

Gender Factor in Choosing Affecting Diabetes Mode of Treatment in Saudi Arabia

Yahya M. AlMurtadha, Abdelrahman O. Elfaki, Osman A. Abdalla and Mustafa H. Alfraj

Abstract— The number of patients with Diabetes is increasing in the Kingdom of Saudi Arabia (KSA). Two issues have been statistically studied: significant relationship between gender and treatment mode, and relations between the gender type and mode of treatment. As results, statistical analysis showed a significance relation (P value < 0.050) between the gender and the diabetes mode of treatment. Then, the second statistical analysis proved that using insulin and diet showed better diabetes control for women. The t-test couldn't identify which treatment mode is better for men, though we used data mining techniques to explore the data and recommend the most effective treatment mode. Regression analysis recommends that using insulin, drugs, diet and smoking cessation showed better diabetes control for men and doing exercises is most effective with women group.

Keywords— Diabetes in KSA, diabetes treatments, diabetes and gender factor, statistical analysis, data mining

I. INTRODUCTION

The Kingdom of Saudi Arabia (KSA) is considered to be one of the rapidly growing countries that have been affected by the life style changes reflecting changing in disease pattern. In KSA, chronic disease accounted for 69% of all deaths in 2002 [1]. Recent studies have shown an increasing rates of diseases like diabetes, hypertension cardiovascular accidents [2]. World Health Organization defines Diabetes as a chronic disease, which occurs when the pancreas does not produce enough insulin (Type 1), or when the body cannot effectively use the insulin it produces (Type 2). This leads to an increased concentration of glucose in the blood (hyperglycemia). Type 1 diabetes is characterized by a lack of insulin production. Type 2 diabetes is caused by the body's ineffective use of insulin. It often results from excess body weight and physical inactivity [3]. According to the World health Organization, around 22% (males) and 21.7% (females) of adults aged 25 and over in KSA had raised blood glucose in 2008 [4]. Recent research in Saudi Arabia shows that the number of patients with Diabetes Mellitus is increasing drastically [5].

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This study will examine the standard NCD report 2005 diabetes dataset reported by the ministry of health in Saudi Arabia in cooperation with the World health Organization to construct statistical model for diabetes treatments. Such model will be of great beneficiary to the medical fields for a significant reason. Normally doctors can't afford the time and energy to look deep into large medical data to extract deep hidden information to produce new treatments rules. The statistical analysis provides deep understanding inside the data, which provide doctors by facts that could be used for creating more treatment alternatives.

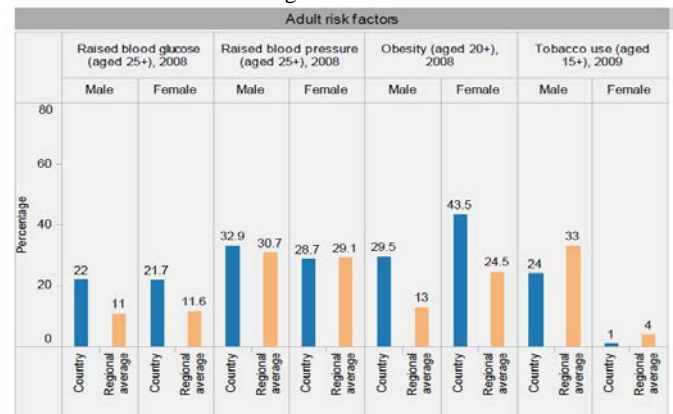


Fig. 1 adult risk factors in KSA regarding Diabetes

II. RELATED WORKS

According to [2], The burden of Non Communicable Diseases (NCDs) has now become a major challenge to development globally and is rising rapidly. The serious complications diabetes can be associated with include high blood pressure, amputations, blindness, kidney failure, and heart failure. Therefore, early detection of the disease and proper care strategies can save lives. In Saudi Arabia, data on NCDs (including diabetes) and their risk factors was either very scanty or not collated [2]. Ministry of health of Saudi Arabia in cooperation with WHO carried out a national situational analysis and a baseline survey of NCD risk factors including diabetes. This survey covered whole of Kingdom of Saudi Arabia to estimate the prevalence of some of the risk factors of non-communicable diseases through interview, physical examination and laboratory examination of blood samples of study participants; based upon the WHO STEPwise© approach. This study recognized six types of treatments as follows:

(a) Drug: oral medication as a treatment type to control the diabetes normally in the form of Tablets. [6] reported

the more commonly recognized drug-, hormone-, or toxin-induced forms of diabetes. (b) Diet: a healthy diet can prevent or control the diabetes. Patients should consult their doctors to make a diet plan on what to eat in the right time, quantities of fat, protein and carbohydrates needed for a healthy body. (c) Weight reduction: type 2 diabetes is associated with overweight. with over 90% of newly diagnosed type 2 diabetics above their ideal weight as reported by UK Global Diabetes Community [7]. Losing weight could control the diabetes. (d) Smoke cessation: Tonstad, 2009 reported increasing risk to develop type 2 diabetes among cigarette smokers [8]. smoking cessation should be coupled with strategies for diabetes prevention such as early detection [9] and weight control [10]. Sudden smoking cessation without proper guidance might result in weight gain and a short-term worsening of some diabetic symptoms [8, 9]. (e) Exercise: previous studies have shown the efficiency of exercise functions in diabetes prevention[11] and reducing mortality risk [12]. (f) Insulin: insulin therapy is a lifesaving, common and important treatment to control the type1 diabetes and type2 diabetes patients [13].

Mukweho,2010 in his study [14] concluded that Lifestyle interventions have been shown to be an effective way of treating and delaying type 2 diabetes. The preliminary analysis in [15] showed that high blood pressure, age, cholesterol, adult BMI, total income, sex , heart attack, marital status, dental checkup, and asthma diagnosis are among the key risk factors. Aljumah et al. concluded that drug treatment for patients in the young age group can be delayed to avoid side effects. In contrast, patients in the old age group should be prescribed drug treatment immediately [5].

according to [16] “DMT2 prevalence was significantly higher in males, with an overall age-adjusted prevalence of 34.7% (95% CI 32.6 to 35.4), than in females, who had an overall age-adjusted prevalence of 28.6% (95% CI 26.7 to 29.3) (P value< 0.001). The overall crude prevalence of obesity was 31.1% (95% CI 30.1 to 32.0). The age-adjusted prevalence of obesity was 40.0%. The prevalence of obesity was higher in females, with an overall prevalence of 36.5% (95% CI 35.1 to 37.83), than in males (25.1% (95% CI 23.7 to 26.3)) (P < 0.001)”. Another study by [17] concluded that Saudi women are potentially at a greater risk than a decade ago to develop cardiovascular diseases and diabetes mellitus, with a notable increase in obesity compared to men. Both previous studies proved the necessity for investigating the gender effect on the prevalence of diabetes.

several previous studies highlighted the importance of conducting deep insight analysis on the diabetes patients due to two main reasons: first, [18] concluded that diabetes prevalence increased from 2.5% in 1982 to 31.6% in 2011. Older age and higher body mass index were the most strongly associated risk factors for diabetes. They also

raised the awareness that over half people diagnosed with diabetes did not meet recommended care targets causing increasing complications such as macro vascular and micro vascular complications. Second, a study by [19] estimated the total indirect cost of treatment in the Arab region including Saudi Arabia to be around USD 72 billion. Therefore, early detection of the disease and proper awareness and care strategies can save lives, personnel and countries budgets.

Data mining had been an appropriate and sufficiently sensitive method to analyze the outcomes of which mode of treatment is more effective to the targeted group [20]. Giving large medical database, data mining tools are useful for extracting deep hidden information in medical data. Data mining techniques have been extensively applied in bioinformatics to analyze biomedical data [21]. furthermore, Data mining can discover novel associations that are useful to clinicians and administrators as well [22]. Diabetes is a particularly opportune disease for data mining for a number of reasons. First, new knowledge about treatment patterns of diabetes can help save money. Second, specialists need to know how to identify and diagnose potential cases quickly [22].

Various mining techniques were applied to construct prediction model. The Homogeneity- Based Algorithm (or HBA) was developed to optimally control the over fitting and overgeneralization behaviors of classification on The Pima Indian diabetes dataset [23]. Concaro et al. in [24] presented the application of a temporal data mining technique to extract temporal association rules over an integrated repository including both administrative and clinical data related to a sample of diabetic patients. Mukweho,2010 in his studey [14] concluded that Lifestyle interventions have been shown to be an effective way of treating and delaying type 2 diabetes. Bagdi and Patil [25] presented a decision support system which combines the strengths of both OLAP and data mining so that doctors can predict patients who might be diagnosed with diabetes. The preliminary analysis in [15] showed that high blood pressure, age, cholesterol, adult BMI, total income, sex , heart attack, marital status, dental checkup, and asthma diagnosis are among the key risk factors. Aljumah et al. concluded that drug treatment for patients in the young age group can be delayed to avoid side effects. In contrast, patients in the old age group should be prescribed drug treatment immediately [5].

III. MATERIALS AND METHODS

A. Datasets

The NCD 2005 data is a standard Non-Communicable Disease risk factor report from the Ministry of Health, Saudi Arabia that will be used in this research. The data represents a national situational analysis and a baseline survey of NCD and their risk factors conducted in 2005. This data can be downloaded from the World Health

Organization web site.

B. The methodology

Figure 2 shows the general process required for diabetes data analysis. Generally, the analysis requires data preparation, statistical analysis, deployment, and results evaluation.

Problem Definition: Understand the objectives, requirements and obstacles from a research perspective, convert this knowledge into a problem definition. Finally, design a plan to achieve the objectives. The main objective of this study is to investigate the gender effect on the diabetes treatment types help to control the disease.

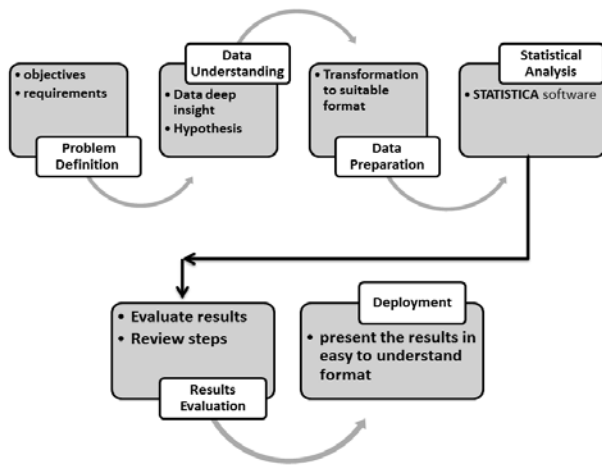


Fig. 2 methodology processes

Data Understanding: looking through the dataset to get familiar with the Tables, columns and attributes. Then identify the necessary Tables and attributes for analysis. Finally, detect interesting subsets to form hypotheses to be proved during the analysis process based on the following hypothesis:

H0: there is no significance relation between the gender and the diabetes healing mode.H1: there is a significance relationship between the gender and the diabetes healing mode.

Data Preparation: different statistical analysis algorithms and methods have different inputs and outputs formats. This process ensures that the dataset goes through the required steps to convert the data to a suitable format for the statistical analysis tool. As illustrated in the Tables (1-6), six Tables were extracted from the NCD dataset describing the diabetes treatment types in Saudi Arabia based on gender. Each Table include 7 columns(Age, Women N, Men N, Women n, Men n, Women %, Men %). “Age” indicates the age ranges of the diabetes patients during the survey. “Women N” the total number of women patients to the corresponding age group. “Men N” the total number of men patients to the corresponding age group. “Women n” is the number of women patients show

improvement in controlling the diabetes by adapting the corresponding treatment type. “Men n” is the number of men patients show improvement in controlling the diabetes by adapting the corresponding treatment type indicated by the Table name. “Women %” indicates the percentage of women patients successfully controlled the disease by following the associated treatment type given by the Table name. “Men %” indicates the percentage of men patients successfully controlled the disease by following the associated treatment type as given by the Table name.

Table1: Number of patients show improvement using insulin treatment

Age	Women N	Men N	Women-n	Men-n	Women %	Men %
15-24	12	11	5	6	40.3	52.8
25-34	28	13	4	3	15.1	22.9
35-44	94	70	16	10	17.4	13.6
45-54	124	130	24	22	19.3	17.2
55-64	89	142	25	29	28.2	20.7

Table 2. Number of patients show improvement using drug treatment

Age	Women N	Men N	Women -n	Men -n	Women %	Men %
15-24	12	11	4	3	33.8	28.6
25-34	28	13	13	7	47.2	52.4
35-44	94	70	57	46	60.3	65.2
45-54	124	130	91	96	72.8	73.7
55-64	89	142	57	102	64.4	71.8

Table 3. Number of patients show improvement using diet treatment

Age	Women N	Men N	Women -n	Men-n	Women %	Men %
15-24	12	11	6	3	51.7	27.2
25-34	28	13	19	9	69.8	69.8
35-44	94	70	78	40	83.0	56.6
45-54	124	130	94	88	75.6	67.8
55-64	89	142	66	88	73.8	62.2

Table 4. Number of patients show improvement using weight treatment

Age	Women N	Men N	Women -n	Men-n	Women %	Men %
15-24	12	11	2	3	16.8	27.3
25-34	28	13	7	5	25.5	40.7
35-44	94	70	43	30	45.5	43.2
45-54	124	130	56	54	45.4	41.4
55-64	89	142	29	42	32.9	29.4

Table 5. Number of patients show improvement using smoking cessation treatment

Age	Women N	Men N	Women -n	Men-n	Women %	Men %
15-24	12	11		2		20.1
25-34	28	13	1	2	3.5	15.6
35-44	94	70	1	13	1.0	18.7
45-54	124	130	1	20	0.8	15.0
55-64	89	142	1	14	1.1	9.8

Table 6. Number of patients show improvement using exercise treatment

Age	Women N	Men N	Women -n	Men-n	Women %	Men %
15-24	12	11	2	6	16.3	56.9
25-34	28	13	9	5	32.5	39.2
35-44	94	70	33	32	35.4	46.1
45-54	124	130	50	55	40.4	42.5
55-64	89	142	21	44	23.9	31.1

Statistical Analysis: various types of statistical analysis tools are currently available and each has its own merits and demerits. STATISTICA software has been selected for the analysis. Since several techniques Such as F-test for precision, Analysis of variance (ANOVA), Linear correlation and regression, etc. are available for analyzing the same problem; more consideration will be given to the results with the higher accuracy witnessed.

Results Evaluation: the results will be evaluated carefully to assure that the objectives have been met and the results are proving the constructed hypothesis.

Deployment: since the results might be in mathematical forms which are difficult for the readers to understand, convert the result to a simple format such as graphs on beside of the mathematical values to be an easy to understand to readers.

Statistical analysis

Variables were expressed as the mean \pm SD. The chi-square test was used to compare categorical data, and the t-test was used for continuous variables. The results were considered statistically significant when $p \leq 0.05$. Standard

statistical software (STATISTICA) and MS Excel were used for the data management and statistical analysis.

The final analysis included 6 Tables, one Table for each diabetes treatment type in Saudi Arabia based on the NCD 2005 report. The data included 714 diabetes patients in Saudi Arabia at the time of the survey in 2005. To the best of our knowledge, a new survey has been conducted in 2014 but the report has not been issued yet.

The description of the surveyed data as follow: 366 (51.26 %) of them are men, and 348 (48.73%) are women. Their age ranged from 15 to 64 years with a mean range of 35-44 years. 70 men (19.20% with SE= 2.40%), and 75 women (21.50% with SE=2.80%) have shown improvement in controlling the diabetes when treated by Insulin. 253 men (69.20% with SE= 2.70%), and 222 women (63.90% with SE=4.70%) have shown improvement in controlling the diabetes when treated by drugs. 228 men (62.30% with SE= 4.30%), and 264 women (75.90% with SE=3.20%) have shown improvement in controlling the diabetes when treated by diet. 134 men (36.60% with SE= 3.80%), and 138 women (39.60% with SE=5.40%) have shown improvement in controlling the diabetes when treated by weight control. 51 men (13.90% with SE= 2.10%), and 4 women (1.10% with SE=0.70%) have shown improvement in controlling the diabetes when treated by smoking cessation. 143 men (39.10% with SE= 3.30%), and 116 women (33.30% with SE=4.90%) have shown improvement in controlling the diabetes when treated by exercise.

In the following, the results of our statistical analysis are presented by applying t-test for both gender groups, gender factor proved to show a significant relations (P value <0.05) with all the treatment types except "smoking cessation" as shown in Table 7. This can be explained by noticing that only 4 (1.10%) out of 348 women show positive response to treatment by smoking cessation. Smoking cessation treatment should be coupled by several strategies like weight control [10] to show efficiency in controlling diabetes. Similar to a current study, Health-related quality of life was found to be related to metabolic control and gender, [26]. This result proved the proposed hypothesis "H1: there is a significance relationship between the gender and the diabetes healing mode". Bhat and Abhyankar (2014) also concluded that gender ($p < 0.01$) was a stronger predictor of health related quality of life [27]. By analyzing each gender group separately, women group has shown a stronger statistically significant difference (P value <0.05) with diet (P value=0.041499) and insulin (P value=0.046293) than other treatment types as shown in Table 8 and Figure3. That is similar to study concluded the existence of different mechanisms of insulin resistance between genders [28]. As shown in Table 9 and Figure 4, men 51 (13.90%) out of 366 show positive response to control the diabetes by smoking cessation. Unlike men, only 4 women (1.10%) out of 348 show efficiency in treatment

by smoking cessation as illustrated by Figure 4.

Table 7. T-test marked differences are significant at $p < .05000$ (gender=both groups men and women)

Treatment	Mean	SD	P value
Insulin	14.40000	9.96048	0.002695
Drug	47.60000	39.63010	0.005087
Diet	49.10000	37.58014	0.003085
Weight	27.10000	21.46936	0.004412
Smoking Cessation	6.11111	7.77817	0.109568
Exercise	25.70000	19.95996	0.004003

Table 8. T-test marked differences are significant at $p < .05000$ (gender=women)

Treatment	Mean	SD	P value
Insulin	14.80000	10.03494	0.046293
Drug	44.40000	35.73234	0.056785
Diet	52.60000	38.20733	0.041499
Weight	27.40000	23.04995	0.069389
Smoking Cessation	1.00000	0.00000	
Exercise	23.00000	19.17029	0.069389

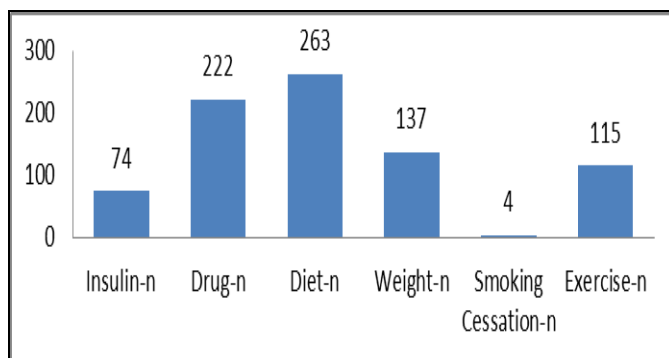


Fig.3 number of patients whose treatment was effective by the associated treatment type (women)

Table 9. T-test for gender= men

Treatment	Mean	SD	P value
Insulin	14.00000	11.06797	0.058406
Drug	50.80000	47.14552	0.077496
Diet	45.60000	41.17402	0.072596
Weight	26.80000	22.48777	0.062280
Smoking Cessation	10.20000	7.94984	0.060831
Exercise	28.40000	22.43435	0.052389

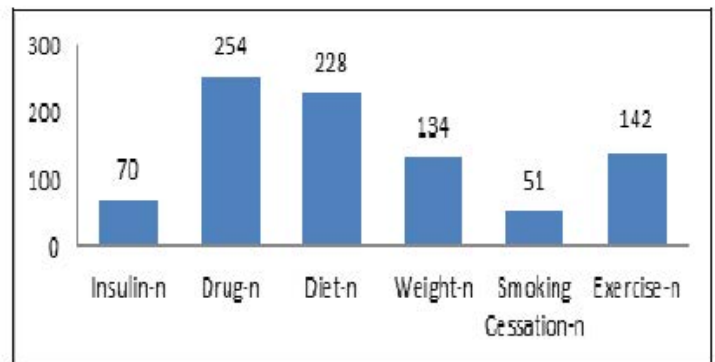


Fig. 4 number of patients whose treatment was effective by the associated treatment type (men)

C. Data Mining

To predict the most effective treatment mode based especially for men gender type, LIBSVM as a library in RapidMiner software for Support Vector Machines (SVMs) is used [29]. LIBSVM is a data mining technique based on the concept of regression to predict a value [30]. Using LIBSVM table 10 shows the prediction of Insulin as a treatment mode to men and women groups. This implies that Insulin is more effective for patients in the “men” group.

Table 10. Prediction Accuracy of Men VS Women using Insulin with Accuracy of 50%

Treatment	True M	True W	Class Prediction
Pred. M	5	5	50%
Pred. W	0	0	0%
Class Recall	100%	0%	

Tables 11-14 show the prediction values for treatment modes of diabetes. It can be concluded that “insulin”, “Diet”, “Drug” and “Smoking” are most effective treatments modes for patients in the “men” group; while “Exercise” is most effective treatment mode for patients in the “women” group. NCD 2005 report stated that during data collection, home activities like cleaning and cooking – normally considered as women’s duties- were considered as exercises.

Table 11. Men VS Women using Diet mode of treatment with Prediction Accuracy of 70%

Treatment	True M	True W	Class Prediction
Pred. M	3	1	75%
Pred. W	2	4	66.67%
Class Recall	60%	80%	

Table 12. Men VS Women using Drug treatment with Prediction Accuracy of 60%

Treatment	True M	True W	Class Prediction
Pred. M	2	1	66.67%
Pred. W	3	4	57.14%
Class Recall	40%	80%	

Table 13. Men VS Women using Smoking Cessation treatment with Prediction Accuracy of 50%

Treatment	True M	True W	Class Prediction
Pred. M	5	5	50%
Pred. W	0	0	0%
Class Recall	100%	0%	

Table 14. Men VS Women using Exercise treatment with Prediction Accuracy of 70%

Treatment	True M	True W	Class Prediction
Pred. M	4	2	66.67%
Pred. W	1	3	75.14%
Class Recall	80%	60%	

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