Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.4, No.25, 2014

Longitudinal Study of Type-2-Diabetes: A Profile Analysis at the Ketu-South Municipality

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Abstract
The main purpose of the study is to investigate the change in Fasting Blood Sugar (FBS) level over time and the effect of some plausible factors on this change for Type-2-Diabetes (T2D) patients on treatment. Retrospective data from the Ketu-South Municipal Hospital, Diabetes Unit, in Ghana in which patients' FBS level and demographic data were monitored regularly every three months was used for the study. Profile analysis was used to study the pattern of change in the FBS level.
The MANOVA test of parallelism showed at 5% significance level that religion was not parallel because there was significant differential in the pattern of change of the FBS level. The other covariates: gender, marital status, drug and education did not significantly differ at the 5% significance level and hence their profiles were tested for parallelism. The parallelism tests revealed that they were parallel and equal but deviated from flatness
The analysis revealed that although the treatment remained effective, the trend of FBS level over time was cubic, indicating that initially the FBS level usually increases and then eventually declines with time, only to rise again. The cubic profile trend obtained was $Fbs = 0.089t^3 - 1.469t^2 + 6.793\text{t}$ with a quadratic rate of change in FBS level given as
$\frac{d}{dt}(FBS) = 0.267t^2 - 2.938t + 6.793$
Where t = 0,1,2,…,t_n for intervals of 0, 3, 6, ….., n months.
The diagnostic statistical tests on the trend confirmed that the trend model was adequate for estimating FBS level of diabetic patients on treatment.
From this research, we are therefore suggesting that in addition to using the drugs to manage the diabetes, the use of the rate of change in FBS level function should be promoted to strengthen the management of diabetic patients on treatment through reliable monitoring and evaluation. We further suggest for more research to test for the significant covariates for the type 2diabetes to fit mixed effect regression model (s) for monitoring type 2 diabetes.
Keywords: FBS level, Type 2 diabetes, Profile analysis, trend model

1. Introduction

Diabetes mellitus is a disease characterized by the inability to regulate blood glucose levels, resulting in chronically increased blood glucose levels, or hyperglycaemia'(Saltiel *et al.,* 2001). Type 2 diabetes mellitus results from an imbalance between insulin sensitivity and insulin secretion. Type 2 diabetes is the most common form of diabetes and comprises 90% of people with diabetes around the world (WHO, Fact Sheet No.312). The world prevalence of diabetes in 2010 among adults aged 20-79 years is estimated to 6.4%, affecting 285 million adults (Shaw *et al.,* 2010). Each year more than 396 million people worldwide die from diabetes and its complications (International Diabetes Federation, 2009).

Both longitudinal and cross-sectional studies have demonstrated that the earliest detectable abnormality in type 2 diabetes is an impairment of the body's ability to respond to insulin. Type 2 diabetes is now increasingly being diagnosed in adult children and adolescents. Researches revealed that men are biologically more susceptible to diabetes than women. Many studies have elaborated the associations between several risk factors and the risk of type 2 diabetes. Body mass index (BMI), lipids, hypertension, smoking, physical inactivity, low education, dietary patterns, family history, and recently also specific genes are the most frequently documented risk factors for type 2 diabetes (Lyssenko *et al*., 2008). This means that the health risks for diabetes are multifactorial with a cumulative effect.

A guiding principle in the treatment of type 2 diabetic patients has been the recommendation to lose weight (American Diabetes Association. 2004). This is because the health benefits of weight loss have long been recognized (Newburgh, 1942). Redmon *et al*., 2005, reported on the 2-year outcome of weight loss therapies in type 2 diabetic patients that the end result was a weight loss of 4.6 kg sustained over 2 years, which led to a decrease of HbA_{1c} of 0.5% indicating improvement in the condition. Models are being developed to study the type 2 diabetes. Spangler *et al.,* (2013) modeled the correlation between diabetes prevalence and subsequent cancer mortality in North Carolina counties and Powers B. J., (2008) also modeled the effect of a hypertension self-management Intervention on Diabetes and Cholesterol Control.

Ghana seems to be epidemiologically limited because epidemiological data on the prevalence of diabetes in Ghana is scanty. However, evidence suggests that diabetes is on the increase. In the 1950s, the prevalence of diabetes among an outpatient urban population in Accra was estimated at less than 0.5% (Dodu, 1958). The impression was therefore created among policy makers that diabetes is rare in Ghana. However, a recent study (Amoah *et al.*, 2002) reported a high prevalence rate of 6.3%. A study on the key predisposing factors of diabetes which assessed the prevalence and sociodemographic aspects of overweight and obesity among residents from rural and urban Accra reported an overall crude prevalence of 23.4% and 14.1%, respectively (Amoah, 2003).

Experts in the medical field work tirelessly to come out with the requisite panacea to help alleviate if not cure the disease. Health practitioners and policy makers find it difficult to predict the FBS level of the diabetic patient, which is very fundamental to the healthcare process in the administration of the drugs. This has triggered researchers to direct their attention to modeling diabetes but the first approach to this is the localised profile analysis using longitudinal study. This study therefore aims to investigate the profile of type 2 diabetes and to determine the pattern of change in FBS level in the diabetic patients on treatment over period of times by conducting a retrospective longitudinal study at Ketu South Municipality of Ghana.

2. Materials and Methods

2.1 Data Used

Secondary data from the diabetes unit of Ketu-South Municipal Hospital was used. In the study, 101 individuals diagnosed of type 2 diabetes (T2D) and put on treatment were followed retrospectively from January 2012 to December 2013. Eligibility criterion was used to recruit eighty (80) patients into the study. The datasets collected on the diabetic patients include the vital statistics: Fasting Blood Sugar (FBS) level, body weight, blood pressure, drug regimen, and some demographic data such as gender, marital status, level of education and religious affiliation.

2.2 Profile Analysis Approach

Generally there are two different types of data that are measured overtime: time series, which takes many measurements on a (usually) small set of individuals, and longitudinal data, which takes a small number of measurements on a (usually) large number of individuals. This research used longitudinal study in which there is a small number of time points at which the individuals give responses, but in this case there is a large amount of data measured at any given time point.

Profile analysis was performed on the FBS level of the patients and the covariates gender, marital status, educational level, duration of treatment (time), and drug regimen were considered. The duration of treatment was in intervals of 3 months, with the initial FBS level taken at time t0 such that the time t = 0, 1, 2, 3 and so on represents 0, 3, 6, 9 months respectively.

This approach is to observe the pattern of the average change in FBS level over time. The variables used for the profile plots were gender, marital status, educational level, religious affiliation and drug regimen. Profiles were constructed for the means of FBS levels versus the time points for the various groups.

2.2.1 Shapiro-Wilks Test for Normality

This test is the significance level for testing normality. Given a set of observations $\bar{x}_1, \bar{x}_2, \bar{x}_3, \dots, \bar{x}_n$ sorted in either descending or ascending order, the test statistics of Shapiro and Wilks, *W* is defined as:

$$W = \frac{(\sum_{i=1}^{n} a_i x_i)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \qquad (1)$$

where $\bar{x} = 1/n \sum_{i=1}^{n} x_i$, is the samples mean and a_i for $i = 1, 2, 3, \dots, n$ are a set of "weight" whose values depend only on the sample size *n*

2.2.2 ARCH-LM Test for Conditional heteroscedasticity

The issue of conditional heteroscedasticity is one of the key problems that a researcher is likely to encounter when fitting models. This happens when the variance of the residuals is not constant. To ensure that the fitted model is adequate, the assumption of constant variance must be achieved. The ARCH-LM test proposed by Engle (1982) was used to test for the presence of conditional heteroscedasticity in the model residuals. The test hypothesis is as follows;

H_0: There is no heteroscedasticity in the model residuals

H_1: There is heteroscedasticity in the model residuals

The test statistic is

$$LM = nR^2 \qquad (2)$$

where n is the number of observations and R^2 is the coefficient of determination of the auxiliary residual regression.

$$e_t^2 = \beta_0 + \beta_1 e_{t-1}^2 + \beta_2 e_{t-2}^2 + \dots + \beta_q e_{t-q}^2 + v_t \qquad (3)$$

where e_t is the residual. The null hypothesis is rejected when the *p*-value is less than the level of significance and is concluded that there is heteroscedasticity.

2.2.3 The Profile trend

Multivariate Analysis of variance (MANOVA) was performed to fit the profile trend and to complement and confirm the profile plot of test of parallelism. Assuming parallelism, the fitted pattern for the FBS level was fully tested for the parallelism, equality and flatness for each covariate.

3. Results

This chapter covers the following findings: Descriptive Statistics of FBS level of patients on treatment, preliminary analysis, profiles of the FBS level with respect to the covariates.

3.1 Descriptive Statistics

The descriptive statistics of the 80 diabetic patients was presented in Table 1. The mean, median, standard deviation, minimum, and maximum scores of FBS level at each measurement point for the 80 diabetic patients were stratified by Gender, Education, Marital status, Religious affiliation and drug.

The age of the patients ranges from 33 to 84 years. The mean and median ages were 58 and 53 respectively. The females were twice as the males, constituting 67.5% and 32.5% respectively but the mean change in FBS level for males was 7.86196 mmol/l whiles that of the females was 7.52880 mmol/l.

Those with primary education had the highest mean FBS level of 8.20222mmol/l and the least of 7.33888mmol/l is scored by patients with senior high school educational level.

With regard to marital status, the widowed patients had the best mean FBS level (7.38888mmol/l) and the patients who were single had the worse mean FBS level of 8.93333mmol/l

Throughout the treatment, three types of drugs were used. Averagely, patients on glimepiride had the best FBS level (7.52936mmol/l) and followed by glibenclamide (7.59540mmol/l) and then metformin (7.71051mmol/l).

3.2 Profile Analysis

3.2.1 Profile plot of FBS by Gender

The pattern of change in FBS level over the period of observation for gender showed that both sexes initially increased sharply and at t1, that of the female declined whiles male remained constant until t2 and after that, both seemed to be changing in almost the same pattern but with the male almost leading (Fig. 1).

3.2.2 Profile Plot of FBS Level by Educational Level

The profile plot of the change in FBS level by educational level over time (Fig. 2) showed variations. The FBS level of patients in all the categories rose initially and all except Senior high, fall at t1 and then all of them, except patients with junior high education, started fluctuating. The change in FBS level of Patients with primary education is ever leading.

3.2.3. Profile Plot of FBS level by Marital status

Figure 3 indicates the average change in FBS level in the marital group. The single category decreased rapidly from time point t0 to t2 and then seemed to assume approximately the same pattern as widow(er), however, others increased initially. Furthermore, married and divorced patients followed approximately similar pattern, commitedly declined. However, the FBS level of the separated patients fluctuates as it moves over the time points.

3.2.4 Profile Plot of FBS level by Drug

From Fig. 4, the average change in FBS level in the drug regimen over time is approximately the same for Metformin and Glimepiride profiles. However, after all of them rose from t0 to t1, Glibenclamide profile slightly differed in the pattern as it flattens from t1 to t2 and then falls rapidly and fluctuates. Averagely, from the profile, even though, is very competitive, metformin seemed to perform worse than glimepiride.

3.2.5 Profile plot of FBS level by Religion

Figure 5 indicates that the average change in FBS level in the religious group is approximately similar for all the religious groupings except "Others" which continue to increase until t2 after the rest declined from t1. Christians, however, leads most of the times.

3.2.6 The Pattern of FBS Level with time

The general pattern of FBS level profile over the period of treatment produced a cubic function (Fig. 6) depicting that the change in FBS level increases over time and then fall, only to rise again.This is confirmed by the cubic model having the highest R^2 value (R^2 *value* = 0.9100) among the eleven trends tested, accounting for 91% of the variability in the data (Table 2). Thus the cubic trend model

$$Fbs = 0.089t^3 - 1.469t^2 + 6.793\text{t}$$

is selected as the best trend.

3.2.7 Significant test for the cubic pattern

Analysis of Variance (ANOVA) table 3 shows that the regression analysis on time for the cubic trend model is statistically significant (p-value = 0.000).

3.2.8 The Cubic Trend Model Diagnoses

The adequacy of the model was tested with Shapiro-wilk and ARC-LM tests (Table 4). The Shapiro-wilks test of normality indicated that the residuals of the model were normally distributed (p-value = 0.0572) and the large W

= 0.935, is a good sign for normality. The ARCH-LM also indicated that the residuals were free from conditional heteroscedasticity (p-value = 0.6207). Hence the diagnostic test revealed that the model is adequate for prediction of FBS level.

3.2.9 Profile test of Parallelism

Multivariate Analysis of variance (MANOVA) was performed to complement and confirm the profile plot of test of parallelism as shown in Table 5. The MANOVA tests indicated that the profiles for the different levels of religion differed and are therefore not parallel. However, gender, marital status, drug and education did not significantly differ at the 5% significance level and therefore parallel, requiring test of parallelism.

3.2.9.1 Test of Parallelism, Equality and Flatness for Gender group

The Hotelling's T^2 statistic for Gender is 2-group Hotelling's $T^2 = 13.424512$

$$F\ test\ statistic: F(9,70) = \left(\frac{80-9-1}{(80-2)\times(9)}\right) \times 13.424512 = 1.3386265$$

The hypothesis H_0: $Vectors\ of\ means\ are\ equal\ for\ the\ two\ g$groups, was rejected at 5% significance level since $Prob > F(9,70) = 0.2333$

The results of the tests for Parallelism, Equality and Flatness for Gender group are presented to Tables 6, 7 and 8 respectively using a standard one-way MANOVA followed by a test that used a transformation of the dependent variables. Assuming homogeneity, at 5% level of significance, the results of the three tests confirmed that there is a significant change in FBS level of patients across the time points, and the pattern and level of change was the same for both sexes.

3.2.9.2 Test of Parallelism, Equality and Flatness by Marital status

The tests of parallelism, equality and flatness by marital status are given in tables 9, 10 and 11 respectively.

The parallelism and equality test revealed that, the pattern of the average change in FBS level for the levels of marital status is not different and are approximately the same. The flatness, however, showed that the FBS level by marital status did not remain the same over time.

3.2.9.3 Test of Parallelism, Equality and Flatness by Drug regimen

The three tests are represented in tables 12, 13 and 14.

At the 5% significant level, the parallelism and equality tests indicated that the difference in the pattern of change for the various types of drug is statistically insignificant. Thus the profiles of the average change in FBS level for the different types of drug is parallel and approximately the same. However, from the flatness test, we reject the null hypothesis that there is no change in FBS level, since the p-value (0.0000) is less than 0.05, indicating that the FBS level by drug changes over time.

3.2.9.4 Test of Parallelism, Equality and Flatness by Educational level

Tables 15, 16 and 17 presented the respective results for the three tests. The parallelism and equality tests are not significant at 5% significance level, meaning that the profiles of the average change in FBS level for the different levels of education are approximately the same. Flatness test is significant, indicating that flatness is not proven and hence the mean FBS level does not remain the same over time

4. Discussion

The FBS level and other vital statistics of 80 diabetic patients on treatment were followed retrospectively through the study period of twenty-four months. The minimum age of the patients is 33years and the maximum age was 84years. The mean age is 58years and the median 53years with majority within the age group of 60-69years, constituting 23.75% suggesting that aging increases the chances of having type 2 diabetes. The females (67.5%) were almost twice as the males (32.5%). The high number of females as compared to males may be due to the higher physical activity related energy expenditure in males compared to female subjects, hence lower rate of males living with type 2 diabetes (Aspray *et al*., 2000). The lower rate in males may also be due to the usual unwillingness or lower rate at which males go for medical screening or test as compared to the females. The males and the females slightly differed in their average, as well as minimum and maximum FBS levels. Even though males were half of the females, the average FBS level of males (7.86196 mmol/l) is slightly higher than that of the females (7.52880mmol/l) which indicates that females seemed to better adhere to the treatment and management plans than the males or by genetic complement, FBS level progresses faster in males (Table1).

The similar initial increase and then decline in the pattern of change of FBS levels over time for both sexes is a direct indication that the treatment and management plans adopted to bring the situation
under control were actually addressing the condition irrespective of gender even though performance is better in females than males. The test of parallelism, equality and flatness, showed that the pattern for both male and female patients is not only the same but also identical with the average FBS level changing over time. Thus while gender did not affect the change in FBS level, time did and that there is no time and group interaction (Tables 1, 6, 7 and 8).

The educational pattern of profiles with consistent leading nature of the FBS level of the patients who had primary education indicated that their understanding of the basics of the condition is low, making them most

susceptible. However, the general pattern seemed to be approximately similar among the educational profiles. The result clearly indicates that high educated patients managed the condition better, perhaps they were able to understand the basic disease management and treatment plans better.

The profiles for the effect of drug regimen on the change of FBS level showed that the three main drug regimens: metformin, glimepiride and glibenclamide seemed to have caused the change in FBS level over time, even though, the FBS level of patients on glibenclamide behaved a little strange as compared to the FBS level of patients on metformin and glimepiride (Figure 4). The profiles suggest that these drugs improved the condition of patients on treatment over time in corroboration of the finding by Garber *et al* (2006) that metformin-glibenclamide treatment resulted in significantly greater reductions in HbA1C and FBS compared with metformin plus rosiglitazone in patients with type 2 diabetes. Zhu *et at* (2013) also suggested that metformin and glimepiride were not significantly different in glycaemic control of Type 2 Diabetes, suggesting that glimepiride would be a good choice second to metformin in the monotherapy of Type 2 Diabetes. These findings confirmed that the drugs in question are very effective in managing the condition.

The profiling of the FBS level pattern of the different categories of marital status is also expressed and all the marital statuses follow almost the same trend with respect to time on treatment. This clearly shows that marital status is not a key indicator of the FBS level of the diabetic patients (Table 1, Figure 3).

Although Christians lead in the religion profile, the profile did not show much difference (Figure 5). The MANOVA test of parallelism showed that there was significant differential in the pattern of change of the FBS level in religion, but gender, drug regimen, marital status, and educational level of the patients did not show any significant differentials in their pattern of change (Tables 5 to 17)

The pattern of change in FBS level followed a cubic distribution (Table 2, Figure 6), indicating, initial increase and eventually falls. Thus while there is a consistent improvement in the FBS level of patients on treatment, this change decreases with time after having increased initially. This may be due to possible inconsistent use of the treatment and management plans or reduction in the efficacy of the treatment with time possibly by some intrinsic and extrinsic factors. The rate of change in FBS level is given by $\frac{d}{dt}(FBS) = 0.267t^2 - 2.938t + 6.793$ which can be used to estimate FBS level per unit time. The diagnoses of the cubic trend model further confirmed that this trend is significantly reliable for estimating the FBS level of patients on treatment (Tables 3 and 4).

5. Conclusion

The Profile analysis of the retrospective data on FBS level of the 80 patients revealed cubic trend in the mean FBS level of patients on treatment, accounting for 91% of variability in the data. The MANOVA test of parallelism showed that religion was not parallel because there was significant differential in the pattern of change of the FBS level in religion. However, the other covariates: gender, marital status, drug and education did not significantly differ at the 5% significance level and hence their profiles were tested for parallelism. The parallelism tests revealed that they were parallel and equal but deviated from flatness. It is therefore concluded from the study that drug regimen, metformin, glimepiride and glibenclamide, are improving the condition. In addition to using the drugs, we suggest the use of the rate of change in FBS level function for monitoring and intervention of diabetic patients on the treatment. We further suggest for further research to test for the significant covariates for the type 2diabetes to fit mixed effect regression model (s) for monitoring patients on treatment.

5. Acknowledgement

We wish to express our heartfelt gratitude to our families: Adampah, Nawumbeni, Nyadanu and our dearest American family, Ruth Polishuk and the children for their social, emotional, financial and spiritual supports. To all members of ECHO Ghana, we are indebted to you for supports accorded us as members of the organization.

A very big thank to the staff of Ketu-South Municipal Hospital, especially the diabetic unit for making their facility available to us for data collection in support of this research.

6. Funding information

Funding of this research is solely by the researchers.

7. Authors' contributions

All authors play almost equal role in preparing this manuscript. Each author contributed at all levels of organising this manuscript

8. Conflict of Interest

The researchers have not conflict of interest whatsoever to declare as far as the preparation of this manuscript is

concerned.

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APPENDIX

Tables

Table 1. Descriptive statistics of FBS level of patients on treatment

Variables	Percentage (%)	Mean (fbs)	Median (fbs)	Min. (fbs)	Max. (fbs)
AGE (years)					
30-39	3.75	8.65556	9.20000	3.00000	12.90000
40-49	20.00	8.80486	8.30000	4.00000	16.50000
50-59	30.00	7.08935	6.80000	3.50000	15.90000
60-69	23.75	7.35263	6.90000	3.70000	13.50000
70-79	18.75	7.45925	7.10000	3.20000	14.20000
80-89	3.75	7.46296	6.90000	4.00000	14.20000
Mean (Age) = 58					
Median (Age) = 53					
Minimum (Age) = 33					
Maximum (Age) = 84					
GENDER					
Male	32.50	7.86196	7.40000	3.00000	16.50000
Female	67.50	7.52880	7.10000	3.20000	16.40000
EDUCATION					
Non	20.00	7.20347	6.75000	3.80000	15.80000
Primary	27.50	8.20555	7.60000	4.10000	16.40000
JHS	25.00	7.37666	7.05000	3.20000	15.70000
SHS	7.50	7.33888	7.15000	3.00000	13.50000
Tertiary	20.00	7.72638	7.20000	3.50000	16.50000
RELIGION					
Christian	46.25	8.18918	7.60000	3.20000	16.50000
Islamic	16.25	6.45982	6.10000	3.70000	12.80000
Traditional	27.50	7.21161	6.95000	3.80000	13.70000
Other	10.00	8.16666	8.00000	3.00000	15.70000
MARITATAL STATUS					
Married	57.50	7.66135	7.20000	3.70000	16.50000
Single	1.25	8.93333	8.60000	6.90000	12.90000
Separated	10.00	8.10138	7.40000	4.40000	15.80000
Divorced	17.50	7.39444	7.20000	3.00000	15.90000
Widow(er)	13.75	7.38888	7.00000	4.00000	15.10000
DRUG					
Metformin	46.25	7.71051	7.10000	3.00000	16.40000
Glibenclamide	36.25	7.59540	7.20000	3.70000	16.50000
Glimepiride	17.50	7.52936	7.20000	3.20000	15.70000

Table 2.Test of trend models

Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	b1	b2	b3
Linear	0.652	1347.957	1	719	0.000	1.147		
Logarithmic	0.693	1623.218	1	719	0.000	4.221		
Inverse	0.566	936.325	1	719	0.000	14.527		
Quadratic	0.853	2081.261	2	718	0.000	3.629	-0.349	
Cubic	0.910**	2407.258	3	717	0.000	6.793	-1.469	0.089
Compound	0.736	2007.201	1	719	0.000	1.359		
Power	0.771	2420.639	1	719	0.000	1.120		
S	0.584	1009.349	1	719	0.000	0.307		
Growth	0.736	2007.201	1	719	0.000	0.307		
Exponential	0.736	2007.201	1	719	0.000	0.307		
Logistic	0.736	2007.201	1	719	0.000	0.736		

Table 3. Analysis of Variance for Cubic trend model

ANOVA					
Source	SS	DF	MS	F	Sig.
Regression	512.393	3	170.798	35.009	.000
Residual	3493.105	716	4.879		
Total	4005.499	719			

Table 4. Trend model Diagnoses

		P-value
Shapiro-Wilks	W = 0.935	0.0572
ARCH-LM	Chi-Sq.= 3	0.6207

Table 5. MANOVA Test for Groups

Source		Statistic	Df	F(df1	df2)	F	Prob>F
Gender	W	0.9923	1	1.0	65.0	1.50	0.4804 e
	P	0.0077		1.0	65.0	1.50	0.4804 e
	L	0.0078		1.0	65.0	1.50	0.4804 e
	R	0.0078		1.0	65.0	1.50	0.4804 e
Marital	W	0.9216	4	4.0	65.0	1.38	0.2495 e
Status	P	0.0784		4.0	65.0	1.38	0.2495 e
	L	0.0851		4.0	65.0	1.38	0.2495 e
	R	0.0851		4.0	65.0	1.38	0.2495 e
Religion	W	0.8547	3	3.0	65.0	3.68	0.0163 e
	P	0.1453		3.0	65.0	3.68	0.0163 e
	L	0.1701		3.0	65.0	3.68	0.0163 e
	R	0.1701		3.0	65.0	3.68	0.0163 e
Drug	W	0.9873	2	2.0	65.0	0.42	0.6602 e
	P	0.0127		2.0	65.0	0.42	0.6602 e
	L	0.0129		2.0	65.0	0.42	0.6602 e
	R	0.0129		2.0	65.0	0.42	0.6602 e
Education	W	0.9623	4	4.0	65.0	0.64	0.6387 e
	P	0.0377		4.0	65.0	0.64	0.6387 e
	L	0.0391		4.0	65.0	0.64	0.6387 e
	R	0.0391		4.0	65.0	0.64	0.6387 e
Residual			65				
Total			79				

W = Wilks' lambda L = Lawley-Hotelling trace P = Pillai's trace R = Roy's largest root
e = exact, a = approximate, u = upper bound on F

Table 6. Multivariate test of parallelism by Gender

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.8543	1	8.0	71.0	1.51	0.1677 e
	P	0.1457		8.0	71.0	1.51	0.1677 e
	L	0.1706		8.0	71.0	1.51	0.1677 e
	R	0.1706		8.0	71.0	1.51	0.1677 e
Residual			78				

Table 7: Test of Equality in Gender.

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.9906	1	1.0	78.0	0.74	0.3917 e
	P	0.0094		1.0	78.0	0.74	0.3917 e
	L	0.0095		1.0	78.0	0.74	0.3917 e
	R	0.0095		1.0	78.0	0.74	0.3917 e
Residual			78				

Table 8. Multivariate Test of flatness by Gender

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.3466	1	8.0	71.0	16.73	0.0000 e
	P	0.6534		8.0	71.0	16.73	0.0000 e
	L	1.8850		8.0	71.0	16.73	0.0000 e
	R	1.8850		8.0	71.0	16.73	0.0000 e
Residual			78				

W = Wilks' lambda L = Lawley-Hotelling trace P = Pillai's trace R = Roy's largest root

Table 9. Test of parallelism by marital status

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.7050	4	32.0	252.4	0.78	0.7931 a
	P	0.3279		32.0	284.0	0.79	0.7829 a
	L	0.3734		32.0	266.0	0.78	0.8037 a
	R	0.1965		8.0	71.0	1.74	0.1031 u
Residual			75				

Table 10. Test of level (Equality) by marital status

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.9760	4	4.0	75.0	0.46	0.7635 e
	P	0.0240		4.0	75.0	0.46	0.7635 e
	L	0.0246		4.0	75.0	0.46	0.7635 e
	R	0.0246		4.0	75.0	0.46	0.7635 e
Residual			75				

W = Wilks' lambda L = Lawley-Hotelling trace P = Pillai's trace R = Roy's largest root
e = exact, a = approximate, u = upper bound on F

Table 11. Test of flatness by marital status

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.6482	1	8.0	68.0	4.61	0.0002 e
	P	0.3518		8.0	68.0	4.61	0.0002 e
	L	0.5428		8.0	68.0	4.61	0.0002 e
	R	0.5428		8.0	68.0	4.61	0.0002 e
esidual			75				

W = Wilks' lambda L = Lawley-Hotelling trace P = Pillai's trace R = Roy's largest root
e = exact, a = approximate, u = upper bound on F

Table 12. Test of Parallelism by drug

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.8359	2	16.0	140.0	0.82	0.6606 e
	P	0.1701		16.0	142.0	0.83	0.6556 a
	L	0.1892		16.0	138.0	0.82	0.6659 a
	R	0.1368		8.0	71.0	1.21	0.3035 u
Residual			77				

Table 13. Test of Level (Equality) for drug

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.9980	2	2.0	77.0	0.08	0.9263 e
	P	0.0020		2.0	77.0	0.08	0.9263 e
	L	0.0020		2.0	77.0	0.08	0.9263 e
	R	0.0020		2.0	77.0	0.08	0.9263 e
Residual			77				

Table 14. Test of Flatness by drug.

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.3613	1	8.0	70.0	15.47	0.0000 e
	P	0.6387		8.0	70.0	15.47	0.0000 e
	L	0.7676		8.0	70.0	15.47	0.0000 e
	R	0.7676		8.0	70.0	15.47	0.0000 e
Residual			77				

Table 15. Test of Parallelism by Educational level

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.6547	4	32.0	252.4	0.96	0.5333 a
	P	0.3951		32.0	284.0	0.97	0.5135 a
	L	0.4555		32.0	266.0	0.95	0.5539 a
	R	0.2220		8.0	71.0	1.97	0.0627 u
Residual			75				

Table 16. Test of Level by Educational level.

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.9407	4	4.0	75.0	1.18	0.3259 e
	P	0.0593		4.0	75.0	1.18	0.3259 e
	L	0.0630		4.0	75.0	1.18	0.3259 e
	R	0.0630		4.0	75.0	1.18	0.3259 e
Residual			75				

Table 17. Test of Flatness by Educational level.

Source		Statistic	Df	F(df1	df2)	F	Prob>F
	W	0.3685	1	8.0	68.0	14.57	0.0000 e
	P	0.6315		8.0	68.0	14.57	0.0000 e
	L	1.7138		8.0	68.0	14.57	0.0000 e
	R	1.7138		8.0	68.0	14.57	0.0000 e
Residual			75				

Figures

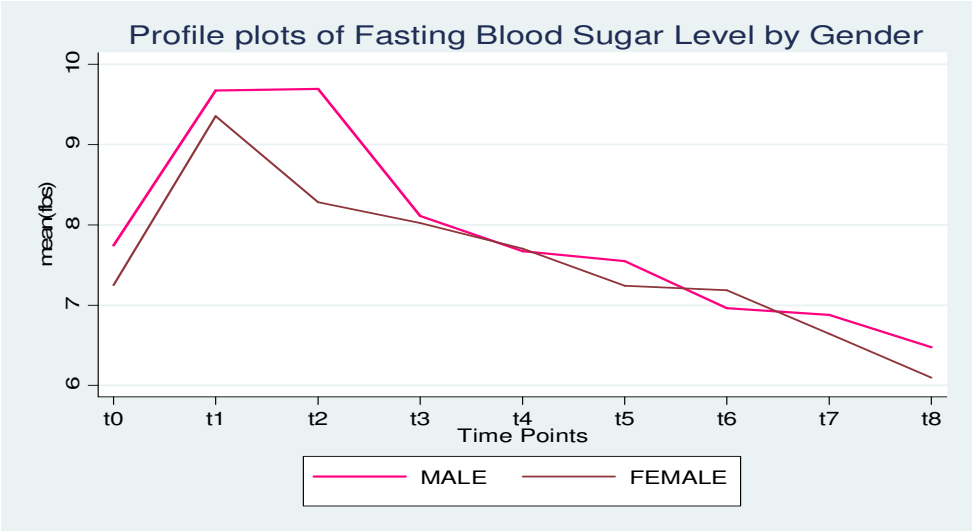

Figure 1**.** Profile plot of FBS level by gender

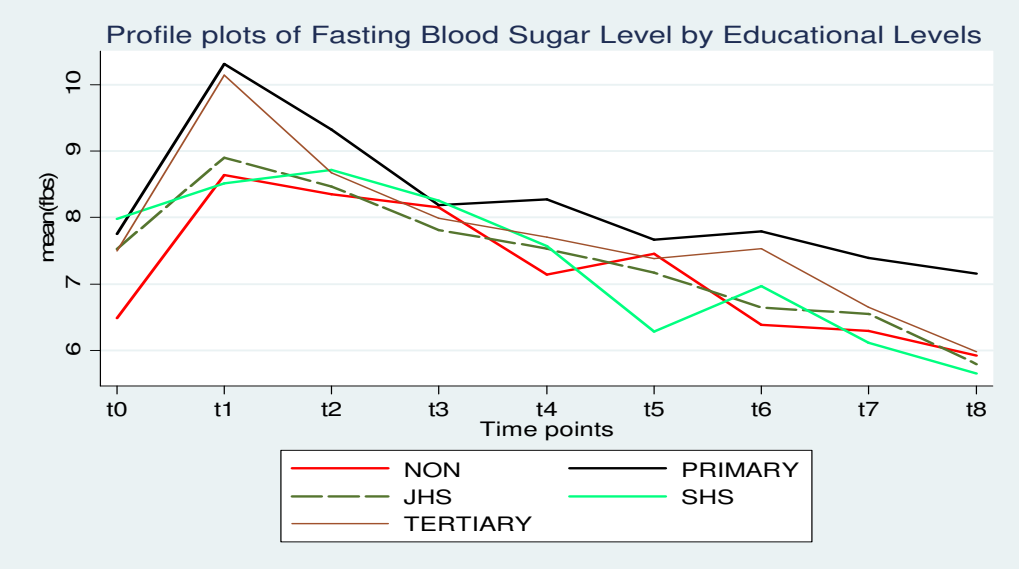

Figure 2**.** Profile plots of FBS level by Educational level.

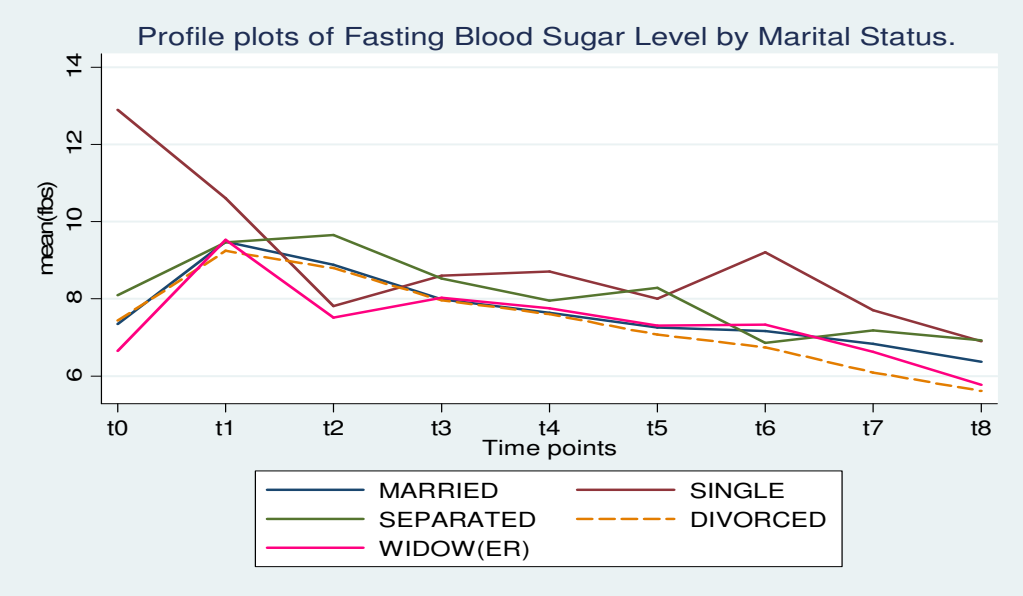

Figure 3. Profile plots of FBS level by marital status.

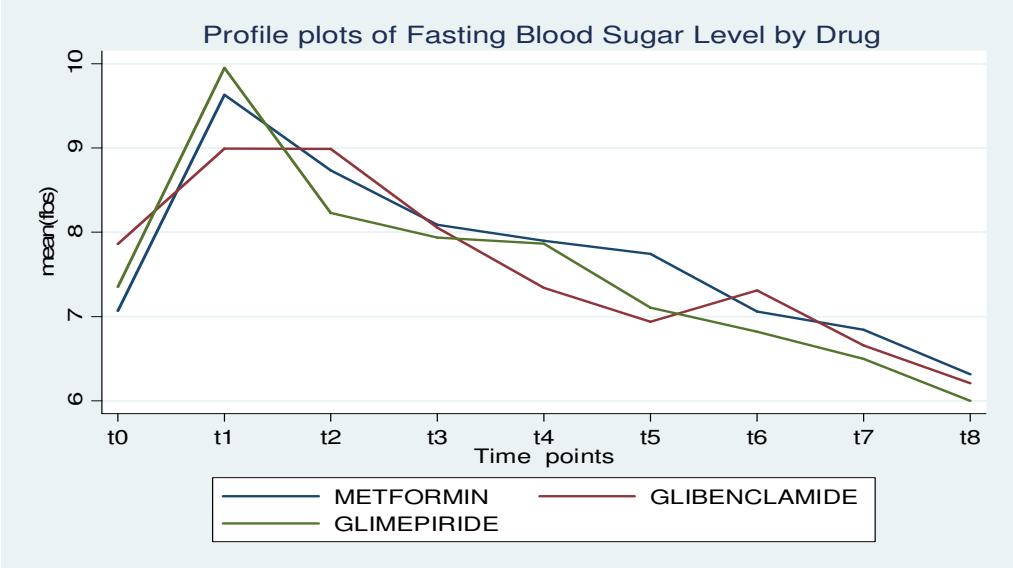

Figure 4. Profile plot of FBS level by drug

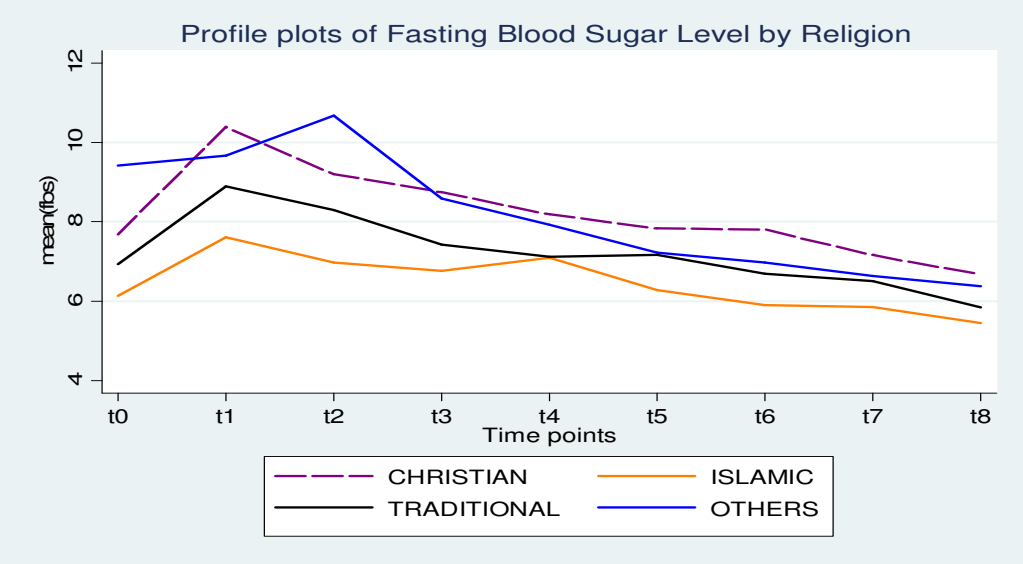

Figure 5. Profile plots of Fasting Blood Sugar Level by Religion.

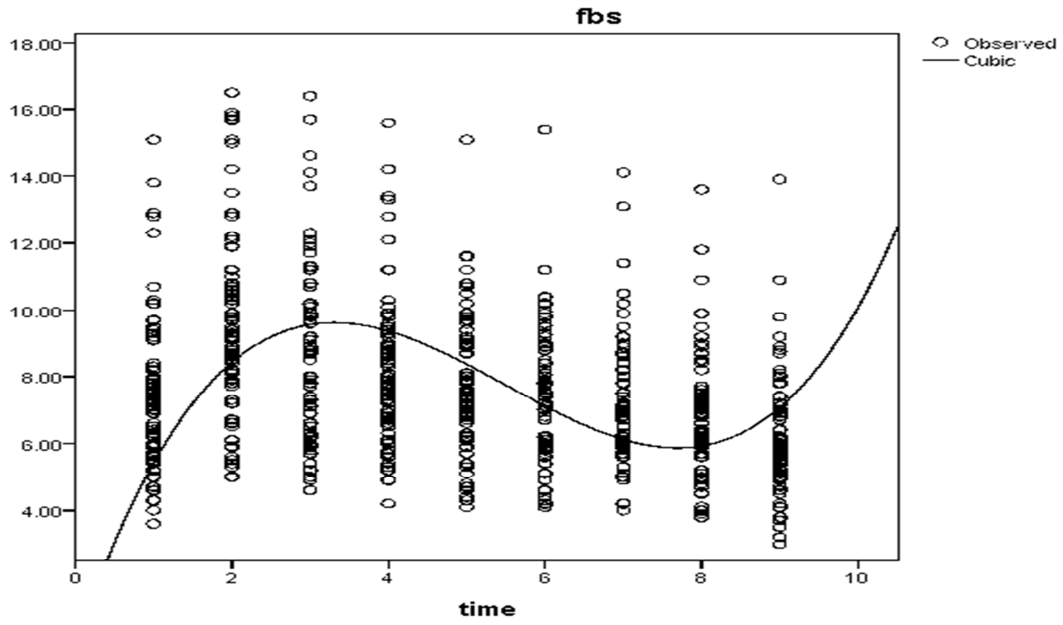

Figure 6. Profile plot of FBS level depicting cubic pattern

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