Analysis of Priorities of Patients Living with Diabetes

Analysis of Priorities of Patients Living with Diabetes

By

HUAN JIANG, B.Sc.

A Project

Submitted to the School of Graduate Studies

In Partial Fulfillment of the Requirements

For the Degree

Master of Science

McMaster University

MASTER OF SCIENCE (2005) McMaster University

(Statistics) Hamilton, Ontario

TITLE: Analysis of Priorities of Patients Living with Diabetes

AUTHOR: Huan Jiang, B.Sc. (Southwest Jiaotong University)

SUPERVISOR: Dr.Lehana Thabane

NUMBER OF PAGES: 84

Abstract

Diabetes is a chronic disease that affects more than 2 million Canadians. In order to reduce the risk of complications, people with diabetes must monitor their symptoms and actively manage diet, exercise, and medication. Patient priority is defined as the patient's implicit or explicit ordering of importance, ease and frequency of preventative or treatment activities for managing diabetes. In this study, we report on the findings of a questionnaire of diabetes patient priorities. The primary purpose of this study was to identify patient priorities and their relationships for managing diabetes from a patient's perspective. Multivariate analysis techniques were applied to find the patterns within the ratings of importance, ease and frequency for seventeen diabetes care activities. Multivariate analysis is used when more than one measurement is taken on a given experimental unit and all the measurements need to be considered together so that one can understand how they are related and what the essential structure is. In our study, the multivariate techniques used were MANCOVA, multivariate regression, and factor analysis. Due to the missing values, simple and multiple imputations were necessary. This study acts as a pilot study for a future, larger study about patient priorities.

Acknowledgements

I would like to dedicate this project to my family and parents who have shown such love, support and encouragement throughout my schooling. Thank you for everything you have sacrificed, all the advice and guidance you have given, and the unconditional love you always shown.

I would like to express my gratitude to my professors for their support and assistance in my study. Your love of the subject, passion for teaching and willingness to help has made all the difference. I would also like to thank my supervisor Dr. Lehana Thabane for his encouragement, patience, and guidance throughout the completion of this project. A special thank you to Dr. Anne Holbrook, Dr. Lisa Dolovich and Kalpana Nair for their advice and support during the course of the project.

Table of Contents

Chapter 1 Introduction **1**

1.1 Background on patient priorities study ...1

1.2 Questionnaire Development ...3

1.3 Objectives and Scope of the Project ...5

1.4 Ethical Considerations ...6

Chapter 2 Methods **7**

2.1 Introduction to Methods ...7

2.2 Preliminary Steps of Data Analysis ...8

2.3 Group Comparisons ...9

2.4 Multivariate Analysis of Covariance ...10

2.5 Factor Analysis ... 11

2.6 Imputation for missing value ... 14

Chapter 3 Results **16**

3.1 Summarization ... 16

3.2 Group Comparisons ... 20

3.3 Multivariate Analysis of Covariance ... 22

3.4 Factor Analysis ...25

3.5 Mean Imputation and Multiple Imputation ...30

Chapter 4 Discussion **32**

Chapter 5 Conclusions **38**

Chapter 6 Appendix **40**

Appendix A: Patient Priorities in Diabetes Questionnaire 40

Appendix B: Diabetes Knowledge Survey Scoring Key 50

Appendix C: SAS Output 52

Appendix D: SAS Code 67

Chapter one

Introduction

1.1 Background on patient priorities study

Diabetes is a chronic disease that affects more than 2 million Canadians [1]. In 1998 the cost of diabetes to the Canadian health care system was estimated to be approximately $7 billion [2]. Another study estimated that diabetes accounts for nearly 1 in 5 health care dollars spent in Canada [3]. The disease has also been found to be a leading contributor to vascular disease, renal failure, blindness, impotence, and limb amputation [4]. Apart from its cost to society and the impact on the quality of life, diabetes also shortens a person's life span by up to 13 years [5].

In addition to being detrimental, diabetes is also one of the most complex diseases with multiple complications to manage. A randomized trial published in 2003 showed that active management of diabetes is required to significantly reduce cardiovascular complications [6]. In this trial, 160 people with type I diabetes were divided into two groups. Eighty patients received conventional therapy (in accordance with national guidelines), while the other eighty received an intensive intervention. The intervention included a stepwise implementation of diet and exercise regimes, medication, and vitamin supplements. For instance, exercise and diet regimes were recommended initially, and medication was added if the initial intervention failed to achieve the desired clinical outcome. Results indicated the intervention group had a significant decline in glycoslated hemoglobin values, serum cholesterol, blood pressure and urinary albumin excretion rate. The study concluded that intensive intervation reduced the risk of both cardiovascular and microvascular events by about 50%. Thus, people must perform numerous, and often, invasive activities to manage their diabetes optimally and, therefore, live longer and healthier.

Performing all the activities can be a daunting task. Patients face many barriers to meeting the targets identified by best evidence. These include not having enough time to work on every target activity on a daily bases, believing that too many of the activities are externally-controlled and require appointments, scheduling and travel time, and feeling unable to integrate all the necessary activities into their work, home, and social life [7- 14].

Healthcare providers may help patients overcome the barriers of managing diabetes by identifying activities patients want more information on, by assisting patients to manage competing priorities, and by influencing and shifting those priorities according to known individual benefit and risk. For instance, the identification of strategies, both successful and unsuccessful could be shared among other patients with the aid of health care providers. However, before clinical outcomes can be examined, it is critical that health care professionals understand the priorities of patients with diabetes.

In this study, patient prioritization is defined as the patient's implicit or explicit ordering of importance, ease and frequency of preventative or treatment activities for managing diabetes in a scale from 1 to 10, where 1= not very important / easy/ often and 10= very important/ easy/ often respectively. The concept has not been studied in great detail. While prior work has explored the outcome of clinician-defined targets [15], there appears to be no research on the clinical outcome of management plans based on patients' own priorities. Existing studies of patient priorities are general and descriptive. However, clinicians need explicit patient priorities to guide recommendations, and ultimately improve adherence and quality of diabetes patients' lives.

1.2 Questionnaire Development

Given the lack of available instruments that measure patient priorities in a global context, a questionnaire, Patient Priorities in Diabetes Questionnaire (PPDQ), was developed (Appendix A) by COMPETE, a research group from the Centre of Evaluation of Medicines, St.Joseph's Healthcare Hamilton. The 9-page questionnaire begins with a page describing the goal of the survey and instructions, and is followed by 4 major sections. The first section is a general knowledge survey (10 items), aimed at measuring people's knowledge about important diabetes care activities. These data were intended to help clarify targets for diabetes education, and elucidate the relationship between patient knowledge and perception of importance, ease and frequency of performing diabetes care activities (measured later in the survey). The 10 questions were designed to cover diabetes care activities related to lifestyle, medication and monitoring. Participants were asked to choose "true," "false" or "I don't know" for each question. A scoring key was developed as well (See Appendix B).

The second section of the PPDQ contains two open-ended questions intended to capture 1) diabetes care activities (including alternative remedies) people engage in, and 2) prioritization of these activities. The first question asked people to describe things they do to look after their diabetes. The second question stated, "Given all the things that you are told to do for your diabetes, how do you decide where you spend your energy and time. Think about how you prioritize your time; how do you decide what you will do first?" Participants were given half a page to respond to each question.

The aim of the third section of the questionnaire was to identify patients' perspectives on the importance, ease and frequency of performing 17 diabetes care activities that are considered relevant to health outcome by health care professionals. Participants were asked to indicate the activities they actively performed in the last year, and to rate (1-10) the importance, easy, frequency of performing each diabetes care activity. These 17 diabetes care activities were derived from 14 diabetes targets compiled by COMPETE, a research group from the Centre of Evaluation of Medicines, St. Joseph's Healthcare Hamilton. A major focus of COMPETE is to improve management of diabetes through better use of information technology. The group has identified 14 areas well supported by good quality evidence that should be targets of preventive activities for people with diabetes (Appendix C). The 14 recommendations were expanded to 17 for the PPDQ, and organized into activities related to lifestyle, to medication and to monitoring.

In the final section of the questionnaire, participants were asked to provide some demographics and clinical information, such as age and type of diabetes to enable future research into relationships between these characteristics, and people's perception and performance of diabetes care activities.

1.3 Objectives and Scope of the Project

The purpose of this study was to assess the validity of the PPDQ questionnaire and to identify patient priorities for managing diabetes. A primary objective was to determine rank ordering of diabetes care activities from the patient perspective. Our secondary objective was to determine factors that affect rank ordering. Some previous studies have consistently found that patient priorities and goals regarding diabetes seem to shift over time as they live with their diseases [16-19]. Our aim was to determine whether complications are related to rank ordering and whether there was discrimination between patients who had and had not incorporated diabetes care activities into their life. We also wished to model the responses to the questions on the survey. Possible factors that can help us model rankings are patient demographic and clinical information.

Another secondary objective of the study was dimension reduction. The 17 diabetes care activities belong to three categories: lifestyle activities, medication related activities and monitoring activities. Our goals were to find redundant items, to determine how ratings of the 17 activities were correlated, and to establish whether they could be grouped according to the three known categories.

In our survey, some participants did not respond to all the items. These missing values not only mean less efficient estimates because of the reduced size of the database but also mean possible biases. Therefore, our last objective was to find whether the responders were systematically different from the non-responders.

1.4 Ethical Considerations

All participants were be required to sign a consent form, stating that they are able to withdraw from the study at any time without any consequences to their medical care. Participants were given a copy of the signed consent form to keep for their records.

Data provided by participants were identified by an ID number. The unique patient identifier was not disclosed and therefore it is not possible to link a specific patient with any of the published results.

The study received research ethics approval from St. Joseph's Healthcare Research Ethics Board.

Chapter Two

Methods

2.1 Introduction to Methods

Our study acts as a pilot for a larger body of research that will explore patient priorities regarding diabetes care activities in a more systematic way. Sample size calculations are typically not used when conducting pilot studies; however, sufficient numbers of participants should be included in order to assess what would be feasible in the subsequent studies. Participants were recruited through advertisements placed on hospital bulletin boards, in pharmacies, and at community health centers. Participants were also recruited from patients affiliated with TIPPS, COMPETE II, and the Access to Diabetes Medication Study – accessing the subgroups of participants who agreed to be contacted about further studies.

To determine whether the questionnaire was interpreted in the manner it was intended, face validity testing was conducted. The PPDQ was initially given to a panel of interdisciplinary health professionals for feedback. Next, people with diabetes were recruited through the McMaster University "Daily News" web page, to provide feedback in face-to-face interviews. Here, respondents were asked to write down or verbally inform the interviewer of anything that was unclear. Lastly, the modified questionnaire was mailed out in three waves, to allow for further feedback and modification.

The complete mail-out contained the questionnaire, an introduction letter, and a consent form, as well as a postage-paid envelope. Within two weeks of the questionnaire being mailed, all potential participants were called by one of two study interviewers and asked if they would be interested in participating in the study. Those who were interested were offered three options: 1) to complete the survey by themselves and mail it in, 2) to complete the questionnaires with the interviewer over the phone at the time of the initial call, or 3) to complete the questionnaires at a later time. For the telephone interview, questions were read to participants over the phone (as the participant followed the print version at home), and responses were recorded by the interviewer at the Centre for Evaluation of Medicines in downtown Hamilton. All participants were reminded to mail in their signed consent form in the postage paid envelope provided.

2.2 Preliminary Steps of Data Analysis

The first step of the statistical procedures was data cross-examination. SAS 9.1, SPSS 11.5, and R were the softwares that were used for the analyses. The data were searched for obvious data entry errors as well as examined for outliers and distribution assumption by using scatter plots, box plots and normal probability plots.

Descriptive statistics were generated for patient scores on importance, ease, and frequency of activities to manage diabetes. Means and standard deviations or medians (interquantile range) were calculated for continuous variables such as age, work hours and duration of diabetes. Percentages were presented for discrete variables such as gender, type of diabetes and complications. Descriptive statistics were also generated for patient scores on importance, ease and frequency of activities to manage diabetes, and patient scores on the diabetes knowledge survey. Mean scores for each of the 17 items were ranked to detect hierarchical patterns in patient perceptions on importance, ease and frequency of participation in diabetes management activities.

2.3 Group Comparisons

Part of the secondary objective of the study was to determine if there was a difference in ratings between patients who had and had not incorporated diabetes care activities in their lives. The concept of "incorporating diabetes care activities into their lives" was defined by how many diabetes care activities they had completed and self reported in the third part of the questionnaire. The participants were divided into three groups according to the percentages of diabetes care activities they had completed (from the third part of the questionnaire): approximately 25% of the participants belonged to the first group, 25% of the participants belonged to the second group, while approximately 50% participants belonged to the third group. The first group consisted of participants who completed more than 88% of activities; the second group consisted of participants who completed less than 82% of activities; the remaining participants belonged to the third group. We used the percentage of activities instead of the number of activities because some activities were not applicable for some participants.

We are testing the null hypothesis $H_0 : r_1 = r_2 = r_3$, where r_i is the average ratings for importance, ease and frequency of the 17 diabetes care activities in group *i* One-way multivariate analysis of variance was used to test the hypothesis. The study was comparing three independent samples, where the significance level was set at 5%; that is, a P-value of less than 0.05 was considered to be significant.

A similar method was used for determining if patients in the first group and patients in the second group had differences in their ratings for importance, ease and frequency of diabetes care activities.

2.4 Multivariate Analysis of Covariance

Multivariate analysis of covariance is typically used to compare more than three group means on a certain set of response variables. The purpose is to compare group differences in the means of the response variables. Demographic information and clinical information were used as the explanatory variables, whereas variables measuring diabetes care activities were designated as dependents. The explanatory variables are: age, gender, work hours, diabetes type, diabetes year, the amount of medication they take, knowledge scores, what kind of health care provider they have, and whether the patients have complications. The relationship between dependent variables and independent variables was measured by analysis of covariance.

The statistical model we used was:

$$\underset{[n\times 1]}{Y} = \underset{[n\times(r+1)]}{Z}\;\underset{[(r+1)\times 1]}{\beta} + \underset{[n\times 1]}{\varepsilon}$$

We assumed that $E(\varepsilon) = \underset{[n\times 1]}{0}$, and $Cov(\varepsilon) = \sigma^2 \underset{[n\times n]}{I}$ [21]

When the predictor variables are correlated among themselves, intercorrelation or multicollinearity among them is said to exist. We could use correlation matrices and scatter plot matrices as simple diagnostic tools to estimate multicollinearity. However, a formal method of detecting the presence of multicollinearity is by means of variance inflation factors. These factors measure how much the variances of the estimated regression coefficients are inflated as compared to when the predictor variables are not linearly related. The diagonal element $(VIF)_k$ is equal to:

$$(VIF)_k = (1 - R_k^2)^{-1} \qquad k=1, 2, \ldots, p-1$$

where R_k^2 is the coefficient of multiple determination when X_k is regressed on the *p-2* other X variables in the model. The largest VIF value among all X variables is often used as an indicator of the severity of multicollinearity. A maximum VIF value in excess of 10 is frequently taken as an indication that multicollinearity may be unduly influencing the least squares estimates. Mean VIF values considerably larger than 1 are indicative of serious multicollinearity problems. After calculating all VIF values, our predictor variables show no evidence of serious multicollinearity [20].

2.5 Factor Analysis

The purpose of factor analysis is to describe the covariance relationships among the 17 diabetes care activities in terms of a few underlying, but unobservable random quantities called factors. The factor model is motivated by the following argument. Suppose variables can be grouped by their correlations. That is, all variables within a particular group are highly correlated among themselves but have relatively small correlations with variables in a different group. It is conceivable that each group of variables represents a single underlying construct, or factor, that is responsible for the observed correlations [21].

The primary question in factor analysis is whether or not the data are consistent with a prescribed structure. In our study, the prescribed structure is the 3-category scheme to which the 17 diabetes care activities belong: lifestyle activities, medication-related activities and monitoring activities.

The observable random vector *X*, with *p* components, has mean μ and covariance matrix Σ. The factor model postulates that *X* is linearly dependent upon a few unobservable random variables $F_1, F_2, \ldots, F_m$, called common factors, and p additional sources of variation $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_p$, called errors or, sometimes, specific factors. In particular, the factor analysis model is

$$\underset{[p\times 1]}{X-\mu} = \underset{[p\times m]}{L}\,\underset{[m\times 1]}{F} + \underset{[p\times 1]}{\varepsilon}$$

The matrix L is the matrix of factor loadings. The random vectors *F* and ε satisfy:

F and ε are independent,

E(*F*)=0, Cov(*F*)=I (identity matrix)

E(ε)=0, Cov(ε)=ψ, where ψ is a diagonal matrix

The orthogonal factor model implies a covariance structure for X.

Cov(X)=LL` + ψ

or

$$Var(X_i) = l_{i1}^2 + \cdots + l_{im}^2 + \psi_i$$

$$Cov(X_i, X_k) = l_{i1}l_{k1} + \cdots + l_{im}l_{km}$$

We have m common factors. The portion of the variance of the ith variable contributed by the m common factors is called the ith communality.

If the sample covariance matrix appears to deviate significantly from a diagonal matrix, then a factor model can be entertained and the initial problem is one of estimating the factor loadings l_{ij} and specific variances ψ_i There are two popular methods of parameter estimation, the principal component method and the maximum likelihood method. We consider the principal component method in our study. From this method, the matrix of estimated factor loadings $\{\tilde{l}_{ij}\}$ is given by

$$\tilde{L} = [\sqrt{\hat{\lambda}_1}\hat{e}_1, \ldots\ldots\ldots, \sqrt{\hat{\lambda}_m}\hat{e}_m]$$

Where $(\hat{\lambda}_1, \hat{e}_1)$, $(\hat{\lambda}_2, \hat{e}_2), \ldots, (\hat{\lambda}_m, \hat{e}_m)$ are the eigenvalue-eigenvector pairs of the sample covariance matrix S. From factor loadings, the prescribed structure was found to be appropriate in our case. Based on that finding, the variable values from the same category were added together and new factors were constructed. The new factors were: lifestyle activities, medication-related activities and monitoring activities. MANOVA was applied to see if there were differences among those factors between patients who have and have not incorporated diabetes care activities into their lives and if there were differences among those factors between patients who have complications and who do not have complications. The methodology of regression analysis was used to assess the effects of the demographic and clinical information on these factors [21-22].

2.6 Imputation for missing values

Our data from the Diabetes Patient Priorities Questionnaire contain some missing value. For those subjects with missing data, we tried two approaches: single imputation and multiple imputation.

Single imputation means substituting a value for each missing value. There are some ways to choose this value: mean estimation, hot-deck imputation and regression imputation. We used mean estimation in our study; that is, the mean of non-missing values was used to replace missing data. The shortcoming of this method is that the resulting standard error estimate is underestimated.

Rubin [23] proposes drawing multiple random imputations of the missing data rather than a single best-fit imputation which would convey a false sense of accuracy if the imputed value are interpreted as ordinary observations. Variability of results between the randomly imputed data set can then be used to assess the true accuracy of an estimated parameter. Rubin [24] also shows that the efficiency of an estimate based on m imputations is approximately

$$(1+\frac{\gamma}{m})^{-1}$$

where γ is the rate of missing information for the quantity being estimated.

In this study, the rate of missing information is less than 20%; five imputations would get 95% efficiency. The multiple imputation method we used was to obtain a random sample of known observations and randomly substitute a value for each missing value. The procedure was repeated five times.

After imputation, further group comparisons and regression analyses were performed to determine whether the results were different from previous analyses.

Chapter 3

Results

3.1 Summary

Table 3.1.1 provides descriptive summaries of the demographic characteristics of the cohort, the final sample of patients that were used in the analyses. The statistics are all based on a cohort of 184 patients. There is missing data for most of the variables in the dataset.

Table 3.1.1 shows that 17.1% of the 184 participants have complications and 76.1% of them are taken care of by their family doctors. The ages of the patients are highly skewed to the right from the histogram; the median age is given as 69, with a minimum age of 27 and a maximum age of 85. Because we only have 15 type I diabetes patients (8.2%) compared with 91.6% type II diabetes patients, it would be very difficult to compare those two groups.

Table 31.1 Patient Characteristics

Demographic and Clinical Characteristics

Demographic Characteristics	
Gender:	N= 182
Male	95 (52.2)
Female	87 (46.7)
Age(yr)	N = 182 Median 69.0 (Min 27,Max 85)
Hours worked outside of home(hrs/week)	N=178 Median 0 (Min 0, Max 70)
Clinical Characteristics	
Type of diabetes:	N = 178
Type I	15 (8.2)
Type II	163 (91.6)
Duration of diabetes(yrs)	N=178 Median 8 (Min 1, Max 50)
Total number of medication taken	N= 172 Median 4 (Min 0, Max 23)
Type of diabetes medication:	N = 182
Oral	70.7
Both oral and insulin	9.8
Insulin	10.3
Neither	8.2
Main diabetes health care professional:	N = 183
Family doctor	139 (76.1)
Specailist	20 (10.9)
Nurse	7 (3.8)
Family doctor & nurse	3 (1.6)
Specailist & nurse	1 (0.005)
Family doctor, specialist & nurse	10 (5.4)
Family doctor & specialist	2 (1.1)
Complications as a result of diabetes:	N = 181
Total number of people responding yes	31 (17.1)
Other complications	20 (10.9)
Nerve damage	63 (35)
Kidney disease	35 (19.3)
Heart attack	54 (29.8)
Stroke	19 (10.5)
Blindness	22 (12.2)
Amputations	6 (3.5)

Table 3.1.2 shows how well participants performed on the diabetes knowledge survey. The total scores are also skewed to the right with a median of 17, a minimum of 2 and a maximum of 26. The fifth question about effects of ACE inhibitors Enalapril, or Fosinopril and the tenth question about the recommended total LDL target are the two questions with the lowest scores. Generally, the questions about lifestyle and monitoring were answered better than those questions concerning medication.

Table 3.1.2

Descriptive Statistics for Knowledge Score

Total Number of Participants: 184 Median: 17 Min:2 Max:26

	Correct	Incorrect	Don't know	Missing
1) People can reduce their risk for some complications associated with diabetes by				
Taking prescription medication	176 (95.7)	5(2.7)	2(1.1)	1(0.5)
Lowering HDL(good cholesterol)	60(32.6)	79(42.9)	44(23.9)	1(0.5)
Not smoking	165(89.7)	6(3.3)	12(6.5)	1(0.5)
Reducing blood pressure	157(85.3)	3(1.6)	23(12.5)	1(0.5)
Taking aspirin	94(51.1)	28(15.2)	60(32.6)	1(0.5)
2) Physical exercise will				
Help to lower blood glucose levels	172(93.5)	3(1.6)	8(4.3)	1(0.5)
Help to raise blood glucose levels	155(84.2)	1(0.5)	27(14.7)	1(0.5)
Increase glucose levels in urine	99(53.8)	13(7.1)	71(38.6)	1(0.5)
Have no effect on blood glucose levels	146(79.3)	6(3.3)	31(16.8)	1(0.5)
3) The diabetes diet is				
The way most North American people eat	142(77.2)	15(8.2)	26(14.1)	1(0.5)
A healthy diet for most people	175(95.1)	5(2.7)	3(1.6)	1(0.5)
Too high in carbohydrates for most people	110(59.8)	22(12.0)	51(27.7)	1(0.5)
Too high in protein for most people	108(58.7)	16(8.7)	59(32.1)	1(0.5)
4) Smoking will increase the risk of				
Serious foot problems leading to amputation	79(42.9)	46(25.0)	58(31.5)	1(0.5)
Heart disease	178(96.7)	2(1.1)	3(1.6)	1(0.5)
Stroke	171(92.9)	2(1.1)	10(5.4)	1(0.5)
No effect on the development of complications	129(70.1)	11(6.0)	43(23.4)	1(0.5)

5) ACE inhibitors (i.e. Ramipril (Altace), Enalapril (Vasotec), or Fosinopril (Monopril)) have beneficial effects on				
Progression of kidney disease	51(27.7)	19(10.3)	112(60.9)	2(1.1)
Coronary event rates	78(42.4)	8(4.3)	96(52.2)	2(1.1)
Stroke	67(36.4)	11(6.0)	104(56.5)	2(1.1)
Cancer	42(22.8)	13(7.1)	127(69.0)	2(1.1)
6) Glycosylated hemoglobin (hemoglobin A1C) is a test that measures average blood glucose level for the past hour	101(54.9)	32(17.4)	49(26.6)	2(1.1)
7) A good way to take care of feet is to look and wash them everyday	132(71.7)	47(25.5)	3(1.6)	2(1.1)
8) The recommended blood pressure (systolic/diastolic) target for people with diabetes is 80/130 or below	121(65.8)	46(25.0)	15(8.2)	2(1.1)
9) The recommended total cholesterol for people with diabetes is below 5.2 mmol/L	93(50.5)	28(15.2)	61(33.2)	2(1.1)
10) The recommended total LDL (bad cholesterol) target for people with diabetes is below 2.5 mmol/L	49(26.6)	42(22.8)	91(49.4)	2(1.1)

Results from section 3 of the PPDQ indicate that medication activities are a high priority, and monitoring activities are a fairly high priority. The importance ratings are consistent with the frequency and ease ratings, where taking diabetes medication as prescribed ranked 1nd, taking a blood pressure medication as prescribed ranked 2st, taking ACE inhibitors as prescribed ranked 3rd. Medication use is clearly viewed as a top priority, while monitoring of glucose levels is a fairly high priority compared to other diabetes care activities [Appendix C, part 1].

Seeing a health professional and foot care are low priorities for people with diabetes. This is consistent with the frequency ratings, where seeing a doctor ranked 15th and getting feet checked ranked 14th. Importance ratings also reflect this trend: seeing a doctor ranked 15th and getting feet checked ranked 17th [Appendix D, part 2] Similar findings are evident in the literature. A 1985 study, which compared compliance on taking medication, diet, exercise and food care, showed that people were non-compliant with foot care [25].

These trends in priorities have implications for education. For instance, foot care should be targeted for diabetes education. This activity is an important amputation prevention strategy, yet in this population only 16% report they check their feet, and having feet checked by a health professional ranked 16th in frequency. Low compliance with foot care may be due to a lack of knowledge about the link between foot checking and amputation, which is confirmed by the low scores on Question 7 on the knowledge questionnaire. Taking medication as prescribed and daily monitoring of glucose levels do not seem to be problems for this population, therefore do not to require increased vigilance.

3.2 Group Comparisons

Differences in the importance, ease and frequency between patients who have and patients who do not have complications were compared with MANOVA with the overall alpha level set at 5%. The result of importance of those diabetes activities is shown below using MANOVA Test Criteria and Exact *F* Statistics for the Hypothesis of No Overall Complication Effect. There appears to be no significant difference between those two groups.

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.5126	1.40	17	25	0.2179

Differences in the importance, ease and frequency between patients who had and who had not incorporated diabetes care activities in their lives were compared with MANOVA with the overall alpha level set at 0.05. Patients were divided into three groups (top 33%, middle 25% and bottom 41%) according to how many percent of diabetes care activities they have completed.

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.0140	6.46	30	26	<.0001

The MANOVA table shows that the three groups show differences in most of the monitoring activities such as measuring blood sugar values at home each week, having feet checked every 6 months, getting eyes checked every year, and having blood pressure measured every 3 months.

3.2.1 The Activities showing Difference in the Importance Ratings

	Low Care (N=5)		Medium Care (N=6)		High Care (N=19)	
Diabetes Care Activities	mean	std	mean	std	mean	std
1) Seeing a doctor every 3 months for diabetes	7.4000	3.2094	9.0000	1.2649	9.8420	0.3746
10) Getting a flu shot every year	7.6000	1.6733	7.1667	3.5449	9.7895	0.6306
11) Measuring blood sugar values at home each week	8.6000	1.6733	9.6667	0.5164	9.9473	0.2294
12) Having feet checked every 6 months	4.8000	3.4205	8.1667	3.5449	9.2105	1.5839
13) Getting eyes checked every year	6.4000	3.9115	9.6667	0.5164	10.0000	0.0000
16) Having blood pressure measured every 3 months	5.8000	4.0866	9.6667	0.5164	9.9474	0.2294

We can use the same method to compare ease and frequency of those 17 diabetes care activities. From Wilks'Lambda, we do not reject the hypothesis of no difference between patients with and without complications for ease and frequency of diabetes care activities. The calculation also shows there is significant differences among patients who ranked in top 33%, in bottom 41% and the rest based on the total percentage of activities they completed, that is, patients who completed more than 88.24%, less than 82.35% and rest. For the ease of diabetes care activities, the differences lie in some lifestyle activities such as exercising at least 1.5 hours each week, sticking to a diet that is good for diabetes, keeping an ideal body weight, taking ASA (aspirin) as prescribed, having feet checked every 6 months, and getting eyes checked every year. For the frequency of performing diabetes care activities, the three groups show differences in some activities like exercising at least 1.5 hours each week, taking ASA (aspirin) as prescribed, having feet checked every 6 months, and getting eyes checked every year. The same conclusion could be made if we compare the top 25% and bottom 25% patients [Appendix C, part 3].

3.3 Multivariate Analysis of Covariance

The explanatory variables consist of 9 factors: age (continuous), gender (two levels or categories), work hours (continuous), diabetes type (two levels or categories), diabetes year (continuous), number of medications (categories), health care provider (categories), complication (two levels or categories) and knowledge score (continuous). The response variables are the ratings of diabetes care activities. The analysis is based on an overall alpha level of 5%.

The explanatory variables were tested for interaction and VIF were calculated. The result is shown below.

Table 3.3.1 Variance Inflation Function

Explanatory Variables	Variance Inflation Function
Patient's Age	1. 6942
Gender	1. 1558
Hours worked outside of home	1. 3986
Type of diabetes	1. 3186
Years with diabetes	1. 2362
Total number of medications taken	1. 0780
Main diabetes health care professional	1. 0709
Complications	1. 1907
Knowledge score	1. 3392

There is no strong evidence of multicolinearity. Therefore, we do not need to consider those variables separately. For the first activity of seeing a doctor every 3 months for diabetes, the results of the ANCOVA are shown below considering the nine factors at the same time.

Table 3.3.2 Analysis of variance for analyzing nine factors.

Source of Variation	df	Sums of Sq	Mean Sq	F	P
Patient's Age	1	2. 5178	2. 5178	0. 4000	0. 5342
Gender	1	5. 3706	5. 3706	0. 8500	0. 3661
Hours worked outside of home	1	4. 6995	4. 6995	0. 7400	0. 3974
Type of diabetes	1	0. 4491	0. 4491	0. 0700	0. 7923
Years with diabetes	1	0. 8623	0. 8623	0. 1400	0. 7154
Total number of medications taken	1	1. 1330	1. 1330	0. 1800	0. 6761
Main diabetes health care professional	1	0. 0451	0. 0451	0. 0100	0. 9334
Complications	1	2. 4974	2. 4974	0. 3900	0. 5359
Knowledge score	1	0. 0034	0. 0034	0. 0000	0. 9816

For this single test, there is no significant P value. We also calculated Wilk's Lambda for the explanatory variables. It indicates that work hours and diabetes type is significantly associated with the response variables.

Table 3.3.3 Wilks' Lambda with dependent variables: importance ratings

Hypothesis	Wilks' Lambda	F value	Pr > F
No Overall AGE Effect	0.2942	1.27	0.3684
No Overall GENDER Effect	0.4411	0.67	0.7714
No Overall WORK HOUREffect	0.1701	2.58	0.0749
No Overall DIABETES TYPE Effect	0.1235	3.76	0.0242
No Overall DIABETES YEAR Effect	0.3642	0.92	0.5767
No Overall MEDICATION Effect	0.2205	1.87	0.1701
No Overall CARE PROVIDER Effect	0.7117	0.21	0.9969
No Overall COMPLICATION Effect	0.3499	0.98	0.535
No Overall KNOWLEDGE SCORE Effect	0.3547	0.96	0.5493

The residuals were examined and Q-Q plots show that the residuals are approximately normally distributed.

Using the same technique, age, gender, work hours, diabetes type, years living with diabetes and total medications seem related to the ratings of ease of performing diabetes care activities. The results for the ratings of frequency are similar to the ratings of ease except that there is no significant relation between gender and the ratings of frequency [Appendix C, part 3].

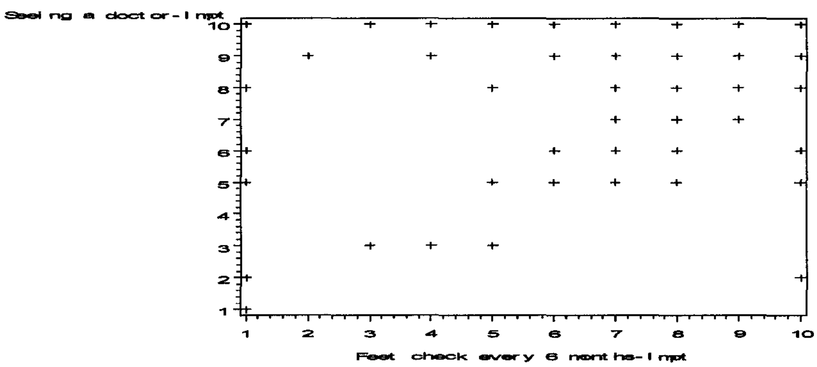
We present the R-square value of the models that demonstrate ease and frequency could be better predicted by the nine factors.

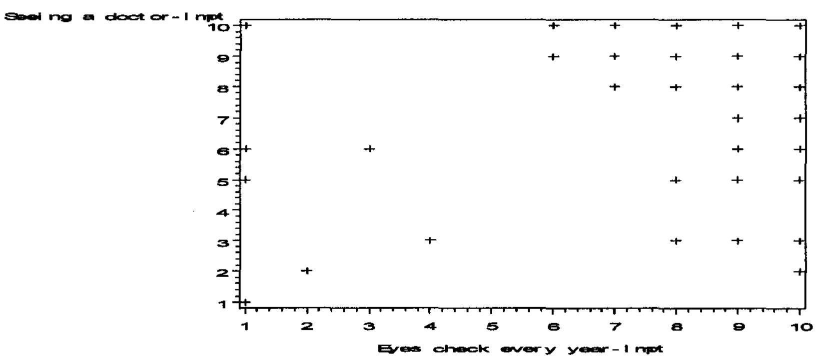
Table 3.3.4 R-square Value for the Multivariate Regression Model

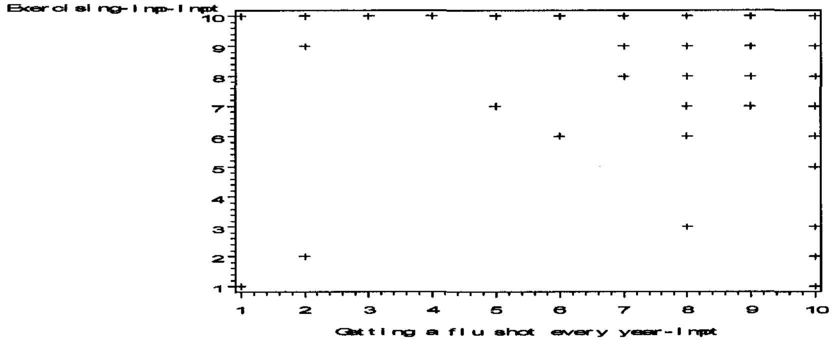
R-square			
Activities	Importance	Ease	Frequency
1. Seeing a doctor every 3 months for diabetes	0.1795	0.2730	0.2524
2. Exercising at least 1.5 hours each week	0.3187	0.3767	0.4053
3. Sticking to a diet that is good for diabetes	0.2252	0.4861	0.2354
4. Not smoking	0.1760	0.1886	0.2077
5. Keeping an ideal body weight	0.3889	0.5137	0.4084
6. Taking diabetes medication as prescribed	0.2260	0.8302	0.5380
7. Taking a blood pressure medication as prescribed	0.1918	0.8302	0.4856
8. Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril and Quinapril)	0.2051	0.4495	0.4161
9. Taking ASA (aspirin) as prescribed	0.2866	0.4063	0.4361
10. Getting a flu shot every year	0.4196	0.5142	0.2439
11. Measuring blood sugar values at home each week	0.2741	0.3889	0.4033
12. Having feet checked every 6 months	0.2824	0.4578	0.429
13. Getting eyes checked every year	0.2793	0.3985	0.3432
14. Having urine checked for protein every year	0.2784	0.2226	0.2589
15. Having cholesterol/lipids measured every year	0.1641	0.1667	0.2061
16. Having blood pressure measured every 3 months	0.2337	0.2374	0.296
17. Having HbA1c levels measured every 6 months	0.1769	0.2722	0.4518

3.4 Factor Analysis

The relationship between two continuous variables can be analyzed using a correlation coefficient or graphically represented using a scatter plot. For instance, the scatter plot for the importance ratings of seeing a doctor and having feet checked every 6 months indicates that the two variables have a positive correlation between them. The same conclusion could be reached if we plot the importance ratings of seeing a doctor against having eyes checked regularly. However, the plot for importance rating of getting a flu shot against exercising does not show any apparent pattern.

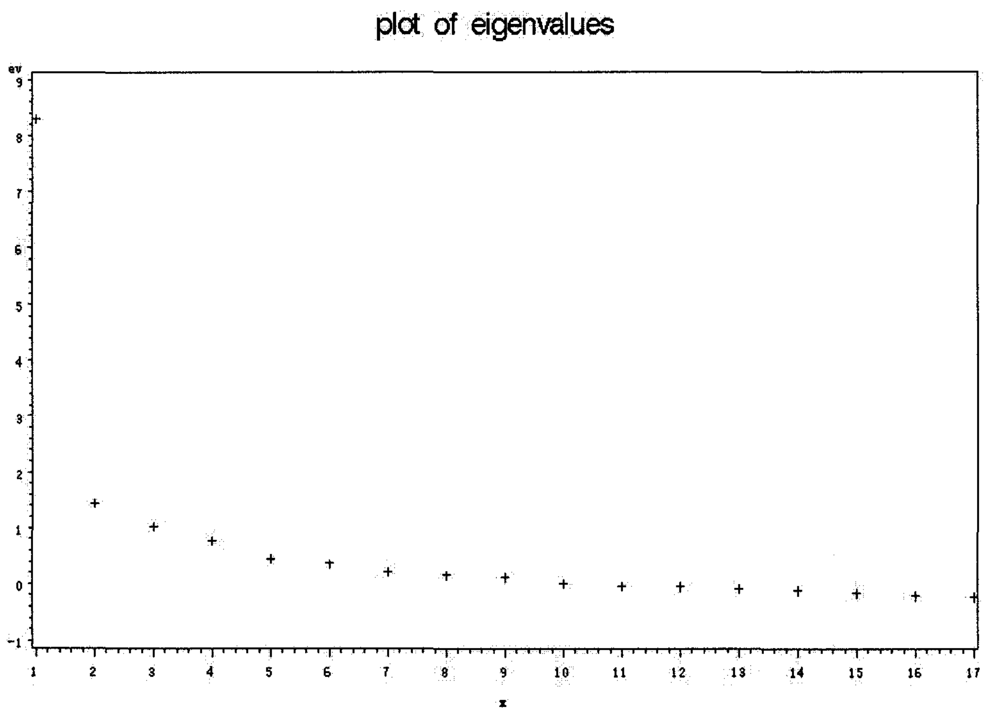






Therefore, we assume that all variables within a particular group are highly correlated among themselves but have relatively small correlations with variables in a different group. In our study, we chose the number of factors to be the number of eigenvalues of the correlation matrix that were greater than 1. From Figure 3.4.1 we found 3 out of 17 eigenvalues greater than 1. Therefore, we decide that the number of underlying random factors should be three.

Figure 3.4.1 Plot of Eigenvalues



Taking p=17 and m=3, principal component solutions to the orthogonal factor model can be easily obtained. Specifically, the estimated factor loadings are the sample principal component coefficients scaled by the square root of the corresponding eigenvalues. The estimated factor loadings, communalities, specific variances, and proportion of total (standardized) sample variance explained by each factor are displayed in Table 3.4.2. It seems fairly clear that the first factor represents monitoring activities and might be called a monitoring factor. All of the monitoring activities rankings load highly on this factor. The second factor represents medication activities and could be called a medication factor. The third factor relates to all the lifestyle activities and might be called a lifestyle factor (Because the loadings are very close for item 14, 15 and 17, we consider that these items belong to factor one).

Table 3.4.2 Rotated Factor Loadings:

Diabetes Care Activities	Factor1	Factor2	Factor3	Community
1) Seeing a doctor every 3 months for diabetes	0.8022	0.3820	0.2808	0.7235
2) Exercising at least 1.5 hours each week	0.0703	0.1313	0.8557	0.2155
3) Sticking to a diet that is good for diabetes	0.0127	0.0749	0.6141	0.6167
4) Not smoking	0.2347	-0.0701	0.7046	0.6044
5) Keeping an ideal body weight	0.0498	-0.0136	0.6710	0.6259
6) Taking diabetes medication as prescribed	-0.2565	0.3454	0.3559	0.8114
7) Taking a blood pressure medication as prescribed	0.2513	0.9297	-0.0264	0.8387
8) Taking an ACE inhibitor medication as prescribed	0.2667	0.8799	-0.1479	0.6495
9) Taking ASA (aspirin) as prescribed	0.2186	0.5321	0.2131	0.1793
10) Getting a flu shot every year	0.4316	0.4655	-0.1346	0.4655
11) Measuring blood sugar values at home each week	0.5125	0.3759	0.3540	0.7190
12) Having feet checked every 6 months	0.8116	0.1404	0.0157	0.7039
13) Getting eyes checked every year	0.8400	0.3189	-0.0784	0.7555
14) Having urine checked for protein every year	0.4888	0.5533	0.3340	0.7461
15) Having cholesterol/lipids measured every year	0.6092	0.6931	0.2171	0.8622
16) Having blood pressure measured every 3 months	0.8950	0.2393	0.1535	0.7964
17) Having HbA1c levels measured every 6 months	0.5337	0.6196	0.1888	0.4334
Cumulative proportion of total sample variance explained	0.4877	0.5720	0.6322	

For each factor, take the largest loadings as equal in magnitude and neglect the smaller loadings. Thus we create the linear combinations.

$$\hat{f}_1 = x_1 + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16} + x_{17}$$

$$\hat{f}_2 = x_7 + x_8 + x_9 + x_{10}$$

$$\hat{f}_3 = x_2 + x_3 + x_4 + x_5 + x_6$$

Plots of factor scores have been examined prior to using these scores in other analyses. Plots show some extent of nonnormality.

We wondered if there were differences between people with and without complications in those three factors. Therefore, MANOVA was used to test the hypothesis of no overall complication effect. From Wilk's Lambda Statistic, we conclude there is no significant difference between two group.

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.8808	1.76	3	39	0.1709

The exact same test could be used to test the null hypothesis that there is no overall total activities effect in the importance between patients who had and had not incorporated diabetes care activities in their lives. Patients were divided into three groups according to what percentage of diabetes care activities they have completed as described in Chapter 2. The results show significant differences among those three groups. Table 3.4.3 shows where the differences are hiding. It seems medication factors and monitoring factors have significant differences.

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.3667	5.43	6	50	0.0002

Table 3.4.3 Group Comparison for the importance of three factors

Factors	F	P-value
Lifestyle	1.22	0.31
Medication	4.53	0.02
Monitoring	12.56	0.00

Analysis of covariance also could be used to reveal the relationship between those factors and patients' clinical and demographic information. The explanatory variables include 9 factors: age (continuous), gender (two levels or categories), work hours (continuous), diabetes type (two levels or categories), diabetes year (continuous), number of medications (categories), health care provider (categories), complication (two levels or categories) and knowledge score (continuous). The response variables are the ratings of diabetes care activities. The analysis is based on an overall alpha level of 0.10. The model does not fit very well, but we find the knowledge score seems to have a strong effect on those factors.

Hypothesis	F value	Pr > F
No Overall AGE Effect	1.65	0.20
No Overall GENDER Effect	0.91	0.45
No Overall WORKHRS Effect	0.48	0.70
No Overall TYPE Effect	0.15	0.93
No Overall DIA_YRS Effect	0.05	0.99
No Overall MED_ Effect	0.31	0.82
No Overall PROVIDER Effect	0.07	0.97
No Overall COMPL Effect	0.38	0.77
No Overall k Effect	3.95	0.02

The same technique could be applied to analyze the ratings for ease and frequency of diabetes care activities. We still focused on the same factors: monitoring, medication and lifestyle. For both of the ratings of ease and frequency, MANOVA shows there is no significant difference between patients with and without complications in factors scores.

However, there are significant differences between patients who had and had not incorporated diabetes care activities in their lives. For the ratings of ease of diabetes care activities, the lifestyle factor shows a significant difference while for the ratings of frequency of diabetes care activities, both lifestyle and medication show significant difference.

3.5 Mean Imputation and Multiple Imputation

The results from mean imputation and multiple imputations are consistent. We compared the groups with and without complication for the ratings of importance of diabetes care activities; all imputations indicate there are no significant differences between these two groups. Table 3.5.1 shows the results.

Table 3.5.1 Group Comparison: mean imputation and multiple imputation

	Mean Imputation	Multiple Imputation
Wilks' Lambda	0.6918	0.7237
P value	0.1661	0.3249

Table 3.5.2 shows the results for importance ratings of three group comparisons among patients who ranked in the top 33%, the bottom 41% and the rest, based on the total percentage of activities they completed.

Table 3.5.2 Group Comparison for Importance Ratings

	Mean Imputation	Multiple Imputation
Wilks' Lambda	0.0377	0.0526
P value	0.0004	0.0013

When we tried to find where the differences reside, the answers are similar. For mean imputation, when we use 0.05 as the significant level, there are differences in seeing a doctor, taking an ACE inhibitor medication, having feet checked every 6 months, getting eyes checked every year, having cholesterol/lipids measured every year, having blood pressure measured every 3 months (Table 3.5.5). For multiple imputation, the five imputations lead to the same conclusion. There are differences in the same activities. The results of mean imputation and multiple imputation are consistent with the original result without imputation.

Table 3.5.5 Difference in Importance Ratings of Diabetes Care Activities

Diabetes Care Activities	Group 1 (N=6)		Group 2 (N=7)		Group 3 (N=19)	
	mean	std	mean	std	mean	std
1) Seeing a doctor every 3 months for diabetes	7.1667	2.9269	8.5714	1.6183	9.8421	0.3746
10) Getting a flu shot every year	7.5000	1.5166	8.0000	3.2659	9.7895	0.6306
11) Measuring blood sugar values at home each week	8.8333	1.6021	9.7143	0.4880	9.9473	0.2294
12) Having feet checked every 6 months	5.6667	3.7238	7.8571	3.3381	9.2105	1.5839
13) Getting eyes checked every year	7.0000	3.7947	8.7143	2.5635	10	0
16) Having blood pressure measured every 3 months	6.5000	4.0373	9.7143	0.4880	9.9474	0.2294

Chapter Four

Discussion

Comments from health care professionals and people with diabetes indicated that PPDQ covered key diabetes care activities. One area that caused confusion was the open-ended question about prioritization. Only a small number of respondents actually addressed the aim of the question (7%). The vast majority of people merely listed activities they participate in caring for diabetes (41%). This may be because people did not prioritize, did not understand the question, did not answer the question because it required too much effort, or perhaps were not consciously aware of what influenced their priorities, so they were unable to describe them.

A significant percentage of people responded “not applicable” to inquires about the importance, ease and frequency of taking ASA (22.3%) and the importance of taking an ACE inhibitor (41.3%). Those patients did not need to take those medications, so they could not rank them (Appendix C).

Our study shows that the presence and absence of complications does not change a patient’s priorities. However, previous studies elucidated this factor may drive people to prioritize certain activities over others. For one participant, fear of fainting from low blood sugar levels, which had previously caused a fall and back injury, led her to describe monitoring blood glucose levels as her top priority. The influence of a bad experience on patient priorities is also evident in a 1997 study aimed at eliciting the difference in the views of people who responded and who did not respond to diabetes interventions. This study found that the experience of complications associated with diabetes prompted people to take diabetes care more serious. This apparent inconsistency may be due to our sample selection. All participants, with the exception of the ones involved in the face validity section, were patients affiliated with COMPETE II; and the Access to Diabetes Medication Study (GSK) who gave permission to be contacted for other studies. A total of 450 people were approached and only 184 agreed to participant in the study, which means those people may pay more attention to their health issues, and therefore may be prone to have the same priorities. Future studies should focus on a random sample and examine if clinical recommendations that align with a patient's experience with complications and non-diabetes activities increase compliance and improve clinical outcomes.

Normally, there are three assumptions underlying a multivariate analysis of variance. The first one is that the dependent variables are multivariately normally distributed for each population. This means (a) that the individual dependent variables must be normally distributed, (b) any linear combination of the dependent variables must also be normally distributed, (c) all subsets of the variables must have a multivariate normal distribution.

It is difficult to check multivariate normal distribution. However, there is evidence that shows that the individual dependent variables, in our case the ratings of importance, ease and frequency, are not normally distributed. Fortunately, the MANOVA appears to be fairly robust in terms of Type I error rate [27]. The second assumption is that the population variances and covariances among the dependent variables are the same across all levels of the factor. So, not only must the variances for all the dependent variables be equal, but the covariance must be equal as well. Our dependent variables are roughly equal while the covariance matrices do not have the property of homogeneity. Some previous studies also show MANOVA is robust if the second assumption is violated. The third assumption, the "independence of observations" assumption, has little room for violation. In our study, the score on a variable for any one participant is independent from the scores of this variable for all other participants. Therefore, MANOVA could be conducted.

The most difficult part of performing and interpreting a MANOVA is determining what to do if a significant multivariate effect has been obtained. For example, what is the next step when we found a difference between people who took care of themselves well and people who did not? We use the most popular way of proceeding, that is, to perform univariate ANOVAs for each of the dependent variables, provided that we control for Type I error across these multiple tests. If we have no clue as to which linear combinations of dependent variables to evaluate, we may choose to conduct follow-up analyses using discriminative analysis. This analysis maximizes the separation between groups on some categorical variable by finding the optimal linear combination of several continuous variables. It yields one or more uncorrelated linear combinations of dependent variables that maximize differences among the groups.

Factor analysis has a tremendous intuitive appeal for behavioral research. It is natural to regard multivariate observations on human process as manifestations of underlying unobservable "traits". Factor analysis provides a way of explaining the observed variability in behavior in terms of these traits. Unfortunately, the criterion for judging the quality of any factor analysis has not been well quantified. Our study consists of situations where the factor analysis model provides reasonable explanations in terms of a few interpretable factors for the ratings of importance. However, the factor analyses do not yield such clear-cut results for the ratings of ease and frequency. We applied the results of importance ratings to ease and frequency ratings taking clinical significance into account. It seems the application is successful because of the consistency of the study.

There are also some potential problems in our factor analysis. First, in an ideal situation, the sample should be split in half. Factor analysis could be performed on one half and the results can then be validated with the other half. In our case, the data set is limited because of a large portion of missing values. Therefore, the stability of the conclusions is susceptible because correlation coefficients tend to be unstable and greatly influenced by the presence of outliers if the sample size is not large. Second, although multivariate normality is often assumed for the variables in a factor analysis, it is very difficult to justify the assumption for a large number of variables. Also a plot of factor scores showed nonnormality to some extent. Some researches has found that, unless the distributions of the variables are strongly nonnormal, factor analysis seems to be robust to minor violations of the multivariate normality assumption.

One of the main problems with the single stochastic imputation methods is the need for developing appropriate variance formulae for each setting. Multiple imputation attempts to provide a procedure that can get the appropriate measures of precision relatively simply in (almost) any setting. Multiple imputation provides a useful strategy for dealing with data sets with missing values. In our study, we used both mean imputation and multiple imputation methods. The outcomes did not show much difference. Besides, we also found the numeric results from each multiple imputation are fairly similar. It may be due to our rating scheme (0-10) and the distributions of those scores are skewed with a median of 9 or 10, which cause the random samples from known data similar with each other.

The study was able to identify low and high priorities, which were supported by findings in previous studies. However there were several limitations, which should be addressed in future studies:

1. The patients who participated tended to be seniors, retired, and the vast majority had type II diabetes. This reduces the generalizability of results to younger segments of the population and those with type I diabetes. This may also be the reason of not being able to identify the difference between people with and without complications. In future studies, efforts should be made to select a random sample to improve generalizability.

2. The distributions are skewed in the ratings of importance, ease and frequency. As a result, the 1st and 17th place in the ease and frequency differ by mean score of about 2.5, which means the order of ranks may have been easily different. Further studies using a scale that pulls 'average' from the middle may help to reduce this bias. In other words replace the Likert scale descriptor "not very important," "neutral" and "very important" with "below average importance," "average importance," and "above average importance." This would help to magnify the difference in ratings for the 17 diabetes care activities.

3. There are 17 questions to test the ratings of importance, ease and frequency. A significant percentage of people responded "not applicable" to inquires about the

importance, ease and frequency of taking ASA (22.3%) and the importance of taking an ACE inhibitor (41.3%), which makes it difficult to do multivariate analysis because observations decreased significantly. In future study, the questions could be phrased more generally to reduce the number of "not applicable" answers.

Chapter 5

Conclusion

Multivariate techniques are used when more than one measurement is taken on a given experimental unit and all and all the measurements need to be considered together so that people could understand how they are related and reveal the potential structure.

In our research project, one-way MANOVA helps us investigate whether the population mean vectors are the same and, if not, which mean components differ significantly. The main findings from one-way MANOVA were patient priorities were different for people who take care of themselves in different ways while patient priorities had no significant difference for patents with complications and patients without complications. Multivariate analysis of covariance is the technique we applied to reveal the relationship between the ratings of importance, ease, and frequency of seventeen diabetes care activities and the patient's demographic and clinical information. The analysis of covariance table did not show significant predictors. However, the Wilk's Lamda test statistics indicated that work hours and diabetes type was significantly associated with the importance ratings; Age, gender, work hours, diabetes type, years living with diabetes and total medication number seemed related to the ease ratings; Age, work hours, diabetes type, years living with diabetes and total medication number was related to the frequency ratings.

Factor analysis confirmed that the seventeen diabetes care activities could be grouped into three categories according their covariance relationships. Based on the findings, we analyzed the three factors: lifestyle, medication, and monitoring factors. Further analyses were performed using MANOVA to reveal if the ratings for diabetes care activities were significantly different for different groups. The results were consistence with the previous analyses: there was significant difference between patients who took care of themselves in different ways while no significant difference between patients with complication and patients without complication.

Sensitivity analyses using mean and multiple imputation methods revealed that the results were robust to methods of imputation.

Chapter Six

Appendix

Appendix A: Patient Priorities in Diabetes Questionnaire

Date Completed: ________________

<u>PATIENT PRIORITIES IN DIABETES SURVEY</u>

The goal of this questionnaire is to help health care professionals better understand patient priorities for living with diabetes.

The questionnaire is divided into three main sections. The first is a general knowledge survey, followed by a section where you will be asked to describe and rate the activities you do to manage your diabetes.

Finally, you will be asked to provide some background information, such as your age and disease history.

You will receive a telephone call from our study centre. The caller will go through each question with you and record your answer. Alternatively, you can complete the survey on your own and mail it back to us in the envelope provided. All of your answers will be kept confidential.

I. Diabetes Knowledge Survey

	True	False	Don't know
1) People can reduce their risk for some complications associated with diabetes by			
▪ Taking prescription medication	O	O	O
▪ Lowering HDL (good cholesterol)	O	O	O
▪ Not smoking	O	O	O
▪ Reducing blood pressure	O	O	O
▪ Taking aspirin	O	O	O
2) Physical exercise will			
▪ Help to lower blood glucose levels	O	O	O
▪ Help to raise blood glucose levels	O	O	O
▪ Increase glucose levels in urine	O	O	O
▪ Have no effect on blood glucose levels	O	O	O
3) The diabetes diet is			
▪ The way most North American people eat	O	O	O
▪ A healthy diet for most people	O	O	O
▪ Too high in carbohydrates for most people	O	O	O
▪ Too high in protein for most people	O	O	O
4) Smoking will increase the risk of			
▪ Serious foot problems leading to amputation	O	O	O
▪ Heart disease	O	O	O
▪ Stroke	O	O	O
▪ Have no effect on the development of diabetes-related complications	O	O	O

5) ACE inhibitors (i.e. Ramipril (Altace), Enalapril (Vasotec), or Fosinopril (Monopril)) have beneficial effects on ▪ Progression of kidney disease ▪ Coronary event rates ▪ Stroke ▪ Cancer	True O O O O	False O O O O	Do n't Kn ow O O O O
6) Glycosylated hemoglobin (hemoglobin A1C) is a test that measures average blood glucose level for the past ▪ Hour ▪ Day ▪ Week ▪ Three months	Circle one answer a) b) c) d)		Do n't Kn ow O
7) A good way to take care of feet is to a) Look at and wash them everyday b) Massage them with alcohol each day c) Soak them for one hour each day d) Buy shoes a size larger than usual	Circle one answer a) b) c) d)		Do n't Kn ow O
8) The recommended blood pressure (systolic/diastolic) target for people with diabetes is a) 80/130 or below b) 130/80 or below c) 140/90 or below	Circle one answer a) b) c)		Do n't Kn ow O
9) The recommended total cholesterol for people with diabetes is a) Below 5.2 mmol/L b) Below 8 mmol/L c) Below 10 mmol/L	Circle one answer a) b) c)		Do n't Kn ow O

10) **The recommended total LDL (bad cholesterol) target for people with diabetes is** a) Below 1 mmol/L b) Below 2.5 mmol/L c) Below 3 mmol/L	Circle one answer a) b) c)	Don't Know O

II. Your activities to manage your diabetes - General:

A. Please describe things you do to look after yourself as a person with diabetes.

B. Given all the things that you are told to do for your diabetes, how do you decide where you spend your energy and time. Think about how you prioritize your time; how do you decide what you will do first?

Your activities to manage your diabetes – Specific:
Please indicate (circle yes or no) the activities that you have actively participated in this past year. Some activities may not apply to you. If this is the case, circle N/A for this activity.

Lifestyle Activity	**Task Completed**			**I am not sure (please check box)**
1) Seeing a doctor every 3 months for diabetes	**Yes**	**No**		
2) Exercising at least 1.5 hours each week	**Yes**	**No**		
3) Sticking to a diet that is good for diabetes	**Yes**	**No**		
4) Not smoking	**Yes**	**No**		
5) Keeping an ideal body weight	**Yes**	**No**		
Medication-Related Activity				
6) Taking diabetes medication as prescribed	**Yes**	**No**	**N/A**	
7) Taking a blood pressure medication as prescribed	**Yes**	**No**	**N/A**	
8) Taking an ACE inhibitor medication as prescribed (e.g., Enalapril, Lisinopril and Quinapril)	**Yes**	**No**	**N/A**	
9) Taking ASA (aspirin) as prescribed	**Yes**	**No**	**N/A**	
10) Getting a flu shot every year	**Yes**	**No**		
Monitoring Activity				
11) Measuring blood sugar values at home each week	**Yes**	**No**		
12) Having feet checked every 6 months	**Yes**	**No**		
13) Getting eyes checked every year	**Yes**	**No**		
14) Having urine checked for protein every year	**Yes**	**No**		
15) Having cholesterol/lipids measured every year	**Yes**	**No**		
16) Having blood pressure measured every 3 months	**Yes**	**No**		
17) Having HbA1c levels measured by blood test every 6 months	**Yes**	**No**		

Rating of Diabetes Care Activities: Importance

Instructions: Please circle the number that best represents your choice for HOW IMPORTANT you consider each of the diabetes care activities noted below. If you feel that an activity is not relevant for you, place a checkmark in the final column.

Note: 1 = Not Very Important, 10 = Very Important

Activity	Not Very				Neutral					Very	Does not Apply to
1. Seeing a doctor every 3 months for diabetes	1	2	3	4	5	6	7	8	9	10	
2. Exercising at least 1.5 hours each week	1	2	3	4	5	6	7	8	9	10	
3. Sticking to a diet that is good for diabetes	1	2	3	4	5	6	7	8	9	10	
4. Not smoking	1	2	3	4	5	6	7	8	9	10	
5. Keeping an ideal body weight	1	2	3	4	5	6	7	8	9	10	
6. Taking diabetes medication as prescribed	1	2	3	4	5	6	7	8	9	10	
7. Taking a blood pressure medication as prescribed	1	2	3	4	5	6	7	8	9	10	
8. Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril and Quinapril)	1	2	3	4	5	6	7	8	9	10	
9. Taking ASA (aspirin) as prescribed	1	2	3	4	5	6	7	8	9	10	
10. Getting a flu shot every year	1	2	3	4	5	6	7	8	9	10	
11. Measuring blood sugar values at home each week	1	2	3	4	5	6	7	8	9	10	
12. Having feet checked every 6 months	1	2	3	4	5	6	7	8	9	10	
13. Getting eyes checked every year	1	2	3	4	5	6	7	8	9	10	
14. Having urine checked for protein every year	1	2	3	4	5	6	7	8	9	10	
15. Having cholesterol/lipids measured every year	1	2	3	4	5	6	7	8	9	10	
16. Having blood pressure measured every 3 months	1	2	3	4	5	6	7	8	9	10	
17. Having HbA1c levels measured by blood test every 6 months	1	2	3	4	5	6	7	8	9	10	

Rating of Diabetes Care Activities: Ease

Instructions: Please circle the number that best represents your choice for **HOW EASY** you consider each of the diabetes care activities noted below. If you feel that an activity is not relevant for you, place a checkmark in the final column.

Note: 1 = Not Very Easy, 10 = Very Easy

Activity	Not Very Neutral Very	Does not Apply to
1. Seeing a doctor every 3 months for diabetes	1 2 3 4 5 6 7 8 9 10	
2. Exercising at least 1.5 hours each week	1 2 3 4 5 6 7 8 9 10	
3. Sticking to a diet that is good for diabetes	1 2 3 4 5 6 7 8 9 10	
4. Not smoking	1 2 3 4 5 6 7 8 9 10	
5. Keeping an ideal body weight	1 2 3 4 5 6 7 8 9 10	
6. Taking diabetes medication as prescribed	1 2 3 4 5 6 7 8 9 10	
7. Taking a blood pressure medication as prescribed	1 2 3 4 5 6 7 8 9 10	
8. Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril & Quinapril)	1 2 3 4 5 6 7 8 9 10	
9. Taking ASA (aspirin) as prescribed	1 2 3 4 5 6 7 8 9 10	
10. Getting a flu shot every year	1 2 3 4 5 6 7 8 9 10	
11. Measuring blood sugar values at home each week	1 2 3 4 5 6 7 8 9 10	
12. Having feet checked every 6 months	1 2 3 4 5 6 7 8 9 10	
13. Getting eyes checked every year	1 2 3 4 5 6 7 8 9 10	
14. Having urine checked for protein every year	1 2 3 4 5 6 7 8 9 10	
15. Having cholesterol/lipids measured every year	1 2 3 4 5 6 7 8 9 10	
16. Having blood pressure measured every 3 months	1 2 3 4 5 6 7 8 9 10	
17. Having HbA1c levels measured by blood test every 6 months	1 2 3 4 5 6 7 8 9 10	

Rating of Diabetes Care Activities: Frequency

Instructions: Please circle the number that best represents your choice for **HOW OFTEN** you complete each of the diabetes care activities noted below. If you feel that an activity is not relevant for you, place a checkmark in the final column.

Note: 1 = Not Very Often, 10 = Very Often

Activity	Not Very				Neutral					Very	Does not Apply to
1☐ **Seeing a doctor every 3 months for diabetes**	1	2	3	4	5	6	7	8	9	10	
2☐ **Exercising at least 1.5 hours each week**	1	2	3	4	5	6	7	8	9	10	
3☐ **Sticking to a diet that is good for diabetes**	1	2	3	4	5	6	7	8	9	10	
4☐ **Not smoking**	1	2	3	4	5	6	7	8	9	10	
5☐ **Keeping an ideal body weight**	1	2	3	4	5	6	7	8	9	10	
6☐ **Taking diabetes medication as prescribed**	1	2	3	4	5	6	7	8	9	10	
7☐ **Taking an blood pressure medication as prescribed**	1	2	3	4	5	6	7	8	9	10	
8☐ **Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril & Quinapril)**	1	2	3	4	5	6	7	8	9	10	
9☐ **Taking ASA (aspirin) as prescribed**	1	2	3	4	5	6	7	8	9	10	
10☐ **Getting a flu shot every year**	1	2	3	4	5	6	7	8	9	10	
11☐ **Measuring blood sugar values at home each week**	1	2	3	4	5	6	7	8	9	10	
12☐ **Having feet checked every 6 months**	1	2	3	4	5	6	7	8	9	10	
13☐ **Getting eyes checked every year**	1	2	3	4	5	6	7	8	9	10	
14☐ **Having urine checked for protein every year**	1	2	3	4	5	6	7	8	9	10	
15☐ **Having cholesterol/lipids measured every year**	1	2	3	4	5	6	7	8	9	10	
16☐ **Having blood pressure measured every 3 months**	1	2	3	4	5	6	7	8	9	10	
17☐ **Having HbA1c levels measured by blood test every 6 months**	1	2	3	4	5	6	7	8	9	10	

III. Demographics Information/Disease history

1. Date of Birth: ________________

2. Gender: _______________

3. Ethnicity: ___________________

4. Number of hours you work outside your home each week: ___________

5. Type of diabetes: (circle) type I type II

6. How long have you been diagnosed with diabetes?: ________________

7. Medications taken for diabetes: (circle) oral insulin neither

8. Total number of medications taken: ________________________

9. Who is the main person who looks after your diabetes?: (circle)

   family doctor specialist nurse

10. Complications as a result of diabetes: (check all that apply)

    A) None______ B) See List Below:

    __Heart Attack
    __Stroke
    __Nerve Damage
    __Blindness
    __Amputations
    __Kidney Disease
    __Other: (describe) ________________________

Appendix B: Diabetes Knowledge Survey Scoring Key

(maxium score=25)

1) People can reduce their risk for some complications associated with diabetes by (5 marks)
- T-Taking prescription medication
- F-Lowering HDL
- T-Not smoking
- T-Reducing blood pressure
- T-Taking aspirin

2) Physical exercise will (3 marks)
- T- Help to lower my blood glucose levels
- F- Help to raise my blood glucose levels
- F-Increase my glucose levels in urine
- F-Have no effect on blood glucose levels

3) The diabetes diet is (4 marks)
- F-The way most North American people eat
- T-A healthy diet for most people
- F-Too high in carbohydrates for most people
- F-Too high in protein for most people

4) Smoking will increase my risk for (4 marks)
- T-Serious foot problems leading to amputation
- T- Heart disease
- T-A stroke
- F-have no effect on development of diabetes-related complications

5) ACE inhibitors (i.e. Enalapril, Lisinopril and Quinapril) have beneficial effects on (4 marks)
- T-Progression of renal disease
- T-Coronary event rates
- T-Stroke
- F-Cancer

6) Glycosylated hemoglobin (hemoglobin A1C) is a test that measures my average blood glucose level for the past
(1 mark)
- Hour
- Day
- Weeks
- Three months (correct)

7) The best way to take care of my feet is to (1 mark)
- Look at and wash them everyday (correct)
- Massage them with alcohol each day
- Soak them for one hour each day
- Buy shoes a size larger than usual

8) The recommended blood pressure (systolic/diastolic) target for people with diabetes is
(1 mark)
- 80/130 or below
- 130/80 or below (correct)
- 140/90 or below

9) The recommended total cholesterol for people with diabetes is
(1 mark)
- Below 5.2 mmol/L (correct)
- Below 8 mmol/L
- Below 10 mmol/L

10) The recommended total LDL (bad cholesterol) target for people with diabetes is (1 mark)
- Below 2 mmol/L
- Below 2.5 mmol/L (correct)
- Below 3 mmol/L

Appendix C : Output

Part 1

Table 7.1. Distribution of "Not applicable" and "I'm not sure" responses in the section of rating the importance of diabetes care activities

Diabetes Care Activity	Not applicable and I'm not sure (%)	Not applicable (%)	I'm not sure (%)
Lifestyle Activity			
Seeing a doctor	2.1	1.6	0.5
Exercising	2.1	1.6	0.5
Sticking to a diet good for diabetes	0.5	0.5	0
Not smoking	13	12.5	0.5
Keeping an ideal body weight	1.1	0	1.1
Medication Activity			
Taking diabetes medication as prescribed	8.2	8.2	0
Taking an blood pressure medication as prescribed	23.4	21.2	2.2
Taking an ACE inhibitor medication as prescribed	53.8	41.3	12.5
Taking ASA (aspirin) as prescribed	25	22.3	2.7
Getting a flu shot every year	1.6	1.6	0
Monitoring Activity			
Measuring blood sugar values	2.7	1.6	1.1
Feet check every 6 months	5.4	4.3	1.1
Eyes check every year	1	0.5	0.5
Taking an blood pressure medication as prescribed	5.5	2.2	3.3
Cholesterol/lipids measured every year	3.8	0	3.8
Blood pressure measured every 3 months	2.2	1.1	1.1
HbA1c levels measured every 6 months	23.9	4.3	19.6

Table 7.2.1 Descriptive Statistics for Importance

Activities	N	Minimum	Maximum	Mean	Std. Deviation	Rank of mean
Taking diabetes medication as prescribed-Impt	169	1	10	9.73	1.383	1
Taking an blood pressure medication as prescribed-Impt	141	1	10	9.45	1.846	2

Taking an ACE inhibitor medication as prescribed-Impt	85	1	10	9.38	1.779	3
HbA1c levels measured every 6 months-Impt	140	1	10	9.39	1.616	4
Not smoking-Impt	160	1	10	9.32	2.082	5
Eyes check every year-Impt	182	1	10	9.24	2.018	6
Cholesterol/lipids measured every year-Impt	177	1	10	9.22	1.878	7
Measuring blood sugar values-Impt	179	1	10	9.21	1.844	8
Blood pressure measured every 3 months-Impt	180	1	10	9.04	2.031	9
Sticking to a diet good for diabetes-Impt	183	1	10	9.03	1.907	10
Exercising-Imp-Impt	180	1	10	8.98	1.987	11
Keeping an ideal body weight-Impt	182	1	10	8.97	1.871	12
Taking an blood pressure medication as prescribed-Impt	174	1	10	8.94	2.142	13
Taking ASA (aspirin) as prescribed-Impt	138	1	10	8.92	2.185	14
Seeing a doctor-Impt	181	1	10	8.82	2.137	15
Getting a flu shot every year-Impt	181	1	10	8.69	2.581	16
Feet check every 6 months-Impt	174	1	10	8.1	2.818	17

Table 7.2.2 Descriptive Statistics for Ease

Activities	N	Minimum	Maximum	Mean	Std. Deviation	Rank of mean
Taking diabetes medication as prescribed-Ease	165	1	10	9.64	1.335	1
Taking an blood pressure medication as prescribed-Ease	137	1	10	9.62	1.394	2
Taking an ACE inhibitor medication as prescribed-Ease	80	2	10	9.57	1.29	3
Cholesterol/lipids measured every year-Ease	171	1	10	9.47	1.535	4
HbA1c levels measured every 6 months-Ease	138	1	10	9.33	1.662	5
Getting a flu shot every year-Ease	173	1	10	9.29	1.971	6
Eyes check every year-Ease	178	1	10	9.28	1.892	7
Taking ASA (aspirin) as prescribed-Ease	129	1	10	9.3	1.939	8
Not smoking-Ease	149	1	10	9.27	2.303	9
Measuring blood sugar values-Ease	179	1	10	9.26	1.937	10
Urine check for protein every year-Ease	170	1	10	9.21	1.852	11
Blood pressure measured every 3 months-Ease	175	1	10	9.15	2.049	12
Seeing a doctor-Ease	179	1	10	8.87	2.217	13
Feet check every 6 months-Ease	165	1	10	8.36	2.646	14
Exercising-Ease	181	1	10	7.86	2.899	15
Sticking to a diet good for diabetes-Ease	182	1	10	7.64	2.551	16
Keeping an ideal body weight-Ease	176	1	10	6.8	3.175	17

Table 7.2.3 Descriptive Statistics for Frequency

Activities	N	Minimum	Maximum	Mean	Std. Deviation	Rank of mean
Taking an blood pressure medication as prescribed-Freq	141	1	10	9.82	0.864	1
Taking diabetes medication as prescribed-Freq	166	1	10	9.76	1.15	2
Taking an ACE inhibitor medication as prescribed-Freq	81	6	10	9.74	0.738	3
Eyes check every year-Freq	177	1	10	9.37	1.786	4
Cholesterol/lipids measured every year-Freq	173	1	10	9.33	1.824	5
Taking ASA (aspirin) as prescribed-Freq	131	1	10	9.27	2.101	6
Not smoking-Freq	139	1	10	9.24	2.296	7
HbA1c levels measured every 6 months-Freq	142	1	10	9.23	1.748	8
Measuring blood sugar values-Freq	178	1	10	9.16	2.011	9
Blood pressure measured every 3 months-Freq	176	1	10	9.15	1.997	10
Getting a flu shot every year -Freq	173	1	10	9.06	2.414	11
Urine check for protein every year-Freq	170	1	10	8.94	2.289	12
Seeing a doctor-Freq	179	1	10	8.77	2.322	13
Sticking to a diet good for diabetes-Freq	182	1	10	8.19	2.187	14
Exercising-Freq	179	1	10	8.08	2.812	15
Feet check every 6 months-Freq	166	1	10	7.86	3.252	16
Keeping an ideal body weight-Freq	177	1	10	7.32	2.892	17

Part 2 Multivariate Analysis of Variance (Covariance)

Importance of Diabetes Care Activities:

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall Complication Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.5126	1.40	17	25	0.2179

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Difference among Patients who ranked in top 25%, patients in bottom 25% and rest. (ranks are based on the total percentage of activities they completed) (three groups)

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0	infty	30	26	<.0001

Importance of Activities	F Value	Pr>F
1. Seeing a doctor every 3 months for diabetes	7.55	0.0025
2. Exercising at least 1.5 hours each week	1.59	0.2221
3. Sticking to a diet that is good for diabetes	0.58	0.5675
4. Not smoking	0.35	0.7088

5. Keeping an ideal body weight	2.36	0.1132
6. Taking diabetes medication as prescribed	2.88	0.0735
7. Taking a blood pressure medication as prescribed	2.88	0.0735
8. Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril and Quinapril)	2.88	0.0735
9. Taking ASA (aspirin) as prescribed	0.82	0.4505
10. Getting a flu shot every year	2.13	0.1381
11. Measuring blood sugar values at home each week	3.05	0.0639
12. Having feet checked every 6 months	7.48	0.0026
13. Getting eyes checked every year	26.86	<0.0001
14. Having urine checked for protein every year	2.21	0.1297
15. Having cholesterol/lipids measured every year	4.43	0.0217
16. Having blood pressure measured every 3 months	17.25	<0.0001
17. Having HbA1c levels measured by blood test every 6 months	2.07	0.1459

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Difference between Patients who ranked in top 25% and patients in bottom 25% for the total percentage of activities they completed (two groups)

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0	Infty	6	9	<.0001

Importance of Activities	F Value	Pr>F
1. Seeing a doctor every 3 months for diabetes	342.25	<.0001
2. Exercising at least 1.5 hours each week	0.06	0.8062
3. Sticking to a diet that is good for diabetes	0.06	0.8062
4. Not smoking	0.06	0.8062
5. Keeping an ideal body weight	0.1	0.7513
6. Taking diabetes medication as prescribed	Not exist.	.
7. Taking a blood pressure medication as prescribed	Not exist.	.
8. Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril and Quinapril)	Not exist.	.
9. Taking ASA (aspirin) as prescribed	0.19	0.6727
10. Getting a flu shot every year	0.13	0.7192
11. Measuring blood sugar values at home each week	Not exist.	.
12. Having feet checked every 6 months	33.93	<0.0001
13. Getting eyes checked every year	infty	<0.0001
14. Having urine checked for protein every year	0.06	0.8062
15. Having cholesterol/lipids measured every year	Not exist.	.
16. Having blood pressure measured every 3 months	infty	<0.0001
17. Having HbA1c levels measured by blood test every 6 months	Not exist.	.

Model:
Independent variables: age, gender, workhrs, type, dia_yrs, med, provider, complication, knowledge score(k)
Dependent variables: i1-i17

Hypothesis	Wilks' Lambda	F value	Pr > F
No Overall AGE Effect	0.2942	1.27	0.3684
No Overall GENDER Effect	0.4411	0.67	0.7714
No Overall WORKHRS Effect	0.1701	2.58	0.0749
No Overall TYPE Effect	0.1235	3.76	0.0242
No Overall DIA_YRS Effect	0.3642	0.92	0.5767
No Overall MED_ Effect	0.2205	1.87	0.1701
No Overall PROVIDER Effect	0.7117	0.21	0.9969
No Overall COMPL Effect	0.3499	0.98	0.535
No Overall k Effect	0.3547	0.96	0.5493

Therefore, the independent variables in our final model are workhrs and diabetes type

Ease of Diabetes Care Activities

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall Complication Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.4318	1.40	16	17	0.2499

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Difference among Patients who ranked in top 25%, patients in bottom 25% and rest. (ranks are based on the total percentage of activities they completed) (three groups)

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.0046	8.80	28	18	<.0001

Ease of Activities	F Value	Pr>F
1. Seeing a doctor every 3 months for diabetes	3.93	0.0348
2. Exercising at least 1.5 hours each week	6.56	0.0058
3. Sticking to a diet that is good for diabetes	8.09	0.0023
4. Not smoking	0.1	0.9044
5. Keeping an ideal body weight	5.87	0.0091
6. Taking diabetes medication as prescribed	Not exist.	.
7. Taking a blood pressure medication as prescribed	Not exist.	.
8. Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril and Quinapril)	0.11	0.8969
9. Taking ASA (aspirin) as prescribed	5.83	0.0093
10. Getting a flu shot every year	1.87	0.1781
11. Measuring blood sugar values at home each week	0.34	0.7155
12. Having feet checked every 6 months	6.32	0.0068

13. Getting eyes checked every year	5.11	0.0151
14. Having urine checked for protein every year	0.85	0.4392
15. Having cholesterol/lipids measured every year	0.48	0.624
16. Having blood pressure measured every 3 months	0.48	0.624
17. Having HbA1c levels measured by blood test every 6 months	0.62	0.5448

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Difference in the ranks of ease of activities between Patients who ranked in top 25% and patients in bottom 25% for the total percentage of activities they completed

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0	Infty	9	5	<.0001

Ease of Activities	F Value	Pr>F
1. Seeing a doctor every 3 months for diabetes	33.25	<0.0001
2. Exercising at least 1.5 hours each week	13.56	0.0028
3. Sticking to a diet that is good for diabetes	23.16	0.0003
4. Not smoking	0.07	0.8003
5. Keeping an ideal body weight	7.49	0.017
6. Taking diabetes medication as prescribed	Not exist	.
7. Taking a blood pressure medication as prescribed	Not exist	
8. Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril and Quinapril)	0.07	0.8003
9. Taking ASA (aspirin) as prescribed	14.5	0.0022
10. Getting a flu shot every year	Not exist	
11. Measuring blood sugar values at home each week	0.09	0.7724
12. Having feet checked every 6 months	31.43	<0.0001
13. Getting eyes checked every year	77.07	<0.0001
14. Having urine checked for protein every year	0.2	0.659
15. Having cholesterol/lipids measured every year	0.07	0.8003
16. Having blood pressure measured every 3 months	0.07	0.8003
17. Having HbA1c levels measured by blood test every 6 months	0.07	0.8003

Model:
Independent variables: age, gender, workhrs, type, dia_yrs, med, provider, complication, knowledge score(k)
Dependent variables: e1-e17

Hypothesis	Wilks' Lambda	F value	Pr > F
No Overall AGE Effect	0.0199	9.23	0.046
No Overall GENDER Effect	0.0269	6.78	0.0702
No Overall WORKHRS Effect	0.0288	6.32	0.0772

No Overall TYPE Effect	0.0259	7.05	0.0666
No Overall DIA_YRS Effect	0.0203	9.05	0.0473
No Overall MED_ Effect	0.0223	8.23	0.0539
No Overall PROVIDER Effect	0.1226	1.34	0.4592
No Overall COMPL Effect	0.163	0.96	0.598
No Overall k Effect	0.0538	3.3	0.1774

Therefore, the independent variables in our final model are age, gender, workhrs, diabetes type, dia_yrs, and med_effect.

Frequency of Diabetes Care Activities

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall COMPL Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.4636	1.29	17	19	0.2925

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Difference among Patients who ranked in top 25%, patients in bottom 25% and rest. (ranks are based on the total percentage of activities they completed) (three groups)

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.0018	9.56	28	12	0.0001

Frequency of Activities	F Value	Pr>F
1. Seeing a doctor every 3 months for diabetes	1.52	0.2437
2. Exercising at least 1.5 hours each week	4.37	0.0275
3. Sticking to a diet that is good for diabetes	1.74	0.203
4. Not smoking	0.17	0.8422
5. Keeping an ideal body weight	1.9	0.1765
6. Taking diabetes medication as prescribed	1.6	0.2272
7. Taking a blood pressure medication as prescribed	1.6	0.2272
8. Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril and Quinapril)	1.6	0.2272
9. Taking ASA (aspirin) as prescribed	6.18	0.0085
10. Getting a flu shot every year	0.97	0.3976
11. Measuring blood sugar values at home each week	1.76	0.1981
12. Having feet checked every 6 months	5.39	0.014
13. Getting eyes checked every year	4.84	0.02
14. Having urine checked for protein every year	1.49	0.2508
15. Having cholesterol/lipids measured every year	0.09	0.9126
16. Having blood pressure measured every 3 months	0.09	0.9126
17. Having HbA1c levels measured by blood test every 6 months	0.57	0.574

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Difference in the ranks of freqency of activities between Patients who ranked in top 25% and patients in bottom 25% for the total percentage of activities they completed

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0	Infty	10	2	<.0001

Frequency of Activities	F Value	Pr>F
1. Seeing a doctor every 3 months for diabetes	0.15	0.7066
2. Exercising at least 1.5 hours each week	0.23	0.6404
3. Sticking to a diet that is good for diabetes	0.87	0.3712
4. Not smoking	0.11	0.746
5. Keeping an ideal body weight	2.6	0.1352
6. Taking diabetes medication as prescribed	Not exist	.
7. Taking a blood pressure medication as prescribed	Not exist	
8. Taking an ACE inhibitor medication as prescribed (i.e. Enalapril, Lisinopril and Quinapril)	Not exist	
9. Taking ASA (aspirin) as prescribed	16.01	0.0021
10. Getting a flu shot every year	Not exist	
11. Measuring blood sugar values at home each week	0.08	0.7867
12. Having feet checked every 6 months	26.44	0.0003
13. Getting eyes checked every year	40.69	<.0001
14. Having urine checked for protein every year	0.16	0.6955
15. Having cholesterol/lipids measured every year	0.08	0.7867
16. Having blood pressure measured every 3 months	0.08	0.7867
17. Having HbA1c levels measured by blood test every 6 months	0.08	0.7867

Model:

Independent variables: age, gender, workhrs, type, dia_yrs, med, provider, complication, knowledge score(k)

Dependent variables: f1-f17

Hypothesis	Wilks' Lambda	F value	Pr > F
No Overall AGE Effect	0.0235	9.77	0.0199
No Overall GENDER Effect	0.083	2.6	0.1835
No Overall WORKHRS Effect	0.0137	16.96	0.0071
No Overall TYPE Effect	0.0511	4.37	0.0817
No Overall DIA_YRS Effect	0.0221	10.39	0.0177
No Overall MED_ Effect	0.0361	6.29	0.0439
No Overall PROVIDER Effect	0.1063	1.98	0.2676
No Overall COMPL Effect	0.1004	2.11	0.2459
No Overall k Effect	0.2525	0.7	0.7347

Part 3 Factor Analysis

Importance ratings of diabetes care activities

Rotated Factor Loadings:

Diabetes Care Activities	Factor1	Factor2	Factor3
1) Seeing a doctor every 3 months for diabetes	0.80218	0.382	0.28083
2) Exercising at least 1.5 hours each week	0.07033	0.13131	0.85574
3) Sticking to a diet that is good for diabetes	0.01271	0.07486	0.61413
4) Not smoking	0.23465	-0.07014	0.70459
5) Keeping an ideal body weight	0.04976	-0.01364	0.67096
6) Taking diabetes medication as prescribed	-0.25652	0.34539	0.35593
7) Taking a blood pressure medication as prescribed	0.25129	0.92973	-0.02638
8) Taking an ACE inhibitor medication as prescribed	0.26667	0.87986	-0.14793
9) Taking ASA (aspirin) as prescribed	0.21855	0.5321	0.21314
10) Getting a flu shot every year	0.43161	0.46551	-0.13455
11) Measuring blood sugar values at home each week	0.51245	0.37589	0.35395
12) Having feet checked every 6 months	0.81156	0.14036	0.01565
13) Getting eyes checked every year	0.83998	0.31891	-0.07835
14) Having urine checked for protein every year	0.48877	0.55328	0.33403
15) Having cholesterol/lipids measured every year	0.60923	0.69314	0.2171
16) Having blood pressure measured every 3 months	0.89497	0.23928	0.15352
17) Having HbA1c levels measured every 6 months	0.53373	0.61964	0.18879

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall Complication Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.8808	1.76	3	39	0.1709

Factors	F	P-value
Lifestyle	4.28	0.0449
Medication	0.50	0.4849
Monitoring	0.08	0.7766

MANOVA Test Criteria and F Approximations for the Hypothesis of No Overall nact Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.3667	5.43	6	50	0.0002

Factors	F	P-value
Lifestyle	1.22	0.3106

Medication	4.53	0.0201
Monitoring	12.56	0.0001

Model:
Independent variables: age, gender, workhrs, type, dia_yrs, med, provider, complication, knowledge score(k)
Dependent variables: factors

Factors	R-square
Lifestyle	0.311749
Medication	0.329856
Monitoring	0.200071

Hypothesis	F value	Pr > F
No Overall AGE Effect	1.65	0.2046
No Overall GENDER Effect	0.91	0.4519
No Overall WORKHRS Effect	0.48	0.7027
No Overall TYPE Effect	0.15	0.9284
No Overall DIA_YRS Effect	0.05	0.9839
No Overall MED Effect	0.31	0.8189
No Overall PROVIDER Effect	0.07	0.9741
No Overall COMPL Effect	0.38	0.7711
No Overall k Effect	3.95	0.0207

Therefore, in our final model, the independent variable is knowledge scores.

Ease ratings of diabetes care activities

Rotated Factor Loadings:

Diabetes Care Activities	Factor1	Factor2	Factor3
1) Seeing a doctor every 3 months for diabetes	0.74694	0.536	-0.01682
2) Exercising at least 1.5 hours each week	-0.0983	0.58497	0.18966
3) Sticking to a diet that is good for diabetes	0.11248	0.65904	-0.05446
4) Not smoking	0.30596	0.03484	0.43029
5) Keeping an ideal body weight	0.10703	0.5375	0.1876
6) Taking diabetes medication as prescribed	-0.01363	0.04601	0.98783
7) Taking a blood pressure medication as prescribed	-0.01363	0.04601	0.98783
8) Taking an ACE inhibitor medication as prescribed	0.16124	-0.05284	0.0222
9) Taking ASA (aspirin) as prescribed	0.1886	0.48179	-0.03934
10) Getting a flu shot every year	-0.09575	0.37475	0.00544
11) Measuring blood sugar values at home each week	0.31032	0.05008	0.22938
12) Having feet checked every 6 months	0.35943	0.68323	0.03476
13) Getting eyes checked every year	0.31478	0.76939	-0.08541

14) Having urine checked for protein every year	0.72035	0.12228	-0.08755
15) Having cholesterol/lipids measured every year	0.83595	0.2318	-0.02057
16) Having blood pressure measured every 3 months	0.91858	0.21841	0.11821
17) Having HbA1c levels measured every 6 months	0.90344	0.14237	0.16812

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall COMPL Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.9298	0.76	3	30	0.5279

	F	P-value
Factor 1	0.68	0.4169
Factor 2	0.21	0.6494
Factor 3	1.09	0.3041

MANOVA Test Criteria and F Approximations for the Hypothesis of No Overall nact Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.2225	7.47	6	40	<.0001

	F	P-value
Factor 1	0.95	0.4033
Factor 2	29.01	< .0001
Factor 3	0.50	0.6128

Model:
Independent variables: age, gender, workhrs, type, dia_yrs, med, provider, complication, knowledge score(k)
Dependent variables: factors

Hypothesis	F value	Pr > F
No Overall AGE Effect	1.15	0.3588
No Overall GENDER Effect	1.13	0.3669
No Overall WORKHRS Effect	11.49	0.0003
No Overall TYPE Effect	1.13	0.3678
No Overall DIA_YRS Effect	0.48	0.6988
No Overall MED_ Effect	2.78	0.0747
No Overall PROVIDER Effect	0.06	0.9811
No Overall COMPL Effect	0.42	0.7418
No Overall k Effect	0.89	0.4661

Therefore, in our final model, the independent variables are workhrs and med_ .

Frequency ratings of diabetes care activities

Rotated Factor Loadings:

Diabetes Care Activities	Factor1	Factor2	Factor3
1) Seeing a doctor every 3 months for diabetes	0.69233	0.50343	-0.05755
2) Exercising at least 1.5 hours each week	0.60233	0.1532	0.46737

3) Sticking to a diet that is good for diabetes	0.16075	0.55702	0.09843
4) Not smoking	0.65093	-0.05895	-0.29702
5) Keeping an ideal body weight	0.36275	0.37052	-0.10662
6) Taking diabetes medication as prescribed	0.01472	0.10168	0.60346
7) Taking a blood pressure medication as prescribed	-0.03336	-0.03354	0.68257
8) Taking an ACE inhibitor medication as prescribed	0.00762	-0.08808	0.56196
9) Taking ASA (aspirin) as prescribed	-0.13508	0.75806	-0.0939
10) Getting a flu shot every year	-0.03098	0.08141	-0.16159
11) Measuring blood sugar values at home each week	0.7752	0.1756	0.02489
12) Having feet checked every 6 months	0.37692	0.55623	-0.12255
13) Getting eyes checked every year	0.15569	0.81771	-0.09958
14) Having urine checked for protein every year	0.64176	0.41626	0.07238
15) Having cholesterol/lipids measured every year	0.78108	0.08075	0.12096
16) Having blood pressure measured every 3 months	0.9137	0.09806	-0.0206
17) Having HbA1c levels measured every 6 months	0.81469	0.02204	0.27181

MANOVA Test Criteria and Exact F Statistics for the Hypothesis of No Overall COMPL Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.7675	3.33	3	33	0.0312

	F	P-value
Factor 1	2.16	0.1506
Factor 2	0.41	0.5246
Factor 3	5.89	0.0206

MANOVA Test Criteria and F Approximations for the Hypothesis of No Overall nact Effect

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.2091	6.73	6	34	<.0001

	F	P-value
Factor 1	2.23	0.1351
Factor 2	13.66	0.0002
Factor 3	0.37	0.6955

Model:
Independent variables: age, gender, workhrs, type, dia_yrs, med, provider, complication, knowledge score(k)
Dependent variables: factors

Hypothesis	F value	Pr > F
No Overall AGE Effect	1.95	0.1571
No Overall GENDER Effect	1.82	0.1788
No Overall WORKHRS Effect	5.61	0.0068
No Overall TYPE Effect	1.47	0.2565
No Overall DIA_YRS Effect	0.82	0.5006
No Overall MED_ Effect	1.64	0.2159
No Overall PROVIDER Effect	1.36	0.2877
No Overall COMPL Effect	3.22	0.0472
No Overall k Effect	0.89	0.4636

Therefore, in our final model, the independent variables are workhrs and complication

Part 4 Imputations

Importance of diabetes care activities

With complication and without complication

		Multiple Imputation				
	Mean Imputation	Imputation 1	Imputation 2	Imputation 3	Imputation 4	Imputation 5
Wilk's Lamda	0.69267995	0.69727246	0.66303912	0.73516077	0.72562155	0.66303912
P value	0.1689	0.1838	0.0928	0.34	0.2953	0.0928

Three groups (top 25%, bottom 25% and else)

		Multiple Imputation					
	Mean Imputation	Imputation 1	Imputation 2	Imputation 3	Imputation 4	Imputation 5	Combined
Wilk's Lamda	0.001	0.034657	0.034657	0.034657	0.0346573	0.034657	0.034657
P value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

			Multiple Imputations											
Diabetes Care Activities	Mean Imput		Imput1		Imput2		Imput3		Imput4		Imput5		Combined	
	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F
1) Seeing a doctor	7.55	0.0025	11.45	2E-04	11.5	2E-04	11.5	2E-04	11.5	2E-04	11.5	2E-04	11.5	2E-04
2) Exercising at least 1.5 hours/week	1.59	0.2221	0.2	0.821	0.2	0.821	0.2	0.821	0.2	0.821	0.2	0.821	0.2	0.821
3) Sticking to a diet	0.58	0.5675	0.56	0.579	0.56	0.579	0.56	0.579	0.56	0.579	0.56	0.579	0.56	0.579
4) Not smoking	0.35	0.7088	0.08	0.925	0.08	0.925	0.08	0.925	0.08	0.925	0.08	0.925	0.08	0.925
5) Keeping an ideal body weight	2.36	0.1132	1.62	0.215	1.62	0.215	1.62	0.215	1.62	0.215	1.62	0.215	1.62	0.215
6) Taking prescribed medication	2.88	0.0735	0.31	0.733	0.31	0.733	0.31	0.733	0.31	0.733	0.31	0.733	0.31	0.733
7) Taking a blood pressure med	2.88	0.0735	0.31	0.733	0.31	0.733	0.31	0.733	0.31	0.733	0.31	0.733	0.31	0.733
8) Taking an ACE inhibitor med	2.88	0.0735	0.31	0.733	0.31	0.733	0.31	0.733	0.31	0.733	0.31	0.733	0.31	0.733
9) Taking ASA (aspirin) as prescribed	0.82	0.4505	0.43	0.652	0.43	0.652	0.43	0.652	0.43	0.652	0.43	0.652	0.43	0.652
10) Getting a flu shot every year	2.13	0.1381	5.78	0.008	5.78	0.008	5.78	0.008	5.78	0.008	5.78	0.008	5.78	0.008

11) Measuring blood sugar values/week	3.05	0.0639	3.75	0.036	3.75	0.036	3.75	0.036	3.75	0.036	3.75	0.036	3.75	0.036
12) Having feet checked every 6 mo	7.48	0.0026	3.75	0.041	3.75	0.041	3.75	0.041	3.75	0.041	3.75	0.041	3.75	0.041
13) Getting eyes checked every year	26.9	<0.0001	6.39	0.005	6.39	0.005	6.39	0.005	6.39	0.005	6.39	0.005	6.39	0.005
14) Having urine checked per year	2.21	0.1297	0.89	0.42	0.89	0.42	0.89	0.42	0.89	0.42	0.89	0.42	0.89	0.42
15) cholesterol/lipids measured per year	4.43	0.0217	4.1	0.027	4.1	0.027	4.1	0.027	4.1	0.027	4.1	0.027	4.1	0.027
16) blood pressure measured per 3 mo	17.3	<0.0001	5.88	0.007	5.88	0.007	5.88	0.007	5.88	0.007	5.88	0.007	5.88	0.007
17) HbA1c levels measured every 6 mo	2.07	0.1459	1.62	0.215	1.62	0.215	1.62	0.215	1.62	0.215	1.62	0.215	1.62	0.215

Ease of diabetes care activities

With complication and without complication

	Mean Imputation	Multiple Imputation					
		Imputation 1	Imputation 2	Imputation 3	Imputation 4	Imputation 5	Combined
Wilk's Lamda	0.6819	0.7092	0.7636	0.7120	0.6523	0.7636	0.7201
P value	0.3890	0.5123	0.7561	0.5257	0.2704	0.7561	0.5641

Three groups (top 25%, bottom 25% and else)

	Mean Imputation	Multiple Imputation					
		Imputation 1	Imputation 2	Imputation 3	Imputation 4	Imputation 5	Combined
Wilk's Lamda	0.0147	0.0071	0.0082	0.0071	0.0071	0.0082	0.0075
P value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Diabetes Care Activities	Mean Imput		Multiple Imputations: Imput1		Imput2		Imput3		Imput4		Imput5		Combined	
	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F
1) Seeing a doctor	3.93	0.0348	7.21	0.0034	7.21	0.0034	7.21	0.0034	7.21	0.0034	7.21	0.0034	7.21	0.0034
2) Exercising at least 1.5 hours/week	6.56	0.0058	1.38	0.2694	1.38	0.2694	1.38	0.2694	1.38	0.2694	1.38	0.2694	1.38	0.2694
3) Sticking to a diet	8.09	0.0023	5.44	0.0109	5.44	0.0109	5.44	0.0109	5.44	0.0109	5.44	0.0109	5.44	0.0109
4) Not smoking	0.10	0.9044	1.01	0.3772	1.01	0.3772	101	0.3772	1.01	0.3772	1.01	0.3772	1.01	0.3772
5) Keeping an ideal body weight	5.87	0.0091	10.77	0.0004	10.77	0.0004	10.77	0.0004	10.77	0.0004	10.77	0.0004	10.77	0.0004
6) Taking prescribed medication														
7) Taking a blood pressure med														

8) Taking an ACE inhibitor med	0.11	0.8969	0.13	0.8765	0.16	0.8542	0.13	0.8765	0.13	0.8765	0.16	0.8542	0.14	0.8676
9) Taking ASA (aspirin) as prescribed	5.83	0.0093	1.80	0.1854	1.80	0.1854	1.80	0.1854	1.80	0.1854	1.80	0.1854	1.80	0.1854
10) Getting a flu shot every year	1.87	0.1781	4.96	0.0153	4.96	0.0153	4.96	0.0153	4.96	0.0153	4.96	0.0153	4.96	0.0153
11) Measuring blood sugar values/week	0.34	0.7155	0.44	0.6485	0.44	0.6485	0.44	0.6485	0.44	0.6485	0.44	0.6485	0.44	0.6485
12) Having feet checked every 6 mo	6.32	0.0068	4.07	0.0294	6.25	0.0063	4.07	0.0294	4.07	0.0294	6.25	0.0063	4.94	0.0201
13) Getting eyes checked every year	5.11	0.0151	4.55	0.0202	4.55	0.0202	4.55	0.0202	4.55	0.0202	4.55	0.0202	4.55	0.0202
14) Having urine checked per year	0.85	0.4392	0.50	0.6131	0.50	0.6131	0.50	0.6131	0.50	0.6131	0.50	0.6131	0.50	0.6131
15) cholesterol/lipids measured per year	0.48	0.6240	1.60	0.2222	1.60	0.2222	1.60	0.2222	1.60	0.2222	1.60	0.2222	1.60	0.2222
16) blood pressure measured per 3 mo	0.48	0.6240	1.60	0.2222	1.60	0.2222	1.60	0.2222	1.60	0.2222	1.60	0.2222	1.60	0.2222
17) HbA1c levels measured every 6 mo	0.62	0.5448	1.45	0.2544	1.45	0.2544	1.45	0.2544	1.45	0.2544	1.45	0.2544	1.45	0.2544

Frequency of diabetes care activities

With complication and without complication

		Multiple Imputation					
	Mean Imputation	Imputation 1	Imputation 2	Imputation 3	Imputation 4	Imputation 5	Combined
Wilk's Lamda	0.5987	0.6108	0.6799	0.6579	0.6038	0.6799	0.6465
P value	0.1478	0.1791	0.4305	0.3383	0.1605	0.4305	0.3078

Three groups (top 25%, bottom 25% and else)

		Multiple Imputation					
	Mean Imputation	Imputation 1	Imputation 2	Imputation 3	Imputation 4	Imputation 5	Combined
Wilk's Lamda	0.0020	0.00076	0.00075	0.00073	0.00064	0.00073	0.00072
P value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

			Multiple Imputations											
Diabetes Care Activities	Mean Imput		Imput1		Imput2		Imput3		Imput4		Imput5		Combined	
	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F	F	Pr>F
1) Seeing a doctor	1.88	0.1781	4.14	0.0304	4.14	0.0304	4.14	0.0304	4.14	0.0304	4.14	0.0304	4.14	0.0304
2) Exercising at least 1.5 hours/week	6.12	0.0081	2.26	0.1287	2.26	0.1287	2.26	0.1287	2.26	0.1287	2.26	0.1287	2.26	0.1287
3) Sticking to a diet	2.67	0.093	6.63	0.0059	6.63	0.0059	6.63	0.0059	6.63	0.0059	6.63	0.0059	6.63	0.0059
4) Not smoking	0.19	0.8248	0.79	0.4666	0.79	0.4666	0.79	0.4666	0.79	0.4666	0.79	0.4666	0.79	0.4666
5) Keeping an ideal body weight	1.4	0.2681	3.48	0.0495	3.48	0.0495	3.48	0.0495	3.48	0.0495	3.48	0.0495	3.48	0.0495
6) Taking prescribed medication	2.63	0.096	0.17	0.8454	0.17	0.8454	0.17	0.8454	0.17	0.8454	0.17	0.8454	0.17	0.8454
7) Taking a blood pressure med	2.46	0.1101	0.17	0.8454	0.17	0.8454	0.17	0.8454	0.17	0.8454	0.17	0.8454	0.17	0.8454
8) Taking an ACE inhibitor med	2.42	0.1137	5.06	0.0160	0.17	0.8454	0.17	0.8454	0.17	0.8454	0.17	0.8454	1.15	0.6795

9) Taking ASA (aspirin) as prescribed	1.96	0.1652	2.27	0.1281	2.19	0.1372	2.19	0.1372	2.19	0.1372	2.19	0.1372	2.20	0.1354
10) Getting a flu shot every year	1.7	0.2066	4.47	0.0241	4.47	0.0241	4.47	0.0241	4.47	0.0241	4.47	0.0241	4.47	0.0241
11) Measuring blood sugar values/week	2.3	0.1245	3.48	0.0495	3.48	0.0495	3.48	0.0495	3.48	0.0495	3.48	0.0495	3.48	0.0495
12) Having feet checked every 6 mo	4.8	0.0192	6.55	0.0062	7.85	0.0028	6.55	0.0062	10.19	0.0008	7.85	0.0028	7.80	0.0038
13) Getting eyes checked every year	1.92	0.1712	2.89	0.0777	2.89	0.0777	2.89	0.0777	2.89	0.0777	2.89	0.0777	2.89	0.0777
14) Having urine checked per year	1.28	0.3	0.30	0.7458	0.30	0.7458	0.30	0.7458	0.30	0.7458	0.30	0.7458	0.30	0.7458
15) cholesterol/lipids measured per year	0.13	0.8763	0.12	0.8836	0.12	0.8836	0.12	0.8836	0.12	0.8836	0.12	0.8836	0.12	0.8836
16) blood pressure measured per 3 mo	5.83	0.0097	5.82	0.0097	5.82	0.0097	5.82	0.0097	5.82	0.0097	5.82	0.0097	5.82	0.0097
17) HbA1c levels measured every 6 mo	0.4	0.6741	0.29	0.7505	0.29	0.7505	0.29	0.7505	0.29	0.7505	0.29	0.7505	0.29	0.7505

Appendix D: SAS Code

Factor Analysis

```
LIBNAME in SPSS 'd:\dps_miss.por';
data a5;
set in.dps_miss;
k=K1__1 +K1__2 +K1__3 +K1__4+ K1__5 +K2__1+ K2__2 +K2__3 +K2__4 +K3__1
+K3__2 +K3__3 +K3__4
 +K4__1 +K4__2 +K4__3+ K4__4 +K5__1 +K5__2 +K5__3 +K5__4 +K6 +K7 +K8 +K9
+K10;
if percent= then nact=;
else
   if percent ge 0.88 then nact=1;
   else
    if percent le 0.76 then nact=-1;
                     else nact=0;
keep id_ i1-i17 age gender workhrs type dia_yrs med_ provider compl k nact;
title;
PROC FACTOR DATA=a5
    simple
      corr
      METHOD=prin
      PRIORS=max
      NFACT=3
    SCORE OUTSTAT=FACT
      SCREE
      ROTATE=VARIMAX preplot plot;
    VAR i1 i2 i3 i4 i5 i6 i7 i8 i9 i10 i11 i12 i13 i14 i15 i16 i17;
      TITLE2 'PRINCIPAL COMPONENTS OF THE RATINGS';
proc print data=fact;
PROC SCORE DATA=A5 SCORE=FACT OUT=PRIN;
     VAR I1-I17;
%MACRO LISTPC(VAR);
```

```
   PROC SORT DATA=PRIN;
        BY &VAR;
   PROC PRINT;

        VAR &VAR id_;
   %MEND;

%LISTPC(FACTOR1);
   TITLE2 'SORTED BY FIRST PRINCIPAL COMPONENT';
%LISTPC(FACTOR2);
   TITLE2 'SORTED BY SECOND PRINCIPAL COMPONENT';
%LISTPC(FACTOR3);
   TITLE2 'SORTED BY THIRD PRINCIPAL COMPONENT';
data a6;
set a5;
set prin;
merge a5 prin;
proc sort data=a6;
by id_;
proc glm;
class compl;
model factor1-factor3=compl;
manova h=compl;
means compl/bon cldiff;
proc glm;
class nact;
model factor1-factor3=nact;
manova h=nact;
means nact/bon cldiff;
proc glm;
 model factor1-factor3=
       age gender workhrs type dia_yrs med_ provider compl k;
 manova h=age gender workhrs type dia_yrs med_ provider compl k ;
 output out=new1 p=yhat1-yhat3 r=resid1-resid3 stdr=eresid1-eresid3;
proc rank data=new1 normal=blom out=rankout1;
 var resid1-resid3;
 ranks normscor1-normscor3;
title 'Q-Q plot for the model of importance';
proc gplot data=rankout1;
plot resid1*normscor1;
plot resid2*normscor2;
plot resid3*normscor3;
run;
```

Multivariate Analysis of Variance

```
LIBNAME in SPSS 'd:\dpsim22.por';
title;
data b1;
set in.dspim1;
k=K1__1 +K1__2 +K1__3 +K1__4+ K1__5 +K2__1+ K2__2 +K2__3 +K2__4 +K3__1
+K3__2 +K3__3 +K3__4
 +K4__1 +K4__2 +K4__3+ K4__4 +K5__1 +K5__2 +K5__3 +K5__4 +K6 +K7 +K8 +K9
+K10;
lifestylei=i2+i3+i4+i5;
medicationi=i6+i7+i8+i9+i10;
monitoringi=i1+i11+i12+i13+i14+i15+i16+i17;
```

```
lifestylee=e2+e3+e4+e5;
medicatione=e6+e7+e8+e9+e10;
monitoringe=e1+e11+e12+e13+e14+e15+e16+e17;
lifestylef=f2+f3+f4+f5;
medicationf=f6+f7+f8+f9+f10;
monitoringf=f1+f11+f12+f13+f14+f15+f16+f17;
if percent= then nact=;
else
   if percent ge 0.8824 then nact=1;
   else
    if percent le 0.7059 then nact=-1;
                     else nact=0;
proc sort data=b1;
by percent;
proc univariate data=b1 normal plot;
var percent;
proc sort data=b1;
by compl;
proc freq data=b1;
table compl;
title 'analysis of importance';
data importance;
set b1;
keep id_ age gender workhrs type dia_yrs med_ provider compl k i1-i17 nact
lifestylei medicationi monitoringi;
if I1 eq 99 THEN delete;
if I2 eq 99 THEN delete;
if I3 eq 99 THEN delete;
if I4 eq 99 THEN delete;
if I5 eq 99 THEN delete;
if I6 eq 99 THEN delete;
if I7 eq 99 THEN delete;
if I8 eq 99 THEN delete;
if I9 eq 99 THEN delete;
if I10 eq 99 THEN delete;
if I11 eq 99 THEN delete;
if I12 eq 99 THEN delete;
if I13 eq 99 THEN delete;
if I14 eq 99 THEN delete;
if I15 eq 99 THEN delete;
if I16 eq 99 THEN delete;
if I17 eq 99 THEN delete;
proc anova;
class compl;
model i1 - i17 = compl;
manova h=compl;
means  compl / bon cldiff;
proc anova;
class nact;
model i1 - i17 = nact;
manova h=nact;
means  nact / bon cldiff;
data importance2;
set importance;
if nact=0 then delete;
proc anova data=importance2;
class nact;
```

```
model i1 - i17 = nact;
manova h=nact;
means  nact / bon cldiff;
proc glm data=importance;
 model i1 - i17=
       age gender workhrs type dia_yrs med_ provider compl k;
 manova h=age gender workhrs type dia_yrs med_ provider compl k ;
output out=new1 p=yhati1-yhati17 r=residi1-residi17
stdr=eresidi1-eresidi17;
proc rank data=new1 normal=blom out=rankout1;
 var residi1-residi17;
 ranks normscori1-normscori17;
title 'Q-Q plot for the model of importance';
proc gplot data=rankout1;
plot residi1*normscori1;
plot residi2*normscori2;
plot residi3*normscori3;
plot residi4*normscori4;
plot residi5*normscori5;
plot residi6*normscori6;
plot residi7*normscori7;
plot residi8*normscori8;
plot residi9*normscori9;
plot residi10*normscori10;
plot residi11*normscori11;
plot residi12*normscori12;
plot residi13*normscori13;
plot residi14*normscori14;
plot residi15*normscori15;
plot residi16*normscori16;
plot residi17*normscori17;
/* factor analysis*/
proc glm data=importance;
class compl;
model lifestylei medicationi monitoringi=compl;
manova h=compl;
means compl/bon cldiff;
proc glm data=importance;
class nact;
model lifestylei medicationi monitoringi=nact;
manova h=nact;
means nact/bon cldiff;
proc glm data=importance;
 model lifestylei medicationi monitoringi=
       age gender workhrs type dia_yrs med_ provider compl k;
 manova h=age gender workhrs type dia_yrs med_ provider compl k ;
 output out=new1 p=yhat1-yhat3 r=resid1-resid3 stdr=eresid1-eresid3;
proc rank data=new1 normal=blom out=rankout1;
 var resid1-resid3;
 ranks normscor1-normscor3;
title 'Q-Q plot for the model of importance factors (mean imputation)';
proc gplot data=rankout1;
plot resid1*normscor1;
plot resid2*normscor2;
plot resid3*normscor3;
proc glm data=importance;
 model lifestylei medicationi monitoringi=workhrs k;
```

```
 manova h=workhrs k ;
 output out=new1 p=yhat1-yhat3 r=resid1-resid3 stdr=eresid1-eresid3;
title;
data ease;
set b1;
KEEP age gender workhrs type dia_yrs med_ provider compl k E1-E17 nact
lifestylee medicatione monitoringe;;
if E1 eq 99 THEN delete;
if E2 eq 99 THEN delete;
if E3 eq 99 THEN delete;
if E4 eq 99 THEN delete;
if E5 eq 99 THEN delete;
if E6 eq 99 THEN delete;
if E7 eq 99 THEN delete;
if E8 eq 99 THEN delete;
if E9 eq 99 THEN delete;
if E10 eq 99 THEN delete;
if E11 eq 99 THEN delete;
if E12 eq 99 THEN delete;
if E13 eq 99 THEN delete;
if E14 eq 99 THEN delete;
if E15 eq 99 THEN delete;
if E16 eq 99 THEN delete;
if E17 eq 99 THEN delete;
proc anova;
class compl;
model e1 - e17 = compl;
manova h=compl;
means  compl / bon cldiff;
proc anova;
class nact;
model e1 - e17 = nact;
manova h=nact;
means  nact / bon cldiff;
data ease2;
set ease;
if nact=0 then delete;
proc anova data=ease2;
class nact;
model e1 - e17 = nact;
manova h=nact;
means  nact / bon cldiff;
proc glm data=ease;
 model e1 - e17=
      age gender workhrs type dia_yrs med_ provider compl k;
 manova h=age gender workhrs type dia_yrs med_ provider compl k ;
output out=new1 p=yhati1-yhati17 r=residi1-residi17
stdr=eresidi1-eresidi17;
proc rank data=new1 normal=blom out=rankout1;
 var residi1-residi17;
 ranks normscori1-normscori17;
title 'Q-Q plot for the model of ease';
proc gplot data=rankout1;
plot residi1*normscori1;
plot residi2*normscori2;
plot residi3*normscori3;
plot residi4*normscori4;
```

```
plot residi5*normscori5;
plot residi6*normscori6;
plot residi7*normscori7;
plot residi8*normscori8;
plot residi9*normscori9;
plot residi10*normscori10;
plot residi11*normscori11;
plot residi12*normscori12;
plot residi13*normscori13;
plot residi14*normscori14;
plot residi15*normscori15;
plot residi16*normscori16;
plot residi17*normscori17;
/* factor analysis*/
proc glm data=ease;
class compl;
model lifestylee medicatione monitoringe=compl;
manova h=compl;
means compl/bon cldiff;
proc glm data=ease;
class nact;
model lifestylee medicatione monitoringe=nact;
manova h=nact;
means nact/bon cldiff;
proc glm data=ease;
 model lifestylee medicatione monitoringe=
       age gender workhrs type dia_yrs med_ provider compl k;
 manova h=age gender workhrs type dia_yrs med_ provider compl k ;
 output out=new1 p=yhat1-yhat3 r=resid1-resid3 stdr=eresid1-eresid3;
proc rank data=new1 normal=blom out=rankout1;
 var resid1-resid3;
 ranks normscor1-normscor3;
title 'Q-Q plot for the model of ease factors(mean imputation)';
proc gplot data=rankout1;
plot resid1*normscor1;
plot resid2*normscor2;
plot resid3*normscor3;
proc glm data=ease;
 model lifestylee medicatione monitoringe=workhrs k;
 manova h=workhrs k ;
 output out=new1 p=yhat1-yhat3 r=resid1-resid3 stdr=eresid1-eresid3;

data frequency;
set b1;
keep age gender workhrs type dia_yrs med_ provider compl k f1-f17 nact
lifestylef medicationf monitoringf;
if F1 eq 99 THEN delete;
if F2 eq 99 THEN delete;
if F3 eq 99 THEN delete;
if F4 eq 99 THEN delete;
if F5 eq 99 THEN delete;
if F6 eq 99 THEN delete;
if F7 eq 99 THEN delete;
if F8 eq 99 THEN delete;
if F9 eq 99 THEN delete;
if F10 eq 99 THEN delete;
if F11 eq 99 THEN delete;
```

```
if F12 eq 99 THEN delete;
if F13 eq 99 THEN delete;
if F14 eq 99 THEN delete;
if F15 eq 99 THEN delete;
if F16 eq 99 THEN delete;
if F17 eq 99 THEN delete;
proc anova;
class compl;
model f1 - f17 =compl;
manova h=compl;
means  compl / bon cldiff;
proc anova;
class nact;
model f1 - f17 = nact;
manova h=nact;
means  nact / bon cldiff;
data frequency2;
set frequency;
if nact=0 then delete;
proc anova data=frequency2;
class nact;
model f1 - f17 = nact;
manova h=nact;
means  nact / bon cldiff;
proc glm data=frequency;
 model f1 - f17=
       age gender workhrs type dia_yrs med_ provider compl k;
 manova h=age gender workhrs type dia_yrs med_ provider compl k ;
output out=new1 p=yhati1-yhati17 r=residi1-residi17
stdr=eresidi1-eresidi17;
proc rank data=new1 normal=blom out=rankout1;
 var residi1-residi17;
 ranks normscori1-normscori17;
title 'Q-Q plot for the model of frequency';
proc gplot data=rankout1;
plot residi1*normscori1;
plot residi2*normscori2;
plot residi3*normscori3;
plot residi4*normscori4;
plot residi5*normscori5;
plot residi6*normscori6;
plot residi7*normscori7;
plot residi8*normscori8;
plot residi9*normscori9;
plot residi10*normscori10;
plot residi11*normscori11;
plot residi12*normscori12;
plot residi13*normscori13;
plot residi14*normscori14;
plot residi15*normscori15;
plot residi16*normscori16;
plot residi17*normscori17;
/* factor analysis*/
proc glm data=frequency;
class compl;
model lifestylef medicationf monitoringf=compl;
manova h=compl;
```

```
means compl/bon cldiff;
proc glm data=frequency;
class nact;
model lifestylef medicationf monitoringf=nact;
manova h=nact;
means nact/bon cldiff;
proc glm data=frequency;
 model lifestylef medicationf monitoringf=
       age gender workhrs type dia_yrs med_ provider compl k;
 manova h=age gender workhrs type dia_yrs med_ provider compl k ;
 output out=new1 p=yhat1-yhat3 r=resid1-resid3 stdr=eresid1-eresid3;
proc rank data=new1 normal=blom out=rankout1;
 var resid1-resid3;
 ranks normscor1-normscor3;
title 'Q-Q plot for the model of frequency factors (mean imputation)';
proc gplot data=rankout1;
plot resid1*normscor1;
plot resid2*normscor2;
plot resid3*normscor3;
proc glm data=frequency;
 model lifestylef medicationf monitoringf=workhrs k;
 manova h=workhrs k ;
 output out=new1 p=yhat1-yhat3 r=resid1-resid3 stdr=eresid1-eresid3;
```

Bibliography

[1] Meltzer S, Leiter L, Daneman D, Gerstein HC, Lau D, et al. 1998 Clinical practice

guidelines for the management of diabetes in Canada. CMAJ 1998; 159(8 Suppl):S1-S29.

[2] Dawson KG, Gomes D, Gerstein H, et al. The economic cost of diabetes in Canada, 1998. Diabetes Care. 2002;25:1303-1307.

[3] McKinlay J, Marceau L. US public health and the 21st century: diabetes mellitus. Lancet 2000; 356(9231):757-61.

[4] McKinlay J, Marceau L. US public health and the 21st century: diabetes mellitus. Lancet. 2000; 356(9231):757-761.

[5] Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2003 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Retrieved December 19, 2004 from http://www.diabetes.ca/cpg2003/chapters.aspx.

[6] Gaede P, Vedel P, Larsen N et al. Multifactorial intervention and cardiovascular disease in patients with Type 2 diabetes. NEJM 2003;348:383-93.

[7] Ary DV, Toobert D, Wilson W, Glasgow RE. Patient perspective on factors contributing to nonadherence to diabetes regimen. Diabetes Care 1986;9:168-72.

[8] Glasgow RE, Toobert DJ, Hampson SE, Wilson W. Behaviour research on diabetes at the Oregon Research Institute. Ann Behav Med 1995;17:32-40.

[9] Brown JB, Harris SB, Webster-Bogaert S, Wetmore S, Faulds C, Stewart M. The role of patient, physician and systemic factors in the management of type 2 diabetes mellitus. Fam Pract 2002;19(4):344-9.

[10] Shiu AT, Wong RY. Fears and worries associated with hypoglycaemia and diabetes complications: perceptions and experience of Hong Kong Chinese clients. J Adv Nurs 2002 Jul;39(2):155-63.

[11] Samuel-Hodge CD, Headen SW, Skelly AH, Ingram AF, Keyserling TC, Jackson EJ, Ammerman AS, Elasy TA. Influences on day-to-day self-management of type 2 diabetes among African-American women: spirituality, the multi-caregiver role, and other social context factors. Diabetes Care 2000 23(7):928-33.

[12] Rayman KM, Ellison GC.When management works: an organizational culture that facilitates learning to self-manage type 2 diabetes. Diabetes Educ 1998 Sep-Oct;24(5):612-7.

[13] Hunt LM, Pugh J, Valenzuela M. How patients adapt diabetes self-care recommendations in everyday life. J Fam Pract 1998 Mar;46(3):207-15.

[14] Cosby JL, Houlden RL. Health beliefs toward diabetes mellitus in two Ontario First Nation populations. Canadian Journal of Diabetes Care 1996; 20L12-9.

[15] Nair K, Dolovich L, Burns S, Holbrook A. Patient Priorities in Diabetes: A Literature Review. 2003.

[16] Hernandez CA, Antone I, Cornelius I. A grounded theory study of the experience of type 2 diabetes mellitus in First Nations adults in Canada. Journal of Transcultural Nursing. 1999; 10:220-8.

[17] Hunt LM, Arar NH, Larme AC. Contrasting patient and practitioner perspectives in type 2 diabetes management. West J Nurs Res. 1998; 20:656-76.

[18] Hares T, Spencer J, Gallagher M, Bradshaw C and Webb I (1992) Diabetes care: who are the experts? Quality in Health Care, 1: 219-224.

[19] Gallagher M, Bradshaw C, Nattress H. Policy priorities in diabetes care: a Delphi study. Quality in Health Care. 1996; 5:3-8.

[20] Neter J, Kutner MH, Wasserman W, Christopher JN, (1990). Applied linear statistical models (4th ed.). Irwin Book Team, Chicago; 385-88.

[21] Johnson RA, Wichern DW (1998). Applied Multivariate Analysis, 4th ed., Prentice Hall, Englewood Cliffs, New Jersey; 396-435.

[22] Srivastava MS (2002) Methods of Multivariate Statistics, J. Wiley & Sons, New York; 428-46.

[23] Little R.J.A. and Rubin, DB (1987) Statistical Analysis with Missing Data. J. Wiley & Sons, New York.

[24] Rubin, DB (1987) Multiple Imputation for Nonresponse in Surveys. J. Wiley & Sons, New York; 114.

[25] Ruggiero L, Glasgow R, Dryfoos JM et al. Diabetes self-management. Self-reported recommendations and patterns in a large population. Diabetes Care 1997; 20:568-76.

[26] O'Connor PJ, Crabtree BF, Yanoshik MK. Differences between diabetic patients who do and do not respond to a diabetes care intervention: a qualitative analysis. Family Medicine 1997; 29: 424-8.

[27] Bray, JH and Maxwell SE(1985). Multivariate analysis of variance. Quantitative applications in the social sciences series #54. Thousand Oaks, CA: Sage Publications.