC
3	1	2	395.6	0.0000	AC	1	326.4	0.0000	AB,BC
4	1	2	1135.3	0.0000	BC	1	1066.1	0.0000	AB, AC

DF	Like. Ratio Chi-Square	Prob Level	Pearson Chi-Square	Prob Level	Model
7	1685.73	0.00001	1587.48	0.0000	Mean

Parameter Estimation Section

Model Term	Number Cells	Percent Count	Count	Average Log(Count)	Effect (Lambda)	Effect Std. Error	Effect Z-Value
Mean	8	2677	100.00	5.8130	5.8130	0.0193	300.76

Data Table Section

diabetes	gender	blood pressure	Actual	Pred	Diff	Chi	FT-SR
1	1	1	615.5	334.6	280.9	15.35	13.04
1	1	2	263.5	334.6	-71.1	-3.89	-4.10
1	2	1	89.5	334.6	-245.1	-13.40	-17.63
1	2	2	66.5	334.6	-268.1	-14.66	-20.23
2	1	1	45.5	334.6	-289.1	-15.81	-23.03
2	1	2	321.5	334.6	-13.1	-0.72	-0.71
2	2	1	482.5	334.6	147.9	8.08	7.36
2	2	2	792.5	334.6	457.9	25.03	19.72

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When we use the variables smoking, diabetes and family history, we have obtained same results of likelihood chi-square ratio and Pearson chi-square which are significant, hence the 3- way & higher is accepted, the association effect of partial and marginal chi-square is significant while the model AB (Smoking, family history is mildly significant (0.0412) . But the other effects are fairly significant, also the step-down test in hierarchal models appears AB, AC, BC. Because the results of likelihood ratio and Pearson chi-square are a significant ratio, the FT-SR is (12.63) which indicates greater than 1.96.

Table (6) Log-linear Models Report

Factors smoking, family history, diabetes

Multiple-Term Test Section

K-Terms	DF	Like. Ratio Chi-Square	Prob Level	Pearson Chi-Square	Prob Level
1WAY & Higher	7	1279.35	0.0000	1099.56	0.0000
2WAY & Higher	4	1044.86	0.0000	930.67	0.0000
3WAY & Higher	1	119.17	0.0000	128.06	0.0000
1WAY Only	3	234.49	0.0000		
2WAY Only	3	925.69	0.0000		
3WAY Only	1	119.17	0.0000		

Effect	DF	Partial Chi-Square	Prob Level	Marginal Chi-Square	Prob Level
A (smoking)	1	77.71	0.0000	77.71	0.0000
B (family history)	1	17.94	0.0000	17.94	0.0000
C (diabetes)	1	138.84	0.0000	138.84	0.0000
AB	1	128.76	0.0000	4.17	0.0412
AC	1	433.47	0.0000	308.88	0.0000
BC	1	612.64	0.0000	488.05	0.0000
ABC	1	119.17	0.0000	119.17	0.0000

Step-Down Model-Search Section

Step No	Best No	DF	Chi-Square	Prob Level	Term Deleted	DF	Chi-Square	Prob Level	Hierarchical Model
1	1	1	119.2	0.0000	None	0	0.0	0.0000	AB,AC,BC
2	1	2	247.9	0.0000	AB	1	128.8	0.0000	AC,BC
3	1	2	552.6	0.0000	AC	1	433.5	0.0000	AB,BC
4	1	2	731.8	0.0000	BC	1	612.6	0.0000	AB, AC

DF	Like. Ratio Chi-Square	Prob Level	Pearson Chi-Square	Prob Level	Model
7	1279.35	0.00001	1099.56	0.0000	Mean

Parameter Estimation Section

Model Term	Number Cells	Count	Percent Count	Average Log(Count)	Effect (Lambda)	Effect Std. Error	Effect Z-Value
Mean	8	2677	100.00	5.8130	5.8130	0.0193	300.76

diabetes	family history	smoking	Actual	Pred	Diff	Chi	FT-SR
1	1	1	529.5	334.6	194.9	10.65	9.44
1	1	2	300.5	334.6	-34.1	-1.87	-1.90
1	2	1	117.5	334.6	-217.1	-11.87	-14.87
1	2	2	87.5	334.6	-247.1	-13.51	-17.84
2	1	1	45.5	334.6	-289.1	-15.81	-23.03
2	1	2	572.5	334.6	237.9	13.00	11.28
2	2	1	418.5	334.6	83.9	4.59	4.34
2	2	2	605.5	334.6	270.9	14.81	12.63

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Concluded remarks:

The purpose of this paper is to examine the relationship between the heart disease and the response of variables (factors). To recognize whether these variables cause the heart disease or not , Logistic regression used to analyze the data were collected as a sample from Jordanian hospital records and patients files , Odds ratios, likelihood chi-square and chi-square , K-terms tests of multiple model in log-linear models, FT-SR to check whether chi-square value would be considered the normal distributed
(Fredman-Tukey standard residual) .

The analysis of results indicates that all variables analyzed together or as groups are significant or adequately fit the model.In the model summary section of analysis of logistic regression, the R2 is 0,57083 and it fits the model well due to the significance. This proves that heart diseases are the biggest killer in Jordan.

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