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ASSESSMENT OF NUTRITIONAL COUNSELING FREQUENCY ON WEIGHT
STATUS IN RENAL TRANSPLANT RECIPIENTS

BY

KELLY BUTLER

A thesis submitted in partial fulfillment of the requirements for the

Master of Science

Major in Nutrition and Exercise Sciences

Specialization in Exercise Science

South Dakota State University

2017

ASSESSMENT OF NUTRITIONAL COUNSELING FREQUENCY ON WEIGHT
STATUS IN RENAL TRANSPLANT RECIPIENTS

KELLY BUTLER

This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science degree and is acceptable for meeting the thesis requirements of this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Matthew Vukovich, Ph.D., Date
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ABBREVIATIONS

RTR	renal transplant recipient
TX	transplant
ONS	oral nutritional supplementation
RE	resistance exercise
PA	physical activity
BPAR	biopsy-proven acute rejection
TG	triglycerides
DM	diabetes mellitus
MNT	medical nutrition therapy
RD	registered dietitian
CKD	chronic kidney disease
EE	energy expenditure
ESRD	end stage renal disease
HX	history
CVE	cardiovascular event
CVD	cardiovascular disease
GFR	glomerular filtration rate

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ABSTRACT

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Objective: The goal of this study was to determine if there is an association between educational interventions by a RD and weight in the twelve months' post-transplantation. A secondary aim is to study trends in blood lipid profiles in participants and the number of times visited with a RD.

Methods: A retrospective study of electronic medical records from consenting, de-identified RTR at a Midwest transplant center were collected. Specific biological and anthropometric measures were analyzed.

Results: Patients that met with the out-patient dietitian more frequently (4 to 9 times) experienced less weight gain than patients that only saw the RD once. Changes in LDL, HDL and TGs were greater in the patients with the most visits compared to those with less frequent visits. Females saw no significant change among tertiles. Males who had greater than four visits lost more weight and had improved BMIs compare to male patients who visited with a clinical dietitian only one time.

Conclusions: Renal transplant recipients experienced less weight gain and had lower BMIs at 12-months post-transplant if they saw the out-patient dietitian four to nine times compared to the patients that only had one to two visits. As for the secondary aim, male participants experienced improved LDL and TG levels with increased visits to the RD. Female participants did not see any significant changes in measured variables.

Chapter 1

Review of Literature

Current evidence on renal transplant recipients and health outcomes relating to weight.

Authors	Subject Characteristics	Study Design	Outcome Measures	Major Findings
Fernandes et al. ¹	n=102 Brazilian based study; 55 men and 47 women; mean age 49.04 ± 1.15y and 114.3 ± 9.0 mo post-tx	Retrospective cross-sectional study design. Multiple logistic regression was used to evaluate CVD risk factors and excessive adiposity post-tx	Pre-tx weight and height, date of tx, hip and waist circumference, % body fat, blood pressure, blood samples for TC, HDL-C, TGs, glucose, calcium, phosphorus, sodium, potassium, total protein and albumin.	Post- tx body weight increase was observed in total group, as well as within each group; mean BMI post-tx for total group and women were indicative of overweight; dyslipidemia was significantly higher in obese women than obese men
Ryan et al. ²	n=32 Adult kidney transplant recipients, residing in Auckland Australia. Recruited during post-transplant care within 1 month of tx.	A single-center, single-blind, randomized controlled trial. Standard care group vs. Intensive nutrition intervention group. An analysis of covariance adjusted for baseline.	Primary - 6 month post-tx weight. Secondary - weight change at 3, 6, and 12 months post-tx, biochemical measurement changes, adherence to dietary advice, level of physical activity, quality of life and a cost-effectiveness analysis of intensive nutrition intervention.	Participants will be randomized into an intensive nutrition intervention conducted a renal dietitian or standard of care group; data collection will occur at baseline, 3, 6, and 12 months post-tx – including markers for glucose metabolism and metabolic risk
Sood et al. ³	n=241,381 Only study that assessed post-transplant-related outcomes in adult patients. Included patients from 17 different countries.	A meta-analysis of retrospective observational studies was created using keywords: obesity, renal transplant and transplantation, postoperative outcomes and surgical outcomes.	Primary - biopsy-proven acute rejection. Secondary - patient death, allograft loss, type 2 diabetes mellitus, and delayed graft function	Obese tx recipients have a significantly higher risk of BPAR; risk of death was slightly higher; significantly greater risk of allograft loss; delayed graft function was 81% more likely; both patient groups had near identical risk of developing DM
Waal et al. ⁴	n=265	A retrospective cohort analysis	Pre-dialysis RD care, demographic data	Patients that received MNT at Stages 3 and

	Adult patients receiving dialysis at the University of Vermont Medical Center Nephrology Department Outpatient Clinic	of data from patients seen for MNT; divided into two groups: those that received MNT from a RD and those that did not. Fisher's exact test for categorical variables and 2-sample t-tests for continuous variables.	and laboratory data were all collected from the EMR	4 had better outcomes, as measured by disease progression and laboratory values, than those at Stage 5 of CKD.
Cupples et al. ⁵	n=44 Participants received a transplant between August 2007 - August 2009 at a large mid-South university hospital-based transplant institute.	Descriptive, correlational study using secondary data from a larger study. Descriptive statistics and analysis of variance for repeated measures were used to compare.	Dietary intake, physical activity, weight and body mass index.	Participants saw a mean weight gain of 6% from baseline to 6 months post-tx. No significant relationship was noted between weight gain and dietary intake, physical activity, age, race, sex and immunosuppressant drugs.
Dontje et al. ⁶	n=28 Patients recruited from the kidney transplant unit at the University Medical Center of Groningen in the Netherlands between Oct 2007 - Sept 2008.	Longitudinal observational study. Descriptive statistics with lifestyle classifications tested with a linear mixed effect analysis.	Demographics, metabolic characteristics and clinical data were obtained from the EMR. Participants physical activity was assessed using an accelerometer.	BMI ($p < 0.001$) and body fat percentage ($p < 0.001$) increases were significant in the year following tx. Patients did increase their activity for the first 3 months, but then remained stagnant or declined in PA.
Zelle et al. ⁷	n=26 Adult RTR visiting the outpatient medical facility at the University Medical Center Groningen, the Netherlands, from Dec 2007 - Dec 2008.	Observational cohort study. Participants were divided into two groups: stable body fat vs. gained body fat ($>3\%$). Differences were analyzed by chi-square test, changes in time using	Body weight, composition, blood lipids, renal function, dietary intake and physical activity at six wk, 3 mn, 6 mn and 12 mn post-tx.	Body weight gain after transplantation was 5.7 ± 5.0 kg and BMI increased an average of 7.9% in the yr following tx. Most of the weight gain was due to an increase in body fat mass.

		ANOVA and paired sample T-test.		
Heng et al. ⁸	n=19 All male, non-diabetic RTR receiving calcineurin inhibitors but not corticosteroids	Observational case-control study. 9 healthy men matched for height, age, and lean body mass. Continuous and categorical variables were analyzed with one-way ANOVA, followed by Fisher PLSD post hoc test and K2 test.	Clinical examination, medical history and treatment record, dietary interview, blood sampling, resting EE measurements, body composition analysis, the calorimetric chamber was used to determine a 24-hr EE and a dietary questionnaire was complete for four days	Eleven RTR gained more than 5% of their body weight post-tx; three participants saw a change in BMI from overweight to obese; four patients moved from normal BMI to overweight; serum TGs were higher in the weight gain group
Marcen et al. ⁹	n=1000 Adult RTRs from the Hospital Ramon y Cajal, Madrid, Spain; 631 men and 369 women, mean age 42.9 yr with at least 2 yrs follow-up	Retrospective observational study. Comparisons between groups using the Student t-test for continuous variables, the chi-square or the Fisher exact test for categorical variables. Multivariate analysis of BMI and weight gain.	Demographics, time on dialysis, BMI, weight gain, cause of ESRD, immunosuppression therapy, donor age, delayed graft function and acute rejection	At 1 yr post-tx, 50% of recipients had body weight increases above 5% and 30% gained 10%; Pre-tx obesity was associated with older age and females; obese patients saw higher incidence of delayed graft function and wound complications
Sancho et al. ¹⁰	n=294; 160 normal BMI vs. 134 overweight BMI. Adult RTRs from the Hospital Universitario Dr Peset, Valencia, Spain, from Nov 1996-April 2006	Retrospective observational analysis. Demographic variables were compared using chi-square analysis for categorical variables and Student t-test for continuous variables.	Demographic variables, immunosuppression medication, BMI	Overweight recipients total cholesterol (P=0.45) and triglycerides (P=0.027) was greater at 6 months post-tx; both groups increased weight and BMI during the first 6 months
Marks et al. ¹¹	n=247 Morbidly obese RTRs (n=23) compared to	Prospective observational study. Survival was calculated	Patient and graft survival, postoperative complications,	Length of stay was significantly greater in morbidly obese patients compared to

	nonobese RTRs (n=224) between Jan 1995 - Feb 2000 at the Swedish Medical Center, Seattle, Washington	using the Kaplan-Meier method. Comparisons between groups were made using the log-rank sum test and differences in proportions were analyzed using the chi-square method	rejection episodes, length of stay and readmission rate within the first 6 months post-tx.	nonobese patients. Readmission rate within the first 6 months and multiple admissions were higher in morbidly obese recipients
Kugler et al. ¹²	n=502 Participants were consecutive adult organ transplant recipients at the Integrated Research and Treatment Center at Hannover Medical School, Hannover, Germany (261 kidney, 73 liver, 29 heart, 139 lung)	Prospective study. Inferential statistics were used to investigate baseline and follow-up characteristics. Nonparametric tests were used to assess group differences.	Identify patterns of weight change, BMI, type of transplant; demographics, length of stay, pre- and post-tx height, weight, number of acute rejection episodes, prescribed corticosteroid doses after transplant and steroid avoidance	Increased BMI at 6 months post-tx was the only predicting variable to explain overweight or obesity at 12 months
Orazio et al. ¹³	n=156 Renal transplant recipients from a state-wide transplant service in Australia between Oct 2009 - Dec 2010	Retrospective and observational study. Comparison between groups was made using independent samples t-test, Mann-Whitney test and Fisher's exact test or Pearson's Chi-square test	Compliance with new dietetic model of care, demographic information, pre-existing co-morbidities, time on dialysis prior to tx, donor source, immunosuppressant regimen, and BMI at tx	Only 35% of patients met the dietetic model of care plan for the facility; significant weight gain was evident for healthy weight and overweight categories (p<0.01) between baseline and 12 months; 32% of patients moved from healthy BMI to overweight 12 months post-tx
Patel ¹⁴	n=33 Adult RTR at a hospital unit: both inpatient ward and outpatient clinic	Group A was studied prospectively and Group B was studied retrospectively.	Weight gain and BMI at 4 months and one yr post-tx	Group A had significantly lower weight gain and BMI at both 4 months and 1 yr post-tx.
Costa et al. ¹⁵	n=131	A retrospective and	Collected demographic	Baseline BMI was 23.04±4.08 kg/m ² ;

	Adult tx recipients between 1991-2011 receiving outpatient follow-up at the Kidney Transplant Unit of the Federal University of Juiz de Fora in Brazil	observational study. The χ^2 , Mann-Whitney, and Wilcoxon tests were used for statistical analysis.	information, clinical data, calculated BMI pre-tx, 6 mn and 12 mn post-tx	significant increase at 6 mnth and 12 mnth post-tx (24.55±4.2; P<0.001 and 24.65±4.16; P<0.001, respectively)
Lopes et al. ¹⁶	n=23 Adult renal transplant patients with a BMI>27, hyperlipidemia and stable renal function in Pamplona, Spain	Prospective cohort study. Normality was tested by the Kolmorovov test, comparison between was tested by paired t test and Pearson's correlation test was used for variables.	Patients advised to follow AHA Step One Diet and received monthly diet support. An assessment of pre- and post-dietary intake, along with blood samples, body composition and body fat mass.	Statistically significant decreases in consumption of total lipids, saturated fat, and cholesterol were noted. The total population and males saw a decrease in total cholesterol (P<0.05, paired test), but not females alone. Significant decrease in weight and body fat mass for total (P<0.001, paired test) and males and females (P<0.01, paired test)
Courivaud et al. ¹⁷	n=337 Adult patients (67% male) that received a kidney transplant at Saint-Jacques Hospital between June 1993 - Dec 2004	A prospective cohort study. A Cox proportional hazard model, log-linearity, proportionality of risk in time; multivariate analysis	Age, gender, hx of CVE, dialysis mode and duration, cumulative steroid dose, use of calcineurin inhibitors and use of tacrolimus vs. CsA, anthropometric measurements, smoking behavior, blood pressure, lipid profile, glucose metabolism, C-reactive protein, renal function and acute rejection	Older age (P=0.049), male gender (P=0.015), pre-tx BMI (P<0.001) and an increase in BMI ≥5% in the first yr post-tx (P<0.001) were predictive factors for developing metabolic syndrome at 1 yr post-tx
Cofan et al. ¹⁸	n=2793 All patients with a functioning renal transplant on December 31, 2003; residents of Catalonia, Barcelona,	Retrospective observational study. The chi-square test used on proportions, ANOVA to compare means, and	All data collected from the Renal Registry of Catalonia. Age, gender, BMI, morbidity, duration of tx, GFR	Obesity was more prevalent in women (21% vs. 13%; P<0.0001) and was associated with age (45-64 yo; P<0.0001). Duration of tx (P<0.0001) was also

	Spain, aged >14 yo, with a tx between 1990 - 2003	logistic regression to assess risk factors		associated with obesity post-tx
Diaz et al. ¹⁹	n=212 142 males and 70 females renal transplant recipients in Barcelona, Spain.	Prospective observational study with patients divided into 3 groups, according to their BMI. Chi-square, Student t and ANOVA were applied to variables.	Demographics were collected, anthropometric measurements assessed pre- and post-tx, BMI, blood pressure, weight	A 10.3% incidence of obese patients at baseline to 17.9% at 5 yrs post-tx, with females being more prone with weight gain. Progressive increases in total and LDL cholesterol were seen as participants increased BMI
Ei-Agroudy et al. ²⁰	n=815 Nondiabetic living-donor kidney transplant recipients from April 1986 - April 2001 from Mansoura, Egypt	Retrospective observational study. ANOVA was used to compare mean values in three groups. Krushal-Wallis test and chi-square test were use for categorical data.	6 mnth post-tx BMI was calculated; divided sample size into 3 groups: normal weight, overweight, and obese. Collected data including: graft function, complications, graft and patient survival and cause of death	Obese group patients developed post-tx hypertension (p=0.03), diabetes mellitus (p=0.02), hyperlipidemia (p=0.04) and ischemic heart disease (p=0.02) significantly more compared to other groups
Baum et al. ²¹	n=506 RTR between 1983-1998 data was collected from a clinical database at the University of Illinois at Chicago Medical Center and divided into three groups based upon race (AA n=252, W n=113, O n=141)	Retrospective observational study. Between group comparisons were performed using ANOVA with individual comparisons made with Scheffe procedure.	Immunosuppressive therapy, renal function, rejection episodes, graft survival and patient survival variables, changes in BMI, total serum cholesterol and post-tx DM.	African Americans had a significantly higher BMI (p<0.01) at 3, 6, and 12 mn post-tx than W and O groups, but all groups saw significant increase in weight over 12 mnths. Total serum cholesterol levels increased by 24% from baseline to plateau at 3 mnths post-tx (5.9±0.1 mmol/L; P<0.001). The percentage of patients with total cholesterol above 5.14 mmol/L at baseline and 3 mn post-tx were 36% to 71%, respectively (P<0.001)

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Chapter 2

Introduction

In 2014, there were 17,105 renal transplant recipients (RTR) with an average of 3,000 patients added to the waiting list each month^{22, 27, 30}. The prevalence of weight gain following renal transplantation is high. Over 50% of RTR will have an average weight gain of approximately 10% in the year following surgery^{13, 14, 30, 33, 38}. This could be linked to multiple factors, such as immunosuppressant drugs, a more liberal diet, and lack of physical activity; however, previous research has shown that this weight gain is more likely associated with demographic factors^{6, 14}. Gaining additional weight after transplant increases the risk of metabolic syndrome, cardiovascular disease, oxidative stress, increases in cholesterol and triglycerides, and eventually mortality^{6, 27, 33}. Since kidney transplants may need to be replaced during a patient's lifetime, weight gain can also lower their chances of being eligible for another transplant. The current research on RTR and weight gain following surgery is significant and shows a population at risk.

Physical activity (PA) has been shown to reduce the health risks associated with chronic kidney disease (CKD)^{2, 5, 12, 13, 16, 30, 37, 38}. Muscle function, physical activity and cardiorespiratory fitness are low in people with CKD even though a sedentary lifestyle is associated with increased mortality^{5, 28}. Current studies have shown success in weight management when patients are prescribed PA, shown how to perform exercises safely, and follow-up is conducted^{2, 5, 12, 13, 14, 19, 23, 30, 31}. However, the development and implementation of PA programs are stalled by lack of funding, time, and knowledgeable personnel at facilities.⁹ Along with these barriers, patients report fear of injury or worsening their condition and a lack of self-efficacy as factors that prevent them from

becoming more physically active.⁸ Studies show an improvement in glomerular filtration rates, self-reported physical functioning, and quality of life, but it should be noted that PA alone did not always translate to weight loss^{31, 38, 42}. More research is needed to determine if PA leads to decreased mortality and improved long-term quality of life for RTR.

Nutrition interventions play an important role in prevention and management of common health issues associated with renal transplant such as obesity, hypertension, diabetes, and cardiovascular disease^{14, 15, 17, 18, 21, 41, 42}. An intervention conducted by Asai et al. with a registered dietitian providing dietary counseling on a sodium restricted diet to help manage hypertension in renal allograft recipients showed positive improvements in salt intake. The study had participants meet with the clinical dietitian three times over sixty days and showed reductions in sodium intake ($P=0.005$)¹. Goodpaster et al. showed improvements in waist circumference, visceral abdominal fat, hepatic fat content, blood pressure, and insulin resistance in severely obese individuals through a one-year intensive diet and exercise intervention¹¹. These studies highlight the benefits of both intensive and modest dietary interventions being effective in helping manage chronic disease states through dietary education. Limited funding and specialty dietitians available for individual counseling make changes in current renal transplant practices difficult to implement⁶. While there is plenty of evidence that reflects the current risk of weight gain associated with a kidney transplant, there is limited information on how the registered dietitian can help manage this risk through dietary interventions.

Renal transplantation is a rising concern in the United States with the demand for kidneys growing and a limited amount of organs available. Increasing positive outcomes

for RTR through the education of weight management strategies would improve long-term quality of life and potentially more years added to life. Once we better understand the factors associated with weight gain, it will be more realistic to develop solutions in preventing the adverse health outcomes associated with it. The long-term goal is to identify effective nutrition and exercise strategies that will lower the risk of weight gain post-renal transplantation.

2.1 Specific Aims

The primary aim of this study was to determine whether there was a relationship between the amount of weight gained following transplant surgery and the number of visits the patient had with a registered dietitian throughout the transplant process. It is hypothesized that individuals who met with the clinical dietitian more frequently will experience less weight gain.

A secondary aim was to determine if changes in the lipid profile of patients were related to the number of visits the patient had with the dietitian. It was hypothesized that the lipid profile will improve in individuals who met with a dietitian more often.

Chapter 3

Methods

3.1 Study Design

A retrospective analysis of 174 renal transplant recipients' medical records was conducted. Patients had been seen by the inpatient dietitian at Hennepin County Medical Center (HCMC) Transplant Clinic during their initial transplant evaluation. The evaluation is a thorough examination of the patient to determine eligibility for transplant. Patients meet with many different disciplines to gain a better understanding of their individual risk, areas that could be improved upon for better surgery outcomes, and education is provided about the transplant process. It is during this process that the inpatient dietitian provides the foundation of nutrition education. This includes specific dietary recommendations, nutritional risks and the concerns of weight gain post-surgery. Basic suggestions for physical activity is also provided by the dietitian in this beginning group session. After surgery and discharge from the hospital, patients continued to receive nutrition counseling through the out-patient dietitian. For data collection, the electronic medical records were de-identified and information from the initial pre-transplant evaluation, and then at two weeks, 3 months, 6 months and 12 months' post-transplantation. Patients were excluded from the study if they opted-out of records research or if they experienced acute rejection. For analysis, the following information was collected: age, gender, weight, height, BMI, waist circumference, blood lipid levels, cholesterol, blood pressure, fasting glucose measurements and the number of times patient met with RD. Each time the RD charted on a patient was noted as an opportunity

where nutrition and physical activity education was provided. The study looked at records beginning in 2010 through 2015.

3.2 Calculations and Statistics

Tertiles were calculated based on the number of visits the patient had with a clinical dietitian pre- and post-transplant surgery. Outcome variables included absolute and percent change in body weight, BMI, cholesterol, HDL, LDL, and triglycerides and were compared across tertiles utilizing a one-way analysis of variance controlling for age and time between pre- and post- measurements. Data were analyzed for the entire group as well as for females and males separately. Statistical significance was set at $P < 0.05$. When a significant F-ratio was calculated, a Tukey-Kramer HSD post-hoc test was used to locate significant differences among tertiles. Baseline data are reported as mean \pm SD, while change (absolute and percent) in outcome variables are reported as least square mean \pm SE.

Chapter 4

Results

Records of 174 patients were acquired for analysis; nine individuals were eliminated from the analysis because of the need to return to dialysis treatment or death. Baseline characteristics are presented in Table 1 as an entire group as well as by tertiles. There were no significant differences among tertiles for weight, BMI or blood lipids.

Table 2 shows the absolute and percent change in variables by tertiles controlling for age and time since transplant for all patients. Individuals in tertile 3, who visited with the dietitian four to nine times experienced less weight gain than individuals who met with the dietitian only once (tertile 1). Changes (absolute and percent) in LDL ($p<0.054$), HDL ($p<0.08$) and TG ($p<0.07$) occurred to a greater extent in patients in tertile 3 compared to patients in tertile 1.

The absolute and relative changes in outcome variables for female patients are presented by tertile in Table 3. There were no differences among the tertiles for the absolute or percent change in variables.

The absolute and relative changes in outcome variables for male patients are presented by tertile in Table 4. Males who had greater than four visits (tertile 3) with a clinical dietitian lost more weight and improved BMI compare to male patients who visited with a clinical dietitian only one time (tertile 1). Changes (absolute and percent) in HDL ($p<0.07$) occurred in patients in tertile 3 and TG ($p<0.08$) in patients in tertile 2 compared to patients in tertile 1.

Chapter 5

Discussion

The purpose of this study was to observe weight changes in renal transplant recipients in the year following transplantation. The results of this study will help to evaluate the role of the registered dietitian nutritionist and weight management post-transplantation. In the present study, participants who met with the dietitian more frequently experienced less weight gain compared to those who only met with the dietitian once. The secondary aim of the study was to observe any changes in the blood lipid profile of participants during the year post-transplantation. Study participants who met with the dietitian four to nine times experienced changes in LDL, HDL and TG to a greater extent. Female participants did not experience any differences in variables. In comparison, the male participants in the study noted significant changes in weight and BMI with increased meetings with the dietitian. Males also saw changes in HDL and TG profile over the course of the year in those patients that saw the dietitian at least three times.

5.1 Nutrition Counseling

Weight gain following renal transplantation is well documented and results in several negative health consequences^{6, 27, 33}. Nutritional counseling has been shown to help with reducing weight gain and promoting weight loss in numerous populations^{9, 11, 15, 17, 18, 21, 24, 25, 41}. An intensive diet education intervention was designed by a group of registered dietitians for a study conducted by Raatz et. al to observe changes in participants that attended the RD-led classes and/or non-RD-related weigh-in visits. Participants were encouraged to attend all thirty-three visits and attendance was

documented. Individuals who attended more of the RD-led classes experienced significant weight loss ($P=0.021$), with no significant changes between sexes or diabetes status³⁴. While this study reflects a different clinical population than the present study, it does demonstrate how implementing dietary changes with the help of a registered dietitian can lead to improvements in weight. Further evidence of the benefits of nutrition counseling and motivational interviewing on weight loss, physical activity and cardiovascular disease risk factors are reflected in a study conducted by Hardcastle et al¹⁵. The primary aim of the study was to observe any sustained effects of motivational interviewing on weight loss, PA and CVD risk factors at 12-months post-intervention. The group that went through the motivational interviewing intervention with a registered dietitian showed significant reductions in cholesterol during the study and maintained it 12-months later¹⁵. The group that received minimal intervention noticed a significant increase in cholesterol at the end of the intervention and 12-months post-study, along with significant increases in BMI from baseline¹⁵. Hardcastle et al. and others have reported an association with improvement in total cholesterol and triglycerides and the number of sessions with a registered dietitian^{15, 17, 18, 25}. This is similar to the findings noticed in the present study, where the total group saw changes in TGs and LDL with four to nine visits with a registered dietitian, while those who met with a dietitian one time experienced no changes in the lipid profile.

There are gender differences in health outcomes and disease management. A study by Chung et. al examined gender differences in adherence to the sodium-restricted diet, knowledge about the diet and heart failure self-care, and perceived barriers to following the prescribed diet⁷. It was found that men and women perceived similar

barriers; however, women were more adherent to the diet than by men as measured by a 24-hour urine excretion ($P=0.01$), were more likely to recognize signs of excess sodium in-take ($P=0.001$) and edema ($P=0.01$), and were better at understanding how to follow the sodium restricted diet than men⁷. The present study highlights the idea that men and women implement advice and self-care differently. Further research needs to investigate the differences in genders in relation to dietary changes and managing disease states. The present study saw differences between genders in lipid profiles when comparing the number of visits with a RD.

5.2 Limitations of the Study

The present study was able to observe significant changes in weight status, BMI and lipid profiles for participants who visited with a RD at least four times. Conducting the analysis from electronic medical records removed observation bias from the research group. However, there are drawbacks to pulling past medical records for research analysis. A concern when looking at electronic medical records is the potential for different coding among physicians. Transcription errors or misclassification could lead to inaccuracies in data. The researchers are reliant upon measurements being recorded accurately into the database instead of performing them on participants. Along with these potentials problems are those of patient privacy. Researchers made every effort to de-identify patients for use in this study, but it remains a high concern when accessing medical records.

The largest limitation of this study is that the researchers were unable to design the type of dietary intervention provided to the transplant recipients. The out-patient dietitian provided dietary information to the individual based on their more pressing

medical needs. It would have likely included information on weight loss and/or maintenance, dietary intake and physical activity. However, there was no documentation to checklists the information provided to the patient.

5.3 Future Research and Considerations

Renal transplant recipients are treated by a multi-disciplinary team that aims to address the most immediate issues as the patient progresses through the transplant process. Future research should aim to observe how more preventive measures can help to improve outcomes in regards to weight status and cardio metabolic health. The present study shows that modest interventions provided by a clinical dietitian can help to manage weight and improve blood lipid profiles. Further research should consider gender differences and address how to implement research into practice.

Table 1. Baseline Characteristics of Subjects by Tertiles of Meetings with Registered Dietitian Post-Transplantation

	All	Tertiles		
		1	2	3
Tertile Ranges, visits		1-2	3	4-9
Tertile Mean		1.6	3.0	5.0
Number of patients,	165	86	36	43
Females	68	36	16	16
Males	97	50	20	27
Age, yrs	50.5 ± 13.1	51.2 ± 13.0	49.6 ± 13.0	50.2 ± 13.5
Height, cm	168.5 ± 10.8	169.5 ± 11.4	166.7 ± 9.5	167.9 ± 10.5
Weight, kg	84.0 ± 22.3	85.4 ± 23.8	77.8 ± 20.1	86.5 ± 20.4
BMI, kg/m ²	29.3 ± 6.0	29.4 ± 6.3	27.7 ± 5.1	30.5 ± 5.8
SBP	142 ± 20	145 ± 20	140 ± 19	139 ± 20
DBP	80 ± 12	81 ± 12	80 ± 12	76 ± 13
Cholesterol	179.8 ± 51.4	181.6 ± 53.4	177.7 ± 41.6	177.9 ± 55.7
HDL	46.8 ± 17.2	47.8 ± 16.5	49.1 ± 20.8	43.0 ± 14.7
LDL	94.6 ± 42.7	98.3 ± 42.2	85.6 ± 2504	94.5 ± 47.8
TG	216.8 ± 134.2	200.2 ± 118.2	250.1 ± 181.2	222.0 ± 114.5
Visits to RD prior to Surgery	0.8 ± 1.0	0.9 ± 1.0	0.8 ± 1.0	0.9 ± 0.9

Table 2. Absolute and Percent Change by Tertiles Controlling for Age and Time Since Transplant

	Tertiles		
	1	2	3
Weight, KG			
Change	4.5 ± 1.0*	1.6 ± 1.5	-0.6 ± 1.4*
% Change	6.1 ± 1.2*	3.0 ± 1.9	0.6 ± 1.7*
BMI, kg/m ²			
Change	1.6 ± 0.3*	0.7 ± 0.5	-0.1 ± 0.4*
% Change	6.1 ± 1.2*	3.0 ± 1.9	0.6 ± 1.7*
CHOL			
Change	-5.5 ± 5.9	-4.9 ± 9.2	1.0 ± 8.3
% Change	1.5 ± 3.1	1.1 ± 4.8	7.4 ± 4.4
HDL			
Change	5.4 ± 1.7	5.2 ± 2.6	11.1 ± 2.4
% Change	17.5 ± 4.2	16.9 ± 6.6	33.1 ± 5.9
LDL			
Change	-5.3 ± 5.1	0.0 ± 7.8	4.1 ± 7.1
% Change	5.8 ± 6.3*	11.7 ± 9.8	27.3 ± 8.8*
TG			
Change	-37.7 ± 12.7	-85.9 ± 19.6	-85.9 ± 17.9
% Change	-2.7 ± 5.3	-20.8 ± 8.2	-25.8 ± 7.5

Data: LSM ± SE. *, significantly different from each other.

Table 3. Absolute and Relative Changes in Outcome Variables for Female Patients

	Tertiles		
	1	2	3
Weight, KG			
Change	5.7 ± 1.4	3.1 ± 2.1	3.0 ± 2.1
% Change	9.2 ± 2.1	5.6 ± 3.2	5.3 ± 3.1
BMI, kg/m ²			
Change	2.2 ± 0.5	1.3 ± 0.8	1.2 ± 0.8
% Change	9.2 ± 2.1	5.6 ± 3.2	5.3 ± 3.1
CHOL			
Change	-4.8 ± 8.4	-10.1 ± 12.8	-5.3 ± 12.7
% Change	1.8 ± 4.2	-1.0 ± 6.3	2.4 ± 6.3
HDL			
Change	7.8 ± 2.3	-0.1 ± 3.6	9.3 ± 3.5
% Change	17.4 ± 4.6	3.1 ± 7.1	21.7 ± 6.9
LDL			
Change	-6.3 ± 7.3	-3.5 ± 11.1	-1.1 ± 10.9
% Change	3.8 ± 8.2	16.4 ± 12.5	11.4 ± 12.4
TG			
Change	-32.9 ± 17.8	-41.6 ± 27.1	-59.9 ± 26.8
% Change	3.5 ± 8.6	-13.6 ± 13.0	-16.7 ± 12.9

Data: LSM ± SE. *, significantly different from each other.

Table 4. Absolute and Relative Changes in Outcome Variables for Male Patients

	Tertiles		
	1	2	3
Weight, KG			
Change	3.7 ± 1.3*	0.4 ± 2.1	-2.9 ± 1.8*
% Change	3.7 ± 1.4*	1.1 ± 2.2	-2.1 ± 1.9*
BMI, kg/m ²			
Change	1.1 ± 0.4*	0.2 ± 0.7	-0.9 ± 0.6*
% Change	3.7 ± 1.4*	1.1 ± 2.2	-2.1 ± 1.9*
CHOL			
Change	-5.9 ± 8.3	0.3 ± 13.1	3.7 ± 11.3
% Change	1.3 ± 4.5	3.5 ± 7.1	9.1 ± 6.1
HDL			
Change	3.6 ± 2.3	9.1 ± 3.7	12.5 ± 3.1
% Change	17.4 ± 6.5	27.4 ± 10.1	40.1 ± 8.7
LDL			
Change	-4.3 ± 7.0	4.0 ± 11.1	5.9 ± 9.5
% Change	7.7 ± 9.0	10.0 ± 14.4	34.4 ± 12.0
TG			
Change	-41.2 ± 17.5	-121.5 ± 27.7	-101.2 ± 23.8
% Change	-7.3 ± 6.9	-26.6 ± 10.9	-31.1 ± 9.4

Data: LSM ± SE. *, significantly different from each other.

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