Chapter 5

Influence of a Dietary Education Programme on Diabetes Care, Knowledge and Activities among Persons with Type 2 Diabetes Mellitus

Abstract

Background: Diabetes mellitus (DM) self-care management is of importance because of the assumption that adoption of a healthy lifestyle will produce better metabolic control of DM, and that this will help to avoid subsequent acute and long-term complications of the disease. Many studies have investigated the link between DM self-care and level of DM control as well as psychosocial factors which may be predictive of self-care.

Aims: The purpose of the study was to describe the knowledge and practices with respect to dietary habits and medication usage among a cohort of 80 male and female type 2 diabetics from ages 40-65 years. Participants were of African heritage and were recruited in a resource-poor setting from the outpatients' clinic at the Mamelodi hospital in Gauteng, South Africa.

Methods: An evaluation was done on a group of patients selected for a randomized controlled clinical trial involving a progressive resistance training (PRT) and a dietary education programme. The self-report Diabetes Self-Care Activity questionnaire was used to assess three categories of DM care over 7 days i.e. knowledge and practices of dietary intake (basic food groups), glucose monitoring and use of medication. The questionnaire was administered at baseline and again at 20-weeks.

Results: With regards to dietary adherence at 20 weeks, the overall data suggests that a large proportion of subjects always (66.25%) adhered to a recommended diet as opposed to usually (20.00%) or sometimes (11.25%). Although the CT group adherence improved significantly ($p=0.01$) the change was not significantly better ($p=0.61$) than that of the PRT group. The majority of the cohort indicated good practice in high-fibre food intake making up either a quarter (36.25%) or half (42.50%) of their diet but there was no change ($p<0.05$) during this study. The majority of the cohort indicated that high-fat foods make either

none (35.00%) or a quarter (43.75%) of their weekly meals and the CT group improved significantly (p=0.009) more in reducing the high fat content of their weekly meals than the PRT group after the study. The majority of the subjects indicated good practice with food high in complex sugars making up make either none (58.75%) or a quarter (37.50%) of their weekly meals and there was no change (p>0.05) in this during the study. The majority of the subjects did not adhere to weekly urine testing with (73.75%) “never” doing so and (16.25%) “rarely” tested their urine over the previous 7 days, but the PRT group adhered significantly (p=0.001) more to this practice than the CT group, after the study. The majority (95.00%) of the cohort indicated good adherence in ingesting all of their prescribed medication and there was no change (p>0.05) in this during the study.

Conclusion: It was evident that adherence to recommended weekly dietary practices could be improved, but generally, the intake of high fibre foods, high fat foods and complex sugars was acceptable. While adherence to urine testing was poor, intake of prescribed medication was good. The dietary education group did reduce their high fat content in foods more than the PRT group, while the PRT group improved their urinary testing more than the CT, which indicates an improved awareness of these aspects brought about by the intervention. However, exercise interventions and dietary education has to be a continuous process in order to impact positively on diabetes care, knowledge and activities among persons with type 2 diabetes mellitus.

Keywords: Dietary education, Type-2 DM mellitus, community setting. DM care questionnaire, dietary knowledge, dietary practices

5.1 Introduction

In as much as the human genetic constitution has remained unchanged over the past 50,000 years or so, it is likely that an evolutionary mismatch between the patterns of nutrient intake and physical activity of our hunter-gatherer ancestors and that of modern industrialised societies underlies the global epidemic of chronic diseases such as diabetes mellitus (DM) [1, 2]. The value of tight blood glucose control in type-2 DM has been convincingly demonstrated in the United Kingdom Prospective DM Study, among other studies [3]. Improvement in glycaemic control is the critical factor in reducing the risks of chronic diabetic complications [4,5] and type-2 DM is more prevalent in those that are overweight and sedentary [6].

According to Social Cognitive Theory [7] adherence to a treatment regimen is influenced by knowledge, beliefs about one's ability to perform certain behaviours and the value of doing so, the skill to do so and incentives for engaging in a particular behaviour. In view of this statement it has been suggested that lifestyle intervention may lead to the primary prevention of Type-2 DM [8], possibly in as many as 50% of cases. In 1995, 135 million adults had DM worldwide, and this number is projected to be 300 million by 2025 [9]. DM is one of the chronic diseases in which self management plays a role in the treatment. Therefore, health care workers and doctors should educate the patient on the disease and its management. It is well understood that a better educated patient will have higher levels of compliance in DM self-care and also lower levels of glycosylated haemoglobin, suggesting better glycaemic control. The theory of reasoned action [10] states that an individuals intention to adhere to the self care regimen is determined by his/her attitude. Attitudes are determined by the individual's beliefs about the outcome of performing certain behaviours. Knowledge of the patients' attitudes towards the disease and DM care is therefore necessary to understand their behaviour and in order to educate them.

The purpose of the present paper was to obtain baseline and 20 week intervention data regarding the attitudes, knowledge and practices with respect to dietary

habits and medication usage among an African cohort of type-2 diabetics in a resource-poor community setting. This analysis formed part of a clinical trial evaluating the efficacy of a physical activity (progressive resistance training) and lifestyle intervention (dietary education) on health outcomes in persons with type 2 diabetes.

5.2 Materials and Methods

5.2.1 Participants

The study was undertaken in Mamelodi, a suburb in the city of Tshwane in the province of Gauteng, South Africa. The study participants (n=80) included black male and female participants between the ages 40-65 years with type-2 DM without complications and a known duration of the disease for at least one year. Most participants were recruited from the outpatient clinic at the Mamelodi government hospital as well as from local churches in the Mamelodi area. The following exclusion criteria were used: Cardiovascular contraindications Unstable angina, untreated severe left main coronary artery disease, angina, hypotension, or arrhythmias provoked by resistance training, acute myocardial infarction, end-stage congestive heart failure, severe valvular heart disease, malignant or unstable arrhythmias, large or expanding aortic aneurysm, known cerebral aneurysm, acute deep venous thrombosis, acute pulmonary embolism or infarction, and recent intracerebral or subdural hemorrhage; Musculoskeletal contraindications: Significant exacerbation of musculoskeletal pain with resistance training, unstable or acutely injured joints, tendons or ligaments, fracture within the last 6 months (delayed union), acute inflammatory joint disease; Other contraindications: Rapidly progressive or unstable neurological disease, failure to thrive, terminal illness, uncontrolled systemic disease, symptomatic or large abdominal or inguinal hernia, hemorrhoids, severe dementia/behavioral disturbance, acute alcohol or drug intoxication, acute retinal bleeding, detachment/severe proliferative diabetic retinopathy, recent ophthalmic surgery, severe cognitive impairment, uncontrolled chronic obstructive pulmonary disease, prosthesis instability, severe (systolic >160mmHg and diastolic >100mmHg) and

malignant hypertension, and signs and symptoms suggestive of immuno-suppression.

5.3 Ethical Clearance

The protocol was approved by the Research Ethics Committees of the Faculties of Humanities and Health Sciences at University of Pretoria (Number 66/2004). The chief executive officer, superintendent and physician providing medical services as well as the health-care workers at the diabetes mellitus (DM) out-patient clinic of the Mamelodi Hospital also consented to the diabetes mellitus study being conducted.

5.4 Study Design and Sampling

A baseline descriptive survey and post intervention analysis was used with quantitative data captured by means of a questionnaire. The initial sample consisted of 91 participants, with a subsequent dropout of 11 participants, leaving forty participants in an experimental group (6 males and 34 females) and forty participants in a control group (11 males and 29 females). Progress through the various stages of this study is highlighted in figure 1. The discontinuation of participants as highlighted in figure 1 was due to personal problem experienced, non-compliance and amputation. Follow–up was done by means of telephone calls and letters that were posted to participants homes or hand delivered while they waited at the diabetes outpatient clinic. Socio-economic problems, psychosocial problems, death in the family and illnesses were given reasons for not attending the exercise and dietary sessions. No adverse effects or side effects were reported in either group.

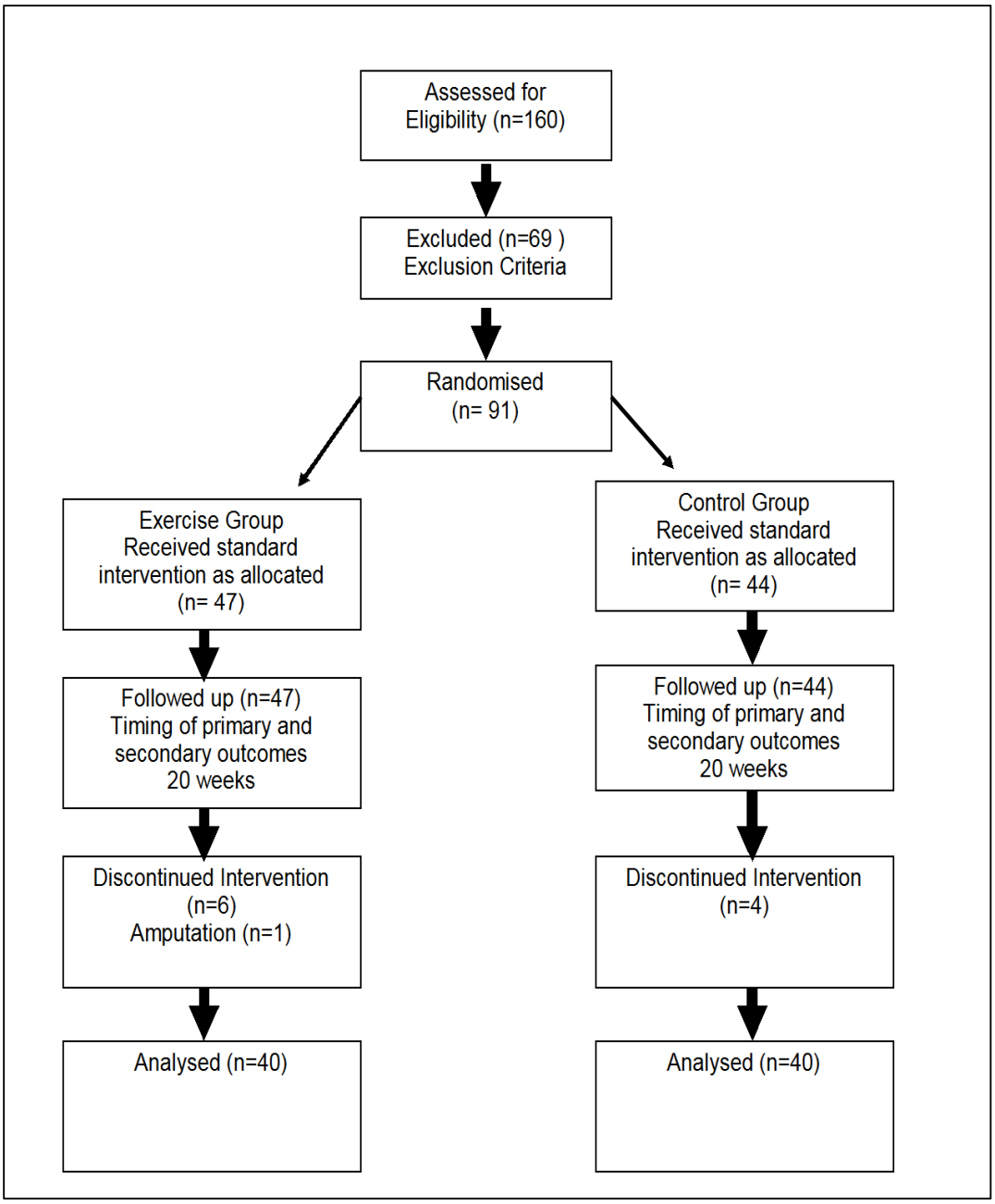

Figure 1: Diagram Showing the Flow of Participants through Each Stage of the Randomized Controlled Trial.

5.4 Intervention Programme

The duration of the study intervention programme was 20-weeks. Due to availability of subjects the study was staggered and therefore spanned over a period of 18 months in total (February 2004-June 2005), and was conducted in periods of 20 weeks until the targeted number of subjects were obtained. The YMCA hall in Mamelodi was used to perform the weekly interventions of dietary educational sessions (control group) and progressive resistance training plus dietary education (exercise group).

5.5.1 Dietary Education

Research has suggested that both diet and exercise are cornerstones [11] which play pivotal roles in the control of type 2 DM. Participants who participated in this intervention programme were given dietary education, conducted in a community hall by the resident dietician at the Mamelodi Hospital with a view to educating participants on proper dietary habits. However, no attempts were made to change their diet during the study. Before block randomization into exercise and control groups, all participants were given general information on lifestyle changes. The participants from the exercise and control groups had no contact or interaction with one another during the study. Dietary education for the control group was conducted twice a month for 20-weeks whilst the experimental group also received their dietary education twice a month following one of their exercise sessions. The PRT group and control group received their dietary education on different days of the week. Both groups received education in the form of dietary aids (food models), which the resident dieticians used to provide detailed information on portion sizes of food consumed. Educational aids such as pamphlets and diagrams were used to illustrate the preferred types of food selected and to explain the glycaemic indices of food groups. The instructions stressed the need for a reduction in the intake of total energy, total fat and cholesterol-rich foods. An ideal meal was served to all participants after the education sessions to enlighten them on the types of food to be consumed while stressing the preparation methods and portion sizes.

5.5.2 Exercise Intervention

Exercise sessions took the form of progressive resistance training (PRT) using equipment such as dumbells, elasticized bands, exercise balls and own body weight. The exercise intensities increased on a monthly basis using 5 differently coloured elastised therabands of varying resistance. The colours of the elasticized therabands and the resistance respectively were: yellow (1.5 kg), red (2.0 kg), green (2.7 kg), blue (3.5 kg) and black (4.5 kg). A bench-press and leg press 1RM test was determined by trial using a sub-sample of 10 subjects (6 females and 4 males) at the physiotherapy gymnasium in the Mamelodi hospital. This was done primarily to determine the initial repetitions per set of exercises than the resistance, as the elasticised tensile resistance (colour) of the theraband was constant for all subjects during each month of the study, with a different theraband (increased resistance) thus being used for each month (X5) of the 20 week program. Dumbells and ankle weights of 2 kg resistance were used, with the repetitions per exercise progressively increasing from 3 sets of 6 repetitions in month 1 to 3 sets of 12 repetitions in month 5. For the first 4 months there was an increase of 2 repetitions each month and in the 5th month the repetitions (12 reps) were the same as the fourth month. Between each station the subjects were given 30 seconds rest to move from one station to the other, and repetition of each exercise was done every 4 seconds. In certain instance chairs were substituted for the exercise gym balls. Tables were improvised for exercise benches and door knobs as well as railings in the hall were used to fasten the elastic bands. Participants performed supervised PRT on two non-consecutive days per week (Appendix 5: Exercises). The exercise programme commenced with 30 minute-sessions, progressing to 60 minute-sessions towards the end of the study. Before and after each exercise session blood pressure and glucose levels were measured to ensure that none of the participants was hypoglycaemic (<3.7 mmol/L) prior to exercising or had high blood pressure readings (increase in systolic blood pressure >170 mmHg) that would be contra-indicative to exercise. If any patients indicated that they did not consume prescribed medication they were not allowed to participate in the days activities. All exercise participants congregated in the community hall where they had to do a general warm up and

stretching exercises for 20 minutes. The exercising participants which comprised of forty people were divided into four groups with ten participants in each group. The groups then did a circuit workout for the remaining 40 minutes, rotating at each station of the circuit. The groups were then given a further 10-15 minutes which was used as a cool-down period as well as to perform few basic stretching exercises. All the exercises were supervised by qualified exercise science students. An attendance register was kept for each exercise session.

5.6 Instrumentation

The Diabetes Self-Care Activity Questionnaire (DSCAQ) [12] was administered to all subjects at baseline and at the end of the 20-week intervention period. The questionnaire (Appendix 2) assessed three categories of DM care over the previous 7-days i.e. knowledge and practices of dietary intake (basic food groups), glucose monitoring and medication usage. A pilot study was conducted to pre-test the Diabetes Self-Care Activity Questionnaire. The questionnaire was administered by the primary researcher. While most subjects indicated their preference to have the questionnaire administered in English, where necessary the resident dietician, who had proven practical experience and the ability to communicate in the local languages (Sotho and Zulu), explained terminologies in the simplest form.

5.6.1 Assessment of the Diabetes Self-Care Activities Questionnaire

The Diabetes Self-Care Activity Questionnaire (DSCAQ) is a self-report measure to monitor the frequency of different regimen activities over a seven day period. The purpose of developing such an instrument was to provide a measure of self-care for several different regimen areas that would be feasible for use in most clinical research settings. Areas of regimen assessed in the questionnaire are diet, glucose testing and medication usage. Many of the items included in this instrument were based on a large-scale project conducted by the Rand Corporation [13] to identify and develop psychometrically acceptable measures of performance of DM regimen activities considered to be most important by a panel

of experts. The latest version of the DSCA scale consists of 12 questions. For each regimen area, items were constructed to measure both absolute levels of self-care behaviour and adherence to individual prescriptions (involving a comparison of self-care behaviour and the perceived prescription).

The adherence levels of dietary self-care are measured using only three items in the questionnaire (Appendix 2). The first category of the questionnaire deals with "adherence to dietary practices based on dietary knowledge" over the previous seven days and three dietary questions which are concerned with the "percentage of meals which included high-fibre foods, high-fat foods, sweets and desserts". The second category deals with the question of "frequency of glucose monitoring", and the last category deals with the questions on "adherence to medication usage". The rationale for employing a 7-day recall period is that self-reported behaviour is expected to vary over time, and one wants to obtain a stable estimate. Asking subjects to remember details over a longer interval may result in increased inaccuracies.

5.7 Statistical Analysis

Data was analyzed using the Stata 10 software programme [14]. Data was summarised using standard descriptive techniques such as mean, SD, median, frequency, percentage and range. A non-parametric inferential technique, the Wilcoxon signed-rank test, was used to calculate differences within groups at baseline and at the end of the study. The two-sample Wilcoxon ranksum (Mann-Whitney) was used to calculate differences between groups at baseline and at the end of the study.

5.8 Results

The demographics of the sample by gender, age, educational level and employment status are given in table 1. The sample size consisted of 17 males and 63 females. The ages of the participants ranged from 40-65 years. The majority (52.50%) of the exercise group had passed standard 7 (grade 9) whilst

the majority (40%) of the control group had passed standard 10 (grade 12). The employment status indicated that majority (52.5%) in the exercise group were unemployed, whilst the majority (40%) in the control group were pensioners. Age and gender (table 1) as well as BMI (table 2) appear not to have been balanced between the two groups and were adjusted for in subsequent analyses (formal statistical testing was not done because, due to randomization, any differences observed were due to chance).

Table 1: Frequency Distribution of Demographic Variables

DEMOGRAPHIC VARIABLES		Exercise (N=40)		Control (N=40)	
		N	%	N	%
GENDER	Males	6	15.00	11	27.50
	Females	34	85.00	29	72.50
AGE (Years)	40-50	11	27.50	6	15.00
	51-60	16	40.00	17	42.50
	61-70	13	32.50	17	42.50
EDUCATIONAL LEVEL	St 1-4	7	17.50	8	20.00
	St 5-7	21	52.50	12	30.00
	St 8-10	11	27.50	16	40.00
	NONE	1	2.50	4	10.00
EMPLOYMENT STATUS	Part-time	1	2.50	4	10.00
	Full time	1	2.50	5	12.50
	Pensioner	17	42.50	16	40.00
	Unemployed	21	52.50	15	37.50

Table 2 highlights the relevant baseline characteristics of participants in the exercise and control groups. The mean values reflect the control and exercise group to be more or less homogeneous which can be attributed to randomization.

Table 2: Baseline Clinical Data

Variable	Exercise (N=40)		Control (N=40)	
	Mean	SD	Mean	SD
Glycosylated Haemoglobin (%)	9.01	3.11	9.32	2.32
Body Mass Index (kg/m^2)	33.53	6.93	30.84	5.36
Waist to Hip Ratio	0.86	0.08	0.88	0.11
Energy Expenditure (METS)*	1662	343-3525	1347	714-2578.5

N= Number of patients
SD= Standard deviation
BMI adjusted at baseline
*Median (min-max)

The distribution of the scores in the dietary and medication categories of the Diabetes Self-Care Activity Questionnaire are reported in tables 3-8 and are represented by the absolute and relative (percentages) frequency of responses to items probed. Results are presented under the following sub-sections:

1. Dietary habits; and
2. Medication routine (including urine glucose monitoring)

5.8.1 Dietary Habits

The results pertaining to the dietary habits of the respondents are presented in tables 3 to 6. There were four dietary questions posed to the subjects, these were:

- How often was a recommended diet followed over the past week?
- What percentage of their meals included high fibre foods?
- What percentage of their meals included high fat foods?
- What percentage of their meals included complex sugars?

Table 3: Adherence to Recommended Dietary Practices

Adherence to Recommended Dietary Guidelines	Control n=40▲		Exercice n=40▲▲		Overall n=80	
	n (%)		n (%)		n (%)	
	Pre*	Post**	Pre	Post	Pre	Post
Always	14 (35.00)	27 (67.50)	22 (55.0)	26 (65.0)	36 (45.00)	53 (66.25)
Usually	9 (22.50)	9 (22.50)	4 (10.0)	7 (17.50)	13 (16.25)	16 (20.00)
Sometimes	13 (32.50)	3 (7.50)	7 (17.50)	6 (15.00)	19 (20.00)	9 (11.25)
Rarely	2 (5.00)	0	5 (12.50)	1 (2.50)	7 (8.75)	1 (1.25)
Never	2 (5.00)	1 (2.50)	2 (5.00)	0 (0)	4 (5.00)	1 (1.25)

*** E vs C pre : p=0.14**
**** E vs C post : p=0.61**
▲ pre vs post in control group: p=0.01
▲▲ pre vs post in exercise group: p=0.59

The distribution of the scores in the 5 categories of "adherence to recommended dietary guidelines" occurring in the previous week is reported in table 3. The subjects were requested to indicate how often they did adhere to the dietician's guidelines when preparing or eating their meals. There was no significant differences when comparing the exercise to the control groups at baseline (p=0.14) and when comparing the groups at the end of the study (p=0.61). When comparing changes in the exercise group changes over the 20 week period there was no significant differences observed (p=0.59), however when comparing changes in the control group (dietary education) over the 20 week period significant (p=0.01) improvement was reflected. The major shift in the results of the control group when questioned after the 20 week intervention was seen in the increased number of subjects who indicated that "always" followed a recommended diet. The overall cohort of subjects (66%) indicated at the end of the study that they "always" follow a recommended diet as compared to the baseline data which constituted of (45%) the subjects.

Tables 4: Consumption of High Fibre Foods

Percentage of High-Fibre Foods in a Meal	Control n=40▲		Exercice n=40▲▲		Overall n=80	
	n (%)		n (%)		n (%)	
	Pre*	Post**	Pre	Post	Pre	Post
0%	0	(5.00)	0	1 (2.50)	0	(3.75)
25%	15 (37.50)	14 (35.00)	14 (35.00)	15 (37.50)	29 (36.25)	29 (36.25)
50%	12 (30.00)	15 (37.50)	13 (32.50)	19 (47.50)	25 (31.25)	34 (42.50)
75%	8 (20.00)	8 (20.00)	9 (22.50)	4 (10.00)	17 (21.25)	12 (15.00)
100%	5 (12.50)	1 (2.50)	4 (10.00)	1 (2.50)	9 (11.25)	2 (2.50)

*** E vs C pre : p=1.00**
**** E vs C post : p= 0.72**
▲ pre vs post in control group: p= 0.38
▲▲ pre vs post in exercise group: p= 0.47

The distribution of the total scores regarding the "consumption of high fibre food" among subjects is reflected in table 4. The subjects had to indicate what percentage of their weekly meal consisted of high fibre foods. The term high fibre was explained to the subjects in layman terms and examples where given. As reflected in table 4 there was no significant differences at baseline when comparing exercise and control groups (p=1.00) as well as the end of the study (p=0.72). When comparing the both groups over the 20 week period it was also found that there was no significant differences within the control (p=0.38) and exercise groups (p=0.47). From the table one can see that overall, the majority of the subjects are distributed either 25% or 50% category i.e. at baseline and at end of the which is in accordance to the norms stipulated by Frost, Dornshorst and Moses [15].

Table 5: Consumption of High-Fat Foods

Percentage of High-fat Foods in a Meal	Control n=40▲		Exercice n=40▲▲		Overall n=80	
	n (%)		n (%)		n (%)	
	Pre*	Post**	Pre	Post	Pre	Post
0%	16 (40.00)	13 (32.50)	11(27.50)	15 (37.50)	27 (33.75)	28 (35.00)
25%	17(2.50)	25 (62.50)	17 (42.50)	18 (45.00)	34 (42.50)	43 (53.75)
50%	4 (10.00)	0	10 (25.00)	7 (17.50)	14 (17.50)	7 (8.75)
75%	2 (5.00)	2 (5.00)	1 (2.50)	0	3 (3.75)	2 (2.50)
100%	1 (2.50)	0	1 (2.50)	0	2 (2.50)	0

*** E vs C pre : p= 0.41**
**** E vs C post :p= 0.009**
▲ pre vs post in control group: p= 0.053
▲▲ pre vs post in exercise group: p 0.57

Table 5 represents the distribution of the subjects consuming high-fat foods under the sub-scales ranging form 0%-100%. In questioning how often the participants consumed high-fat foods over the previous seven day period, a good trend was observed because of an overall reduction in the undesirable, high-fat categories (75% and 100% category) and an increase in the low-fat consumption (25%) category. More participants in the control group moved to low-fat categories post intervention, which is indicative that, in this respect, diet education alone was more effective than diet education and exercise which showed no-significant change (p=0.5). When comparing between-group data there was a highly significant difference between groups (p=0.009) at the end of the study which can largely be ascribed to significant (p=0.05) pre and post differences in the control group. As in the case of analysis dealing with "adherence to dietary recommendations", the exercise group could be viewed as being too reliant on the exercise intervention as a treatment modality as opposed to the dietary adherence. In viewing the overall data the majority of the subjects post intervention (n=43; 53.75%) indicated that 25% of their diet consisted of high fat food as compared to the baseline data where only 34 (42.50%) had indicated this to be the case. This reflects a reduction in the 100%, 75% and 50% category and a shift to the lower (25% to 0%) fat consumption categories.

Table 6: Consumption of Complex Sugars

Percentage of Complex Sugars Eaten in a Meal	Control n=40▲		Exercice n=40▲▲		Overall n=80	
	n (%)		n (%)		n (%)	
	Pre*	Post**	Pre	Post	Pre	Post
0%	20 (50.00)	23 (57.50)	20 (50.00)	24 (60.00)	40 (50.00)	47 (58.75)
25%	15 (37.50)	16 (40.00)	16 (40.00)	14 (35.00)	31 (38.75)	30 (37.50)
50%	4 (10.00)	1 (2.50)	3 (7.50)	1 (2.50)	7 (8.75)	2 (2.50)
75%	1(2.50)	0	1 (2.50)	1 (2.50)	2 (2.50)	1 (1.25)
100%	0	0	0	0	0	0

* E vs C pre : p= 1.000 ▲ pre vs post in control group: p= 0.50

** E vs C post : p= 0.91 ▲▲ pre vs post in exercise group: p= 0.38

In questioning how often the participants consumed foods high in complex sugars over the previous seven-day period, there was no significant difference (p=0.91) in post test scores between the groups. This could reflect good dietary adherence at base-line, thus leaving the groups with little room for improvement (less that 10 % of total energy being derived form complex sugars) [15]. With regard to food high in complex sugars majority of the subjects indicated that their weekly meals consisted of 0% pre: 40 (50.00) vs. post 47 (58.75) or 25% pre: 31 (38.75) vs. 30 (37.50) of their weekly meals. Although better distribution trends were observed in the exercise group, the changes were non significant (p=0.38). This could be attributed to the potential realisation in the exercise group regarding the value of low glycaemic index and simple carbohydrate for sustained energy-release during exercise. When viewing the overall data it is clearly seen that majority of the individual consumed no complex sugars at baseline 40 (50%) and a slight improvement has been seen at 20 week whereby 47 (58.8%) indicated they consumed no complex sugars.

5.8.2 Glucose Monitoring

Subjects who were receiving oral medication (tablets only) were expected to use urine dip-stick tests to monitor their glucose levels. The use of glucose testing strips for capillary finger-prick monitoring levels was reserved for patients on insulin therapy.

Table 7: Adherence/Frequency of Urine Tests

Adherence to Urine testing	Control (n=40)▲		Exercise (n=40)▲▲		Overall (n=40)	
	n (%)		n (%)		n (%)	
	Pre*	Post**	Pre	Post	Pre	Post
0% Never	37 (92.50)	35 (87.50)	34 (85.00)	24 (60.00)	71(88.75)	59(73.75)
25% (1/4) Rarely	1 (2.50)	1 (2.50)	3 (7.50)	12 (30.00)	4 (5.00)	13 (16.25)
50%(1/2) Sometimes	0.00	3 (7.50)	0.00	1 (2.50)	0.00	4 (5.00)
75% (3/4) Usually	1 (2.50)	1 (2.50)	2 (5.00)	1 (2.50)	3 (3.75)	2 (2.50)
100% (All) Always	1 (2.50)	0.00	1 (2.50)	1 (2.50)	2 (2.50)	2 (2.50)

* E vs C pre : p= 0.75
** E vs C post : p= 0.001
▲ pre vs post in control group: p= 0.22
▲▲ pre vs post in exercise group: p= 0.14

Table 7 reports on the participants' response regarding the percentage of the urine testing adhered to by the recommendation of a doctor. The overall majority of the subjects fell within the 0% (never) category at baseline, as well as after 20 weeks as availability to consumables to test urine was unavailable to subjects on a weekly basis. There was a slight improvement in the exercise group at 20 weeks where 30% of the people appearing in the "rarely" as compared to 60% who "never" used to test their urine at baseline, but the within-group changes were non-significant ($p>0.05$) in both the groups. When comparing values between groups at the 20 week, there was a significant difference ($p=0.001$). It was also observed that subjects in the exercise group indicated testing their urine more frequently, i.e. in the category "rarely" (30%) at twenty weeks as compared to

baseline where only (7.5%) tested. It was indicated during the education sessions in both groups that some of the subjects did purchase a dip-stick to have a more stringent control over their glucose.

5.8.3 Medication Usage

The distribution of the scores in the 5 categories of "adherence to medication" is reported in table 8. The subjects were requested to indicate how much (volume) of the recommended diabetes medication (tablets) did the subjects consume. They could indicate in any one of the following categories: all, most, some none of them or no pills taken to control diabetes mellitus.

Table 8: Adherence to Medication Usage

Adherence to Medication Usage (volume)	Control n=40▲		Exercice n=40▲▲		Overall n=80	
	n (%)		n (%)		n (%)	
	Pre*	Post**	Pre	Post	Pre	Post
All of Them	39 (97.50)	37 (92.50)	38 (95.00)	39 (97.50)	77 (96.25)	76 (95.00)
Most of Them	1 (2.50)	3 (7.50)	0.00	1 (2.50)	1 (1.25)	4 (5.00)
Some of Them	0.00	0.00	1 (2.50)	00.00	1 (1.25)	0.00
None of Them	0.00	0.00	1 (2.50)	0.00	1 (1.25)	0.00
Don't take Pills	0.00	0.00	0.00	0.00	0.00	0.00

* E vs C pre= 1.000
** E vs C post= 0.62
▲ pre vs post= 0.32
▲▲ pre vs post= 0.39

The majority (96.25%) of the cohort indicated good adherence in ingesting all of their prescribed medication. Comparison of the exercise and control groups at baseline showed no significant difference (p=1.000) in the adherence to medication usage. Similar results were observed when comparing the post-test data results, with a non-significant difference (p=0.62) emerging between the exercise and control group. When comparing within group data a non-significant

difference was evident in the control group (p=0.32). The same results of non-significance were observed in the exercise group (p=0.39). In essence, subjects were compliant and did adhere to medication usage and there was no change (p>0.05) in this during the study.

5.9 Discussion

Self-care management in DM is of importance, because the assumption is that adoption of a healthy lifestyle will produce better metabolic control and that this will help to avoid subsequent, acute and long-term complications of the disease. Many studies have investigated the link between DM self-care and level of DM control as well as psychosocial factors which may be predictive of self-care [16, 17]. Prospective cohort studies show that "low-risk lifestyle behaviour" can slow onset of type-2 DM in both males and females [18, 19].

The main dietary component for a diabetic individual should be carbohydrate containing foods with a low glycaemic index and cis-monounsaturated fat. A combination of carbohydrate and cis-monounsaturated fatty acids should provide 60-70% total daily energy intake. Total fats should be restricted to 35% total energy. Cis-monounsaturated fatty acids should provide between 10-20% total energy. Saturated fatty acids should provide fewer than 10% of total energy. Protein intake should range between 10-20% of total energy. Protein intake should not go below 0.6 g/kg normal body weight/day but should be at the lower end of the range (0.8 g/kg body weight/day) in cases of nephropathy or where abnormal microalbuminuria has been identified [15].

This study used a quantitative method in order to gain a better understanding of the attitudes, knowledge and practices of black type-2 diabetic patients in a resource-poor setting with respect to dietary habits and medication usage. When examining their diet from a nutritional point of view, good practices were observed in certain categories after the 20 week of intervention. With regards to dietary adherence the baseline response indicated no significant difference (p=0.14) between the exercise and control groups, with the majority (45%) of the complete

cohort of participants at baseline indicating that they "always" followed a recommended diet. This was encouraging, but could be improved. With regards to the question on consumption of high-fibre foods, the majority of the subjects did indicate that high-fibre foods made up either a quarter or half of their weekly diet. This can be viewed as a good practice, but could be improved with proper education on dietary habits. The participants in the exercise and control groups consumed low-fat diets as suggested by the data where the majority of the subjects indicated that high fat food constituted between 0 - 25 % of their weekly diets. Diets high in carbohydrate (maize, sorgum and brown bread) and low in saturated fat are typical of traditional African diets [20, 21]. With regard to food high in complex sugars the baseline response indicated that the majority of the total cohort fell in the low categories i.e. either 0% or 25% of their total weekly meal, these categories of synthetic sugars indicated in general good practice. The low energy intake is very similar to that found in two other studies in the Northern Province in South Africa in black adults and although portion sizes were demonstrated to individuals, it was difficult for the subjects to establish appropriate portion sizes [20, 21]. The major barrier to dietary compliance was educating these individuals on food portion sizes and foods allowed. Prior to the study, there was no practice of regular scheduled appointments to visit the outpatient dietician for dietary education and very limited knowledge of portion sizes. Patients received basic information on dietary education during a routine visit to the hospital once every six months. Visits to the dietician were not compulsory and patients received conflicting information from nurses and other hospital staff on diet. It became evident that nurses and other health care workers are not qualified to counsel these patients on dietary education. These above-mentioned health workers have poor/limited knowledge on dietary education and advice on recommended traditional diets. The information given was inconsistent, incorrect or confusing to patients.

In South Africa the test to measure blood glucose and HbA_{1c} is expensive whilst home glucose testing requires considerable educational input to be of any benefit [5]. In general what is offered to diabetics accessing public health facilities in resource-poor South African settings is random blood or urine glucose testing at

the local clinic. The accuracy of monitoring of glycaemic control and the usefulness of these tests in diabetic management has been questioned. Although there is strong evidence emphasizing health benefits of lifestyle modification for people with type-2 DM, less is known about the efficacy of primary care-based strategies for achieving the physical activity and dietary changes necessary to acquire these benefits [22]. This suggestion has been validated by recent systematic reviews addressing behavioural counselling (routine counselling with follow up) by primary health care workers to promote the values of healthy eating [23] and physical activity [24, 25] to the general population. The reviews acknowledge the difficulty of drawing conclusions for primary care-based studies completed to date, because of the lack of rigor and variation in population and study designs.

Most recently the Diabetes Prevention Programme (DPP) [26], in the United States examined strategies to evaluate the safety and efficacy of lifestyle and pharmacological interventions to delay or prevent development of type-2 DM in a diverse, high-risk population with impaired glucose tolerance. The DPP study reported that participants could reduce their chance of developing DM by 58% through physical activity and diet. The DPP's major goal was to achieve a minimum of 150 minutes of physical activity, similar in intensity to brisk walking and a minimum of 7% weight loss and maintenance per week.

There is good evidence that nurses and dieticians have a role to play in counselling and managing patients diagnosed with type-2 DM [27-30]. However, their role in promoting healthy lifestyle choices for people with pre-DM is less evident. Referral to specialized diabetic centres such as the Centre for Diabetes Endocrinology (CDE) or specialized regional focus groups in support of DM, can provide patients with important information regarding outcomes but evaluation of such data is limited and was not reported in this study. Furthermore centres such as CDE are private medical centres which may not be accessible to patients from a resource-poor setting.

In this study all the participants were type-2 diabetics and mostly overweight and had poor glycaemic control. Although the results of the majority of the participants showed favorable practices, it is difficult to determine the compliance with good dietary practices. The question may arise as to whether poor dietary knowledge and education contributed to the poor management of the factors stated above. A shortcoming of the dietary intervention program was that we were unable to control their dietary intake for the period of 20 weeks, due to cost implications. Although it was observed that the intake for dietary fibre was reasonable, this was not sufficient to bring about a reduction in the LDL cholesterol, which is one of the benefits associated with high dietary fibre intake [31].

The recommendation based on this study would be that proper dietary education be given to the patients attending the hospital on a regular basis, and that the dietician should always be available for consultations. Education should include a diet plan starting from the traditional staple diets, but emphasising a portion size in layman's terms, probably using "cup" sizes for easy comprehension. Patients should be advised on what the glycaemic index represents and the importance of this in simple terms, as well as what impact it may have on the glucose levels. Nurses and other health care workers who assist diabetic patients should be trained in optimal dietary education which will be beneficial to diabetic patients.

Pertinent to patient education and part of lifestyle modification is glycaemic control which encompasses self-monitoring or home blood glucose monitoring and administration of medication. It was observed in this study that patients attending the out-patient clinics in Mamelodi Hospital were required to visit the hospital every month to collect their oral medication. Due to the lack of resources and budget allocated by the Department of Health, blood glucose and blood pressure monitoring and urine tests are limited to once a month and once every six months respectively, with HbA_{1c} done once a year. Therefore diabetes monitoring (HbA_{1c}), urine dip-stick test and finger prick tests are not done on a regular basis to advise the subjects on how good or poor their diabetes management is.

In conclusion, it was evident that adherence to recommended weekly dietary practices in this cohort could be improved, but generally, the intake of high fibre foods, high fat foods and complex sugars was acceptable. While adherence to urine testing was poor, intake of prescribed medication was good. The dietary education group did reduce their high fat content in foods more than the exercise and dietary education group, while the latter group improved their urinary testing more than the group receiving dietary education only. This indicates an improved awareness of these aspects brought about by the intervention. However, exercise interventions and dietary education have to be a continuous process in order to impact positively on diabetes care, knowledge and activities among persons with type 2 diabetes mellitus, particularly in a resource poor setting.

5.10 References

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Chapter 6

Summary, General Conclusions and Recommendations

Type-2 DM is the most common chronic disease worldwide which requires continuing medical care. The number of people with type-2 DM is increasing rapidly. Six percent of the world population suffers from this disease, but only half of them have been diagnosed [1]. Strict metabolic control for micro-vascular related outcomes and blood pressure control for micro- and macro-vascular-related outcomes seem to be important in the prevention of vascular complications. In diabetics, micro and macro-vascular disease is the major cause of morbidity and mortality [2, 3, 5]. In order to reduce DM complications blood glucose, blood pressure and blood lipid control as well as foot care are imperative. Once DM has been diagnosed treatment with oral medication is often avoidable but DM patients are confronted with the need for life-style adaptations that entail, weight reduction, adapted nutrition requirements and more exercise.

The primary aim of this research was to study the effect of a community-based exercise (Progressive Resistance Training) and lifestyle (Dietary Education) intervention on health outcomes among African patients with type-2 DM in a resource-poor setting, with respect to the variables stated below.

- Part 1: Levels of physical activity (Chapter 2)
- Part 2: Glycosylated haemoglobin and lipid profiles (Chapter 3);
- Part 3: Morphological, musculoskeletal and cardio-respiratory fitness (Chapter 4); and
- Part 4: Activities of diabetes care (Chapter 5)

6.1 Brief Description of the Study

The study was undertaken in Mamelodi, a suburb in the City of Tshwane Metropolitan Municipality in the province of Gauteng, South Africa. The participants (n=80) included black male (6=control group and 11=exercise group)

and female (34=control and 29=exercise group) participants from 40-65 years with type 2 DM without complications and a known duration of the disease for at least one year. Most participants were recruited from the outpatient clinic at the Mamelodi government hospital whilst they were waiting to be seen by a doctor. Participants were also recruited from local churches in the Mamelodi area.

The duration of the study intervention programme was 20-weeks. Due to availability of subjects the study was staggered and therefore spanned over a period of 18 months in total (February 2004-June 2005), and was conducted in periods of 20 weeks until the targeted number of subjects were obtained. The YMCA hall in Mamelodi was used to perform the weekly intervention of progressive resistance exercise and dietary educational sessions.

6.2 Main Findings

Part 1: **Habitual Physical Activity among an African Cohort of Persons with Type 2 Diabetes Mellitus in a South African Resource-Poor Community Setting**

Results: Using the short version of the International Physical Activity Questionnaire (IPAQ) the cohort showed a distribution of 16 (20.0%) subjects in the low activity category, 49 (61.25%) in the moderate activity category and 15 (18.75%) in the vigorous activity category, respectively. The median baseline weekly energy expenditure (METS) was 2052.5 (p25 - p75; 677 - 2793). Gender had a differentiating effect on physical inactivity (sitting time) with males (median 180 minutes) spending significantly (p=0.02) more time sitting than females (median 120 minutes). However gender, age, and BMI had no significant differentiating effect on categories of physical activity or energy expenditure. Similarly age and BMI did not influence levels of physical inactivity (sitting time).
Conclusion: The prevalence of physical inactivity at baseline among the cohort of patients studied was moderately high. Most subjects reported doing physical activity of a moderate nature, with low energy expenditure. Males were more

inactive than females. Efforts are needed to encourage active living and discourage sedentary habits, among patients with type-2 DM.

Part 2: **Effects of Progressive Resistance Training (PRT) on Glycosylated Haemoglobin (HbA_{1c}) and Lipid Profiles in Participants with Type 2 Diabetes Mellitus.**

Results: On measuring blood glucose and lipid profiles, the following pre-post intervention changes (mean (SD) were found for the PRT vs. CT for HbA_{1c} (PRT: pre 9.01 (3.1) vs. post 8.47 (2.4); p=0.04 vs. CT: pre 9.32 (2.3) vs. post 9.17 (2.5)%: p=0.72), TC (PRT: pre 4.92 (1.10) vs. post 4.69 (0.81); p=0.11 vs. CT: pre 5.08 (0.84) vs. post 5.04 (1.02) mmol/L: p=0.09), LDL (PRT: pre 3.05 (0.97) vs. post 2.89 (0.74); p=0.19 vs. CT: pre 3.17 (0.86) vs. post 3.11 (0.93) mmol/L: p=0.19), HDL (PRT: pre 1.05 (0.25) vs. post 1.09 (0.28); p=0.13 vs. CT: pre 1.27 (1.11) vs. post 1.09 (0.52) mmol/L: p=0.87), TG (PRT: pre 1.06 (0.84-1.74) vs. post 1.04 (0.79-1.52); p=0.16 vs. CT: pre 1.29 (1.1-1.9) vs. post 1.2 (0.95-2.03) mmol/L: p=0.73). However, none of these changes within the PRT group were significantly better (p>0.05) than that in the control (dietary intervention only) group.

Conclusion: The PRT and dietary education program combined failed to show a better improvement in metabolic parameters, than a dietary education program alone. Although this study failed to demonstrate a statistically significant change of at least 1% in the HbA_{1c} it is important to note that even the 0.5% difference achieved, can be considered as clinically significant. PRT needs to be of sufficient frequency and intensity to be effective as a treatment modality in persons with type 2 diabetes.

Part 3: **The Efficacy of a 20-Week Progressive Resistance Training Programme on Morphological, Musculoskeletal and Aerobic Fitness in Participants with Type 2 Diabetes Mellitus.**

Results: On measuring morphological, musculoskeletal and cardio-respiratory fitness, the following pre-post intervention changes were found for the PRT vs. CT. Umbilical abdominal circumference (PRT: pre 106.91 (16.16) vs. post 104 (15.26); p=0.09 vs. CT: pre 105.0 (14.38) vs. post 105.66 (14.07) cm: p=0.58); anterior abdominal circumference (PRT: pre 100.34 (12.88) vs. post 98.34 (10.44) cm; p=0.07 vs. CT: pre 99.74 (12.86) vs. post 96.63 (12.50) cm: p=0.08); body mass index (PRT: pre 33.53 (6.92) vs. post 33.37 (6.76); p=0.70 vs. CT: pre 30.85 (5.36) vs. post 31.36 (5.58): p=0.37), waist to hip ratio (PRT: pre 0.85 (0.08) vs. post 0.85 (0.09); p=0.60 vs. CT: pre 0.89 (0.14) vs. post 0.86 (0.09): p=0.13); fat percentage (PRT: pre 45.09 (6.04) vs. post 44.55 (5.99); p=0.06 vs. CT: pre 42.30 (6.39) vs. post 42.12 (6.59) %: p=0.96). None of these morphological changes within the PRT group were significantly better (p>0.05) than that in the CT group. Muscular endurance (wall squat) scores were PRT pre 50.5 (29-109) vs. post 115 (58-172.5); p=0.0011 vs. CT: pre 33 (21.5-54.5) vs. post 51.5 (37-121) sec; p=0.0017), with a greater change in CT group (p=0.004); muscular strength (abdominal crunches) PRT pre 35.12 (10.8) vs. post 35.65 (9.30); p=0.81 vs. CT: pre 30.27 (9.62) vs. post 34.07 (11.91) reps: p=0.03), flexibility (sit and reach) PRT pre 37.32 (9.13) vs. post 38.81 (9.56); p=0.17 vs. CT: pre 39.28 (8.73) vs. post 39.35 (9.25) cm; p=0.92). Aside from the wall squat (p=0.004), none of these musculoskeletal changes between the groups differed significantly (p>0.05). Six minute walk distance was PRT: pre 324.18 (114.88) vs. post 445.78 (69.67); p=0. 00 vs. CT: pre 353.98 (128.90) vs. post 440.60 (104.41) m: p=0.00). Ratings of perceived exertion (RPE) in the PRT vs. CT for the 6 min walk showed lower indices of pre-exercise dyspnea (0.25±0.52 vs. 0.48±0.94) and fatigue (0.21±0.42 vs. 0.63±0.87; p≤0.01) and similar post-exercise dyspnea (1.95±1.28 vs. 1.98±1.61) and fatigue (2.03±0.97 vs. 2.3±1.8) - despite the PRT subjects being able to cover a greater distance in the 6 min, although the latter was not statistically significant (p=0.29).

Conclusion: PRT and dietary education had no significant superior benefit than dietary education alone on body composition, musculoskeletal and cardio-respiratory fitness. An inadequate intensity and duration of the PRT intervention are possible reasons for not observing an effect.

Part 4: **Influence of a Dietary Education Programme on Diabetes Care Knowledge and Activities among Person with Type 2 Diabetes Mellitus**

Results: With regards to dietary adherence at 20 weeks, the overall data suggests that a large proportion of subjects always (66.25%) adhered to a recommended diet as opposed to usually (20.00%) or sometimes (11.25%). Although the CT group adherence improved significantly ($p=0.01$) the change was not significantly better ($p=0.61$) than that of the PRT group. The majority of the cohort indicated good practice in high-fibre food intake making up either a quarter (36.25%) or half (42.50%) of their diet but there was no change ($p<0.05$) during this study. The majority of the cohort indicated that high-fat foods make either none (35.00%) or a quarter (43.75%) of their weekly meals and the CT group improved significantly ($p=0.009$) more in reducing the high fat content of their weekly meals than the PRT group after the study. The majority of the subjects indicated good practice with food high in complex sugars making up make either none (58.75%) or a quarter (37.50%) of their weekly meals and there was no change ($p>0.05$) in this during the study. The majority of the subjects did not adhere to weekly urine testing with (73.75%) “never” doing so and (16.25%) “rarely” tested their urine over the previous 7 days, but the PRT group adhered significantly ($p=0.001$) more to this practice than the CT group, after the study. The majority (95.00%) of the cohort indicated good adherence in ingesting all of their prescribed medication and there was no change ($p>0.05$) in this during the study.

Conclusion: It was evident that adherence to recommended weekly dietary practices could be improved, but generally, the intake of high fibre foods, high fat foods and complex sugars was acceptable. While adherence to urine testing was poor, intake of prescribed medication was good. The dietary education group did reduce their high fat content in foods more than the PRT group, while the PRT

group improved their urinary testing more than the CT, which indicates an improved awareness of these aspects brought about by the intervention. However, exercise interventions and dietary education has to be a continuous process in order to impact positively on the diabetes care, knowledge and activities among persons with type 2 diabetes mellitus.

6.3 General Conclusion

1. Although the current PRT intervention study did not prove to be more effective than dietary education alone, and may raise a question with respect to clinical benefit, the introduction and implementation of exercise in the subjects' lives created an awareness of the importance of exercise in managing DM.
2. Although his study failed to demonstrate a statistically significant improvement of at least 1% in the HbA_{1c} it is important to note that even the 0.5% difference achieved is of clinical significance but would need a larger sample to prove statistical significance.

   2. The limited effect of the exercise intervention may have been attributed to the exercise session not being intensive enough or the relatively small sample size. As stated the subjects that were recruited were not participating in structured physical activity, but in a resource poor setting, many individuals walk to their destinations and thus daily walking activity could not be controlled, in either of the groups, thus diluting the effect of the PRT in the exercise group.

6.4 Recommendations for Future Research

On the basis of this study, the following recommendations are made for further research on exercise and type 2 DM patients:

1. There is a need for more research into different combinations of intensity-specific types and volumes of progressive resistance training, as a form of physical activity, required for greater efficacy in managing type-2 DM.

2. Post randomisation matching of groups with respect to confounding variables such as age, gender and exercise status, and HbA_{1c} status (poor versus well controlled), should be addressed in future study design.
3. Supervised exercise interventions should be sustained for at least one year duration with clinical and exercise variables being re-tested in follow-up after a one year period.
4. A controlled diet should be implemented together with a structured exercise program to observe if there would be major changes in the clinical variables such as lipid profiles, BMI, and $HbA_{1c.}$
6. The effects of well structured aerobic-type exercise, resistance-type and a combination of these should be investigated in this population.

6.5 Recommendations for Practice

On completion of this research the following recommendations for practice are made:

1. All DM patients should visit dieticians for structured dietary education, specifically on proper dietary intake;
2. Continuous service of a biokineticist/exercise scientist should be available at all public hospitals to evaluate the physical activity status of individuals, educate patients on the value of physical activity in managing DM and its co-morbidities; and to provide home-based exercise programmes.
3. Accordingly, continued supervised exercise sessions of suitable frequency, duration and intensity using basic equipment should be provided at community centres.

6.6 References

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