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Using the Multiple Correspondence Analyses to Study the Addiction of Drug and Alcohol in Iraq

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Abstract: *Drug and alcohol addiction are a social problem that emerged last decades in Iraq. In this study, we discuss the problem of an addiction by using multiple correspondence analyses (MCA). MCA is one of the multivariate methods as it is used to study the correlation strength that exists between more than two categorical variables. The data classifies according to Iraqi governates, gender, and patient status (inpatient or outpatient). A relation between variables was clarified through Burt matrix. Our results show the drug addiction is the larger than alcoholic addiction in all Iraqi governates. The main reason of drug addiction is taking its continuously without consulting a specialist.*

Kew word: *Multiple correspondence analyses, Singular value, Inertia, Alcohol addiction, Drug addiction.*

I. Introduction

The problem of addiction is one of the biggest problems in the world. It has many effects on the society, such as health, social, economic and security. This problem is not limited to one type of addiction or to a specific country or a limited class of society. Rather, it includes addictions (alcohol, drugs, psychotropic drugs, sedative drugs, stimulant drugs, etc.), and for all different layers of society. Drug addiction is a psychological or physical disorder that results from a disorder in certain centers of the brain that results in unlawful dependence on the drug without need it. Therefore, the patient feels the urgent need to take these medications. Meanwhile, addiction to alcohol and drugs leads to diseases and physical complications. The annual death rate of addicts is 1.2%, which means six times greater than the death rate of non-addicts (Ministry of Health/ Iraq, 2016)

Many researchers have discussed the MCA method in many practical applications in society. Tenenhaus and Young (1985) explored the relationship between several criteria associated with the

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analysis of the major components associated with (PCA). Hoffman and Leeuw (1992) reduced the distances between the variable categories and linked all the categories together through a graph and without relying on calculating the value of the

χ^2. Individual jobs are in one or more degrees in educational field were determined by Peter et al. (1997). Kaminska et al. (1999) used the MCA method to classify epilepsy patients into three groups based on age and gender variable. Nutritional patterns and groups of people with similar food consumption habits using MCA and cluster analysis, were identified by Guinot et al. (2002). In the same year, Hwang and Takane divided data into several separate subcategories according to row and column restrictions to explore relationships between them. MCA and K- Means in a unified framework were combined through one graph by Hwang et al. (2006). Lin et al. (2008) used MCA to explore the relationship between different units of video semantic. Lombardoa and Beh (2010) combined between SVD (singular value decomposition), and BMD (Bivariate moment decomposition) to obtain HD (hybrid decomposition). They used it in simple and multiple correspondence analysis. A comparison between airline companies operating, according to service characteristics and passenger characteristics by using MCA and cluster analysis, was investigated by Wen and Chen (2011). Josse et al. (2012) proposed an algorithm to deal with the missing value in MCA analysis. Key cognitive dimensions and uncover relationships between cognitive, clinical, physical, and lifestyle variables were obtained by Costa et al. (2013). D'Espositoa et al. (2014) used MCA analysis to analyze and represent two-mode networks graphically.

The contribution of this paper is to apply multiple correspondence analysis to detect relationship between descriptive variables of addiction phenomenon, whether it is drug or alcohol, according to the Iraqi governates, gender and patient's status (outpatients or inpatients). MCA provides results that make it easier for the researcher to have a broad perception of the interrelationships between data and to discover homogeneous totals of vocabulary

II. The theoretical side

In this section, we show the theoretical side of the study that represents simple correspondence, Burt matrix and MCA.

2.1 Simple Correspondence Analyses

In simple correspondence analysis, we have tow- dimensional contingency table with positive values (k). Both rows (n) and columns (a) are drawn as points in a two-dimensional field. The location of these points indicates the contingency of both the rows and the columns of the data matrix. The ratio matrix (P) is calculate by dividing every value in the matrix (x) on the total of the

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values (William and Christensen, 2012; Beh and Lombardo, 2014; Mc Cormick, 2017):

$$P = n^{-1}X \quad (1)$$

where P is also known as the correspondence matrix.

Depending on the contingency matrix, the results are laid out in two directions for the rows and columns as follows:

$$\left.\begin{array}{l} r_i = \sum_{j=1}^{m} p_i j \\ r = p1 \end{array}\right\} \quad (2)$$

And

$$\left.\begin{array}{l} c_j = \sum_{i=j}^{\wedge} p_{ij} \\ c = p1 \end{array}\right\} \quad (3)$$

Thus, diagonal matrixes for the rows (D_r) and columns (D_c) are as follows:

$$D_r = diag(r) \quad (4)$$

$$D_c = diag(c) \quad (5)$$

From equations (1 to 5), we can find the singular value decomposition (*SVD*) matrix Q:

$$Q = D_r^{-\frac{1}{2}}(p - rc)D_c^{-\frac{1}{2}} \quad (6)$$

where the rank of the matrix Q is: $L = \min(n - 1, m - 1)$

So we can get (*SVD*) matrix Q according to the following equation:

$$(Q) = W \quad (7)$$

Whereas, the matrices A and B are orthogonal, which means = = I. A and B are two matrix whose columns are Eigen vectors corresponding to the Eigen values λ^2, λ^2, … … λ^2 for the two matrixes QQ , Q Q, respectively. The matrix W is a diagonal matrix containing singular value ($\lambda_1, \lambda_2, \ldots \ldots \ldots, \lambda_L$) for matrix Q.

The matrix QQ , Q Q can be written as follows:

be written as follows:

$$Q\acute{Q} = D_r^{-\frac{1}{2}}(p - r\acute{c})D_c^{-1}(p - r\acute{c})\acute{} D_r^{-\frac{1}{2}} \quad (8)$$

Hence, standard coordinates of rows (U) and columns (V) are given by:

$$U = D_r^{-1}A \quad (9)$$

$$V = D_C^{-1}B \quad (10)$$

Accordingly, Principal coordinates of rows (F) and columns (G) are as follows:

$$F = UW \quad (11)$$

$$G = VW \quad (12)$$

From Appendix (A), we extract the matrix (Z) whose elements are (0,1); 1 when the value is in that category of the variable, and 0 for the opposite case. Thus, the dimensions of the matrix (Z) are ($I \times J$), since (I) is the number of observations, and (J) is the sum of the levels of the nominal variables. This means, the matrix contains K of variables provided that $K > 2$ and each variable include JK of levels. Therefore, the Burt matrix can be obtained from the following equation (Greenacre and Blasius, 2006; Greenacre, 2017):

$$Burt = \acute{Z}Z \quad (13)$$

The Burt matrix is characterized by being a diagonal block for each nominal variable, and rectangular for each variable above or below the main diameter.

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2.2 Multiple Correspondence Analyses (MCA)

MCA is one of the multivariate methods as it is used to study the correlation strength that exists between more than two categorical variables. It improves the correlation standard between the variable categories and is characterized by its ability to optimize the categorical variables. The most common definition of "MCA" is the application of CA to the Burt correspondence matrix, where we note here the coordinates of all rows and columns are available. The relationship between the singular value λ of the Z indicator matrix and the singular value of the Burt matrix is as follows (Roux and Rouanet, 2010; Greenacre, 2017):

$$\lambda_p = (\lambda^z_p)^2 \qquad (14)$$

where $p = 1,2, \ldots \ldots \ldots, j - m.$

We can note that the coding is for one categorical variable with multiple columns in the MCA. Thus, the total inertia is amplified in the indicator matrix *Z*. Then, the singular values can be adjusted by analyzing the Burt matrix or the indicator matrix *Z* so as follows:

$$adj = (\lambda^z_p) = \left[\frac{m}{m-1}\left(\lambda^z_p - \frac{1}{m}\right)\right]^2 \qquad (15)$$

III. Applied Side

In this section, we clarify the addiction phenomenon in Iraq, and apply MCA method to find the final results.

3.1 Data Description

The addiction phenomenon is considered one of the rejected phenomena in the societies of the countries of the world, especially in our society. Nevertheless, it has spread recently and significantly despite the health problems caused by addiction and the negative social consequences that result from it, hence the importance of this topic. We use MCA method on factual data was taken from the annual report of the Ministry of Health/ Iraq in 2015.

3.2 Variables of the Study

Variables include governorate, gender, addiction type, and patient's status:

1- Iraqi Governorates: It includes 13 from 18 governorates, except the Kurdistan Region and the governorates of Anbar and Salah al-Din. The difficult political circumstances that these governorates went through were led to the lack of its data.

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2- Addiction type: addiction has been classified into two types:

- Drug addiction: It is a common condition and can be suffered by anyone without feeling it. It comes from repeated use of the drug without consulting the specialist doctor, as well as psychological and behavioral attachment to the drug.
- Alcohol addiction: It is a disease resulting from the continuous drinking of alcohol, which leads to the patient's inability to stop drinking alcohol.

3- Addicts Classification: The addicts were divided into two categories (Inpatients and Outpatients), depending on the degree of addiction.

4- Gender: male and female.

Appendix A shows the number of addicted in Iraq

3.3 Analysis Results

The results are extracted by using statistical program (SPSS). From Eqs. (14 &15), we can find the matrix Z by converting the data of Table 5 (see appendix A) into (0-1) values, as shown in Table (1).

Table 1. Indicator matrix (Z)

No.	Governorates													Add. type		Pat. type		Gender	
	baghdad	basrah	nineveh	maysan	Al-dewaniya	diala	babylon	kerbela	kirkuk	wasit	Thi-qar	Al- muthanna	Al-najaf	Med. Add.	Alcohol Add.	Outp.	Inpat.	mal.	Fem.
1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0
2	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0
3	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0
4	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0
5	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5074	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0
5075	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0

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The Burt matrix is obtained from Eq. (13),
as shown in Table (2):

Table 2. The Burt matrix

Governorates													Addictive type		Addicted type		Gender	
3286	0	0	0	0	0	0	0	0	0	0	0	0	2376	910	2920	366	1934	1352
0	137	0	0	0	0	0	0	0	0	0	0	0	136	1	126	11	90	47
0	0	99	0	0	0	0	0	0	0	0	0	0	87	12	99	0	86	13
0	0	0	159	0	0	0	0	0	0	0	0	0	128	31	159	0	146	13
0	0	0	0	124	0	0	0	0	0	0	0	0	105	19	114	10	121	3
0	0	0	0	0	10	0	0	0	0	0	0	0	9	1	9	1	6	4
0	0	0	0	0	0	402	0	0	0	0	0	0	33	369	402	0	397	5
0	0	0	0	0	0	0	174	0	0	0	0	0	165	9	174	0	130	44
0	0	0	0	0	0	0	0	42	0	0	0	0	10	32	31	11	37	5
0	0	0	0	0	0	0	0	0	29	0	0	0	29	0	26	3	26	3
0	0	0	0	0	0	0	0	0	0	274	0	0	56	218	274	0	270	4
0	0	0	0	0	0	0	0	0	0	0	212	0	29	183	212	0	211	1
0	0	0	0	0	0	0	0	0	0	0	0	128	82	46	126	2	119	9
2376	136	87	128	105	9	33	165	10	29	56	29	82	3245	0	3001	244	2058	1187
910	1	12	31	19	1	369	9	32	0	218	183	46	0	1831	1671	160	1515	316
2920	126	99	159	114	9	402	174	31	26	274	212	126	3001	1671	4672	0	3243	1429
366	11	0	0	10	1	0	0	11	3	0	0	2	244	160	0	404	330	74
1934	90	86	146	121	6	397	130	37	26	270	211	119	2058	1515	3243	330	3573	0
1352	47	13	13	3	4	5	44	5	3	4	1	9	1187	316	1429	74	0	1503

The Burt matrix is obtained from Eq. (13), as shown in Table (3):

Table 3. The Burt matrix

Dimension	Singular Value	Inertia	Proportion of Inertia	
			Accounted for	Cumulative
1	.424	.180	.180	.180
2	.297	.088	.088	.268
3	.278	.077	.077	.345
4	.250	.063	.063	.408
5	.250	.063	.063	.471
6	.250	.063	.063	.533
7	.250	.063	.063	.596
8	.250	.063	.063	.658
9	.250	.063	.063	.721
10	.250	.062	.063	.784
11	.250	.062	.063	.846
12	.250	.062	.063	.909

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13	.232	.054	.054	.963
14	.156	.024	.024	.987
15	.114	.013	.013	1.000
Total		.999	1.000	1.000

From table (3), we deduce that the inertia of the first and second axis represents (18% and 8.8%) of the total variance, respectively. This means, the first and second axes represent (26.8%) of the total variance for all axes, so relied upon to interpret the data.

Table 4. Mass and contribution of each variable

Variabls	Mass	Score in Dimension		Contribution	
		1	2	Of Point to Inertia of Dimension	
				1	2
Baghdad	.162	-.428	-.429	.070	.100
Basrah	.007	-.912	1.095	.013	.027
Nineveh	.005	-.210	2.240	.001	.082
Maysan	.008	.057	2.155	.000	.123
Al-Dewaniya	.006	.038	1.732	.000	.062
Diala	.000	-.814	.361	.001	.000
Babylon	.020	1.871	-.196	.163	.003
Kerbela	.009	-.604	2.046	.007	.121
Kirkuk	.002	1.201	-2.573	.007	.046
Wasit	.001	-.479	1.772	.001	.015
Thi-qar	.013	1.582	.237	.080	.003
Al- Muthanna	.010	1.758	.029	.076	.000
Al-Najaf	.006	.455	1.453	.003	.045
Drug addiction	.160	-.584	.242	.128	.032
Alcohol addiction	.090	1.034	-.430	.228	.056
Outpatients	.230	.022	.144	.000	.016
Inpatients	.020	-.252	-1.671	.003	.187
Male	.176	.395	.202	.065	.024
Female	.074	-.939	-.480	.154	.058
Active Total	1.000			1.000	1.000

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We can deduct from the mass column of Table (4) that the hospital outpatients are most important than inpatients, because they represent the largest mass (0.230). Then, male addicts with the second mass (0.176). The capital Baghdad have the highest mass (0.162) as a number of addicts compared with other governates. Moreover, the drug addiction, with mass (0.160), is the larger than alcoholic addiction in all Iraqi governates.

From column (5) of Table (4), the contribution of alcohol addiction in the first axis was (22.8%) to inertia, and Babylon Governorate comes second with a contribution (16.3%). Babylon Governorate consider the largest contribution in relation to inertia compared with other Iraqi governorates. Also, the female ratio (15.4%) is the third largest ratio, which means it is greater than male contribution in the first axis to inertia. The rest of the variables come descending in the first axis.

As for the second axis (the last column of Table 4), we can notice that the contribution of the inpatients (18.7%) come first. Then, the contribution of the governorates Maysan (12.3%) and Karbala (12.1%). We continue in descending proportions of the contributions of the variables from the second axis to inertia. Figure (1) shows the graphic representation of the variables on the first and second axes.

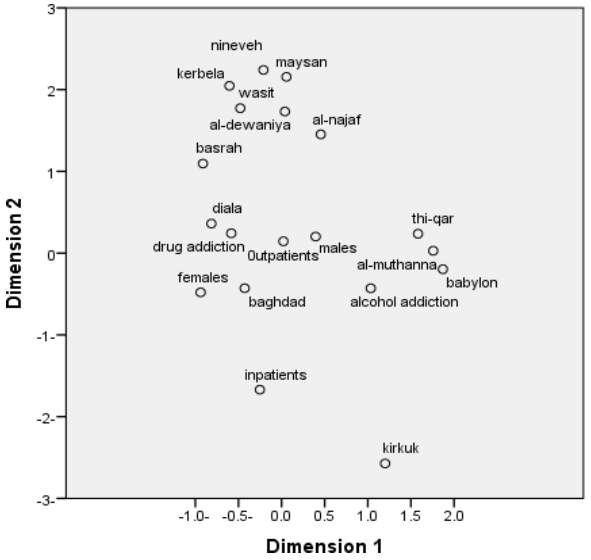

Figure1. Graphical representation of the variables on the first and second axes

From Figure (1), the governorates (Nineveh, Maysan, Karbala, Diwaniya, Wasit, Najaf, Basra) are almost equal in the numbers of addicts. Also, the drug addicts are most male and outpatients in Diyala Governorate. It has the lowest percentage of Alcohol addictions compared with other governates.

We also note that the highest and lowest percentage of drug addiction among females register in Baghdad and Muthanna Governorates, respectively. Moreover, alcohol addiction is higher than drug addiction in Dhi-Qar, Muthanna and Babel governates. Meanwhile, inpatients in hospitals were less than the outpatients.

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4 Conclusions and Recommendations

This paper concerns Multiple Correspondence Analysis (MCA) method and its application in the addiction phenomena in Iraq. The method can be used to study complex phenomena, compared to other methods, depending on the interrelations between them. The addiction has divided into two types; drug and alcohol. The effect of gender, governate and patient's status on the addiction phenomena, was clarified.

Our results showed the number of male addicts is greater than female addicts in Iraqi society. The lack of awareness among many people led to the percentage of outpatients is higher than inpatients. Also, most people use drugs continuously without consulting a specialist doctor, so led to drug addiction. Moreover, the capital Baghdad and Babel governate were represented the highest and lowest percentages of addicts, respectively.

The increase in establishing treatment centers to treat addicts and urge them to take the necessary treatment to eliminate addiction in Iraq, whether it is drug or alcohol addiction. This study can be improved future by comprising between multiple correspondences analysis with other multivariate methods. Also, the study other factors that can effect on this phenomenon, such as learn level, living level and so on.

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Appendix A

Table 5. The number of addicted in Iraq, according to the governorates and gender

Governorates	Alcohol addiction					Drug addiction				
	inpatients		outpatients		Grand total	inpatients		outpatients		Grand total
	Mal.	Fem.	Mal.	Fem.		Mal.	Fem.s	Mal.	Fem.	
baghdad	145	2	449	314	910	160	59	1180	977	2376
basrah	1	0	0	0	1	1	9	89	37	136
nineveh	0	0	12	0	12	0	0	74	13	87
maysan	0	0	31	0	31	0	0	115	13	128
Al-dewaniya	3	0	16	0	19	6	1	96	2	105
diala	1	0	0	0	1	0	0	5	4	9
babylon	0	0	369	0	369	0	0	28	5	33
kerbela	0	0	9	0	9	0	0	121	44	165
kirkuk	8	0	24	0	32	0	3	5	2	10
wasit	0	0	0	0	0	3	0	23	3	29
Thi-qar	0	0	218	0	218	0	0	52	4	56
Al- muthanna	0	0	183	0	183	0	0	28	1	29
Al-najaf	0	0	46	0	46	2	0	71	9	82
Total	158	2	1357	314	1831	172	72	1887	1114	3245

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