Evaluation of Nutritional Quality Through a Counselor Administered Weight Loss Program Utilizing a Smart Phone App

by

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ABSTRACT

This study evaluated the LoseIt Smart Phone app by Fit Now Inc. for nutritional quality among users during an 8 week behavioral modification weight loss protocol. All participants owned smart phones and were cluster randomized to either a control group using paper and pencil record keeping, a memo group using a memo function on their smart phones, or the LoseIt app group which was composed of the participants who owned iPhones. Thirty one participants completed the study protocol: 10 participants from the LoseIt app group, 10 participants from the memo group, and 11 participants from the paper and pencil group. Food records were analyzed using Food Processor by ESHA and the nutritional quality was scored using the Healthy Eating Index – 2005 (HEI-2005). Scores were compared using One-Way ANOVA with no significant changes in any category across all groups. Non-parametric statistics were then used to determine changes between combined memo and paper and pencil groups and the LoseIt app group as the memo and paper and pencil group received live counseling at biweekly intervals and the LoseIt group did not. No significant difference was found in HEI scores across all categories, however a trend was noted for total HEI score with higher scores among the memo and paper and pencil group participants $p=0.091$. Conclusion, no significant difference was detected between users of the smart phone app LoseIt and memo and paper and pencil groups. More research is needed to determine the impact of in-person counseling versus user feedback provided with the LoseIt smart phone app.

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Chapter 1: Introduction

Overview

Obesity is a growing problem for people in many parts of the world, and has been steadily increasing over the past three decades. In the United States in 2007-2008 the age adjusted prevalence of overweight and obesity was estimated to be 68.0%, overweight being classified as Body Mass Index (BMI) 25 - 29 kg/m^2 and obesity classified as BMI $\geq$ 29 kg/m^2.[1] Increases in obesity among US adults continue in both sexes, all ages, all races, all educational levels, and all smoking categories. Obesity is strongly associated with several major health risk factors including; coronary heart disease (CHD) the second most preventable cause of death, metabolic syndrome, type 2 diabetes mellitus, and insulin resistance.[2,4-5] According to Finkelstein et al, the estimated costs associated with obesity in the United States alone was in excess of $147 billion per year in 2008 nearly double their prior estimate just ten years earlier.[3]

Successful weight loss is one of the most proven methods to successfully reduce the risk of developing the health conditions mentioned above. The National Weight Control Registry (NWCR) is an organization that monitors the habits of successful weight loss and maintenance. The NWCR has defined successful weight loss maintainers as people who have intentionally lost greater than or equal to 10% of their initial body weight and maintained that weight loss for at least 1 year. With over 5000 members in its registry the NWCR has identified several significant characteristics associated with

successful weight loss and maintenance. Those identified in this population are: exercise on a daily basis, recording dietary intake, frequent self-monitoring of weight, and consuming a diet low in calories and fat. [6]

Techniques in monitoring weight loss have become more technologically advanced in recent years. With the advent of the internet, programs such as ChooseMyPlate.gov have adapted tools to track physical activity, weight, and diet online using a personal computer. With applications from the internet now being available instantly through the use of smart phones and the personal digital assistant (PDA), individuals can instantly record their food at the time of consumption resulting in more accurate and more consistent diet records.[7] One application of this type is the "LoseIt" application for smart phones produced by FitNow, Inc. This program allows operators to input their food intake into their smart phones and keep an accurate record of foods they eat along with their physical activity throughout the day.

Moat weight loss initiatives place great emphasis on healthy weight loss and improving nutritional quality. In the current literature there is little or no research evaluating the nutritional quality of dieters using technologically based diet and physical activity recording devices. Knowing the diet quality of users of these devices is of significant importance as direct feedback from these devices may be tailored specifically to individual users based on their diet and physical activity input. The purpose of this study is to assess dietary quality of individuals using either the smart phone app LoseIt or a smart

phone memo function to record their daily dietary intake versus traditional paper and pencil method.

Primary Hypothesis:

There will be no difference in dietary quality as measured by the HEI 2005 dietary intake scoring method among those using the smart phone app LoseIt, the smart phone memo function, or the pencil/paper method to record dietary intakes over a period of 8 weeks with a weight loss intervention - program.

Definitions:

- LoseIt: A Smart Phone application designed by the company FitNow, Inc. a privately held company with headquarters in Boston, Massachusetts utilized for tracking food intake and exercise as a means to succeed at weight loss and weight maintenance.
- Diet quality: Diet quality will be defined using the Healthy Eating Index - 2005 (HEI-05). The HEI reflects the dietary guidelines outlined in the former My Pyramid guide to healthy nutrition initiative established by the US Department of Agriculture.
- Smart Phone: A cellular phone capable of accessing internet, and utilizing a variety of available programs designed for cellular technology. The basic workings of a personal computer in the package of a cell phone.

Limitations:

The study protocol relies on self-reported dietary intakes; this method of dietary recording is limited by poor accuracy mainly due to under-reporting of food intake. Also, the HEI-05 is one of several methods for determining dietary quality and is limited as an instrument of assessing individual dietary quality as it was developed as a means of assessing large populations.

Delimitations:

Participants were required to have access to a smart phone device and more specifically those randomized to the LoseIt group required an iPhone by Apple. While Smart Phones are widely used in this present time period, there are still a wide variety of people who do not yet have this technology. This may limit the applicability of this data to the general population at the present date.

Chapter 2: Literature Review

History of Technology for Diet Monitoring

Since as early as 1985 researchers were evaluating the use of technology as a means to monitor dietary intake and to deliver a weight loss program. In a pioneering study by Burnett, K.F. et al published in the Journal of Consulting and Clinical Psychology entitled "Ambulatory Computer-Assisted Therapy for Obesity: A New Frontier for Behavior Therapy" researchers set out to determine the impact on weight loss of a micro-computer used with a weight loss program.[8] At this time the thought of a mobile micro-computer was very innovative, and the technology was not readily available to most of the population. The success of this study had the potential to greatly shape the future of weight loss therapy.

A portable lap size computer was developed for this study consisting of a limited keypad for data entry, and a two line 20 character liquid crystal display for delivering messages. The computer weighed about 2 lbs and could easily be carried on a shoulder strap. Study subjects were asked to report food intake during and between meals along with physical activity. A reminder was set to beep every four hours to stimulate food record entry. The computer system would automatically display feedback regarding total calories eaten, percent calorie goal and calories for a particular item. The results of this study displayed short-term weight change during the 8-week post-base line period of an average -8.1 lbs for the experimental group, and -3.3 lbs for the control group. Long-term weight maintenance at 24 weeks

indicated a weight change of -15.7 lbs, for the experimental group, and -4.2 lbs for the control group. At their 40 week follow up, a weight change of -17.7 lb and -2.3 lb for the corresponding groups. At both intervals comparison of the between-group means indicated significant differences, $t(5)=2.88$, $p<.02$; $t(5)=3.80$, $p<.01$. It was hypothesized that the aid of the computer devices assisted in the development of behavioral changes complementary to healthy weight loss and weight loss maintenance up to 40 weeks follow up.

In 1990 Agras et al. performed a similar study utilizing a hand-held computer that aided in setting goals and planning. The program delivered motivating messages and feedback, and tracked caloric intake and exercise. It was found that all groups in the study lost equivalent amounts of weight which was termed “modest weight loss”. What was more important was that these studies established the possibility of a technology based effort to modify human behavior through a weight loss program. Several different modalities of behavioral modification therapy for weight loss have since been considered and evaluated, such as the telephone, television and video recording. And still more possibilities arise as technology continues to develop and produce more feasible possibilities.

In 1996 Meyers et al. evaluated the use of television as a medium of delivering a behavioral modification weight loss program comparing groups receiving counsel via television to those receiving pre-recorded video cassettes to a live-contact group.[9] It was found that all participants using the video or

television weight loss program had successful weight loss compared to a control group regardless of method of delivery of weight loss counseling. As access to the internet became more readily available in homes throughout the United States the notion of using the internet as a medium for a weight loss program became much more feasible. Many had caught on to this possibility and while the advent of the internet presented many options for weight loss education, a question regarding the validity of web content was apparent.

In the Journal of the Royal Society of Medicine, Miles et al.[10] performed a study to evaluate the content of various web pages posing to be weight loss programs available on the internet in the year 2000. Using a popular search engine on the internet, a search string for the words "weight loss diets" was formulated. With over a million links available, the first 50 were explored and evaluated for the following content; method of weight loss or type of product offered, physiological basis of product or methods (action), promotion with a calorie controlled diet, hazards or side-effects, and cost. Of the 50 sites available on the internet only 3 sites offered weight loss counsel based on sound dietary advice of reducing caloric intake and increasing physical activity. The majority of websites reviewed offered some form of diet replacement products, vitamins and minerals or herbal supplements, holistic approaches, or books on dieting. There were only 2 sites recommending surgical interventions which were sites supported by medical insurance companies. Of the 50 sites reviewed, 48 were based out of the USA, 1 was based out of Britain, and 1 was based out of Brazil.

Given its great reach, the internet clearly had the potential of becoming a leading medium for delivering a behavioral modification weight loss program. In 2001, Tate et al.[11] performed a study to determine if a structured internet based weight loss program would produce greater results in initial weight loss and waist circumference compared to a weight loss education web site. This was one of the first studies of its kind to deliver feedback and specific dietary advice via the internet and allowed counselors to correspond with participants by receiving weekly submissions of food records for evaluation. Participants were all given the same introductory information and access to a web page with links to educational content. The behavioral therapy group however received additional links for behavioral counseling and diet monitoring and participated in weekly emails with a counselor. The behavioral therapy group achieved significantly greater results in initial weight loss and decreased waist circumference. In this group of participants, internet instruction for a weight loss program and behavior modification was most significantly successful when met with regular feedback and personalized behavior modification counseling.

During the late 19th century and early 20th century there was a large growth in the popularity of the use of the hand held personal digital assistant (PDA) diaries. These devices were small hand held personal computing devices with limited capabilities. Mainly they were used for scheduling and planning, but

had the capability of being used as a diary, voice recording device, and often had some basic games and document creating capabilities.

A study by Stone et al. published in 2003 evaluated participant compliance with reporting episodes of pain using a PDA based program versus a paper diary.[7] This study was pivotal at determining whether the use of hand held technology increased the compliance of participants reporting health related information over paper and pencil methods. Participants were asked to record at various pre-determined times throughout the day. Paper diaries were monitored using electrical sensors which time stamped when the diary was opened and closed. Participants using the paper diary were found to be compliant only 10.9% of the times they were asked to record their data. The PDA group was compliant 93.6% of the times they were asked to record, a staggeringly significant difference between the PDA and paper and pencil group.

In a study published in 2004 by Beasley et al researchers evaluated the use of the PDA for accuracy of keeping a food record. Researchers used a PDA based dietary software program called DietMatePro which utilized web integration and the most recent version of the USDA Standard Release nutrient database as its foundation.[12] Users also had the ability to add foods to their personal food database using the food label for nutritional information.

The purpose of the study was to evaluate the accuracy of food records entered into the PDA program. Researchers compared a 3-day diet record using the PDA software to a monitored 24 hour recall. The findings were consistent with that of the 24 hr recall with no significant difference in mean calorie, protein, or carbohydrate intake. This study confirmed that the use of a hand held diet recording device could produce accurate results for food intake.

In 2006 a research group used a PDA device equipped with diet monitoring software to evaluate participant compliance to a weight loss program. As part of the Women's Health Initiative Diet Modification arm participants were able to participate in a PDA study by Glanz et al.[13] This study looked at self-monitoring throughout a weight loss program, and evaluated participant attitudes towards self-monitoring. The study found that participants using the PDA program were significantly better at self-monitoring and their attitudes towards self-monitoring were greatly improved.

The use of PDA devices has continued to be evaluated and technology has continued to progress. As the development of mobile technology continued growing the cellular phone became an appealing option for communicating data regarding weight loss and diet monitoring.

In 2009 Patrick et al. evaluated the use of SMS (Short Message Service: text) and MMS (Multimedia Message Service: small picture) message transmission via mobile phones as a means of a weight loss intervention.[14] In this 16 week

trial, participants would receive two to five SMS or MMS messages daily which were individualized and often requested responses to stimulate participant engagement. The results of the study were significantly favorable for the SMS and MMS messaging as a means of administering a weight loss program. The intervention group lost a mean of 7.3 lbs while the control group lost 2.3 lbs. This study indicates regular contact with a health counselor via SMS and MMS messaging can be an effective method of administering a weight loss intervention.

Efficacy of Technology for Weight Loss

Of all the changes in Technology and the now many options available for delivering a weight loss program there are still many questions which must be answered. Which, if any of the methods is effective, and what are the benefits of using the technology for this type of application compared to the costs?

To understand the benefits of using technology the costs must be evaluated. A cost efficiency study was performed early on when the use of a computer kiosk was added to a weight loss program in a managed care setting. Wylie-Rosett et al. published "Computerized Weight Loss Intervention Optimizes Staff Time: The Clinical and Cost Results of a Controlled Clinical Trial Conducted in a Managed Care Setting" in 2002.[15]

Incremental levels of intervention included a workbook alone, computerized tailoring using on site kiosks with touch screen monitors, and the addition of both computers and staff counseling. In this 3 arm 12 month intervention, 588 individuals were randomized to each group and measured for weight loss and relative cost of treatment. Mean 12 month weight losses were 2.2, 4.7, and 7.4 pounds respectively. Mean cost per participant was $12.33, $41.99, and $133.74 respectively.

Interventions that correlated most to weight loss included more computer logons, achieving computer-selected goals, more self-monitoring, increased walking, decreased energy and fat intake, and higher attendance at staff counseling group sessions. This study demonstrated that more frequent use of computer tailored behavioral modification instruction resulted in greater weight loss, and the addition of in-person counseling resulted in the greatest weight loss. However, these factors also contributed to increasing cost of weight loss. So, not only was the technology based program more effective it was also more expensive.

While the costs are increasingly greater with added technology and counsel, do the results continue to prove more effective with other types of applications? One of the leading researchers in the use of internet to deliver a behavioral weight loss program has been Deborah F. Tate. In the previously mentioned study in 2001, Tate et al.[11] performed a study to determine if a structured internet based weight loss program would produce greater results

in initial weight loss and waist circumference than a weight loss education web site.

Participants for this study were randomized into two groups; a web based educational group, and a web based behavioral modification group. There were 65 total participants randomized to two groups who completed the 6 month trial. In the web based educational group, 32 participants were given initial instructions regarding dieting and access to a web site with links to weight loss education. In the behavioral modification group the same initial instructions were given, but they were given access to additional web based information for behavior modification.

Participants were also asked to correspond with counselors via email and to submit weekly self-monitoring diaries from which they received a therapist's feedback. Each was given a standard calorie restriction diet of 1200 – 1500 kcal per day and less than 20% calories from fat was recommended. Physical activity to burn a minimum of 1000 kcals per week was also recommended. Each group was required to participate in this initial instruction visit and follow up visits at 3 months and 6 months to completion of the study.

The behavioral therapy group achieved significantly greater results in initial weight loss and decreased waist circumference. The group lost a mean of 10.2 (7.1 SD) lbs by 3 months and 10.4 (11.4 SD) lbs by 6 months as compared to 4.3 (6.9 SD) lbs and 4.1 (8.4 SD) lbs for the education group during the same

intervals with a p=.005 level of significance using repeated measures analysis. Changes in waist circumference likewise were greater for the behavioral therapy group at 3 months and 6 months with mean change of 6.7 (4.7 SD) cm and 6.4 (5.5 SD) cm compared to 3.0 (4.0 SD) cm and 3.1(4.4 SD) cm for the education group at the same intervals p=.001 and p=.009 for each interval. This study displayed that a weight loss program administered via the internet is significantly more successful when met with regular feedback and personalized behavior modification counseling. The author followed up this study with one of similar design for subjects at risk of type 2 diabetes published in 2003.[16] The length of protocol in this study was extended to 12 months, and participants were given the use of email for submitting weekly self-monitoring information and receiving weekly counsel and feedback. At 12 months it was found that the behavioral therapy group lost significantly more weight and waist circumference ($p<.05$) than the education group They concluded that adding email to a basic internet weight loss intervention program improved weight loss in adults at risk of type 2 diabetes.

Shortly after the first publication by Tate et al another prominent researcher published a study evaluating the use of the internet to facilitate weight loss and weight loss maintenance. Harvey-Berino et al published a study in 2002 which concluded the use of internet is feasible for delivering a weight maintenance program.[17]

Subjects were recruited to participate in a 6 month weight loss program followed by a 12 month weight maintenance study. One hundred and twenty two subjects were recruited and randomized into three groups; an internet support group (IS), an in-person support group (F-IPS), or a minimal in-person support group (M-IPS). Both the IS and F-IPS groups had contact with a therapist bi-weekly during the maintenance phase, and the M-IPS group only had contact monthly for the first six months of the maintenance phase, then no contact for the remainder of the study. Internet contact for the IS group consisted of bi-weekly video chat sessions, email discussion, and dietary intake and exercise data evaluation.

Results of this study indicated that participants in the face to face contact groups M-IPS and F-IPS had greater success at maintaining weight loss through a 12 month period following a weight loss program than participants connecting to therapists via internet (IS -14.5 lbs (15 SD), M-IPS -26.4 lbs (23.6 SD), and F-IPS -26.4 lbs (16 SD), $p<0.05$). Participants who were randomized to the IS group were also found to participate less in the bi-weekly internet therapy and chat sessions (54% vs. 39%, $p<0.04$). This was somewhat contrary to the expected outcome as prior studies had been cited indicating a reason for weight gain following a weight loss intervention was waning of attendance at post treatment counseling sessions. It was thought that the advent of the internet would increase participation resulting in more steady weight loss retention.

A similar publication by Harvey-Berino et al. published the same year examined the acceptability and feasibility of using internet support for weight loss maintenance.[18] Participants for this study were randomized to three groups; in-person therapist-led, Internet therapist-led, and a control group. Participants in the two intervention groups received counseling biweekly from a therapist for a maintenance period of 22 weeks following a 15 week weight loss program. Acceptability and adherence to behavioral change was measured by the following measures; attendance at group sessions, completion of self-monitoring goals, energy and total fat intake measures, physical activity measures, a five item questionnaire, and number of peer contacts by group members.

There were significant differences in participation from the internet group and the therapist group with the therapist lead group being more likely to attend scheduled meetings (58% (22) vs. 33%(23), P<.005). There was no significant difference between groups in achieving the self-monitoring goals, or peer support contacts (P=.53, and P=.14 respectively).

Participants reported in the five point questionnaire that they were more satisfied with their program in the therapist lead intervention versus the internet led group. Both groups significantly decreased their caloric and fat intake during the 22 week program while increasing their calories burned during physical activity. And participants lost an average 1.6 kg of body weight during the program. This study confirms that an internet based

intervention is feasible, and acceptable for weight loss maintenance, however involvement of a therapist or counselor provides the greatest benefit. Limitations of this study include the short duration of the measured outcome. This study embodied a 15 week weight loss period followed by a 22 week maintenance period totaling 37 weeks of counsel and participation. Successful weight loss and weight maintenance takes place over a period of 6 month weight loss, and 12 month weight maintenance.[6] While this study displayed the feasibility of using internet delivered weight maintenance support it cannot conclude the long term success of a given program.

A more recent study by Lubans et al. evaluating the use of the internet for a weight loss program entitled the Self-Help Exercise and Diet using Information Technology or SHED-IT study sought to identify the possible mechanism of success in an internet based weight loss program.[19] A 24 month prospective randomized controlled clinical trial using product of coefficients test to identify potential mediators, and least squares regression to test single mediator models. Participants in the study were overweight and obese men living in Newcastle, Australia. Participants were placed on a 3 month randomized controlled trial for weight loss utilizing Internet based behavioral intervention versus a control group receiving in person weight loss counseling.

In the intention-to-treat analysis both groups lost weight, but compared to the control group the intervention group did not have a statistical significant

total effect on weight p=.716. In the per-protocol analysis the intervention had statistically significant total effect on weight loss p<.05. The intervention did not have a statistically significant effect on any of the hypothesized mediators. Although, it was found that most men reduced fat intake over the study period. No other significant data was reported.

As part of the SHED-IT study, researchers Morgan et al evaluated the efficacy of an Internet-based weight loss program for men age 18-60 with a BMI between 25 and 37 kg/m2 at an early stage after 6 months in a 24 month study protocol.[20] After a 3 and 6 months intervention the Internet group lost 5.0% and 5.7% of their baseline weight respectively. Weight loss in the control group was 3.2% and 3.9% respectively. Per-protocol analysis was performed to assess compliance among participants at 3 months and 6 months. The SHED-IT study identified success with weight loss using the internet based protocol, but was unable to identify what mediators resulted in significant weight loss.

The Internet has proven to be a successful method of delivering a behavioral weight loss program and most effective when paired with counseling. Studies have simultaneously evaluated the use of hand held computing devices. In addition to those mentioned earlier, several studies have produced evidence of success using the hand held devices.

One of the leading researchers Jeannette Beasley was one of the first to evaluate the accuracy of diet records kept using a PDA device and follow up with a behavioral therapy intervention study. In 2005 researchers studied accuracy of a food record using a personal digital assistant (PDA), and determined any sources of error in the PDA food records as previously mentioned.[12] Thirty nine participants were recruited to complete a 3 day food record utilizing a PDA-based dietary software program. At the end of the three day trial a 24 hour food recall was collected. Participants were also observed during weighed meal consumption which was timed. Correlation analysis was used, and caloric intake was compared as a unit to quantify potential error.

There were no significant differences in daily totals for calories and macronutrients between PDA records, 24 hour recall, and observed meal intake. Errors associated with food records recorded on the PDA device were attributed to portion size estimation error. In conclusion there was found to be no significant difference in PDA food records versus 24 hour recall over a reporting period of 3 days. Limitations of this study would be the duration of measured outcome, and the limited control measure being only a 24 hour recall which by itself has questionable accuracy.

Burke et al. initiated one of the largest and longest in duration trials evaluating technology based self-monitoring techniques for weight loss and weight management.[21] The purpose of this trial was to examine the impact

of replacing the traditional paper and pencil method of recording dietary data with a personal digital assistant (PDA) for self-monitoring of a weight loss and weight maintenance program over a long term period of 24 months. Two hundred and ten participants were randomized to three groups; standard paper group, PDA group, and a PDA + Feedback group. Each group received 1 hour intervention sessions weekly for the first 4 weeks, and every 2 weeks during months 5-6, a 6 month assessment, continued 2 week sessions through months 7-12, and 12 month assessment, monthly sessions for months 13 – 18, a 21 month session, and finally a 24 month assessment. At baseline, anthropometric measures were taken following a 12 hour fast, and 2-24 hour food recalls were taken for a week day and leisure day. PDA groups had software preloaded to track their diet and also provide feedback regarding calorie, fat gram, and exercise goals.

This study evaluated the baseline data of the self-monitoring and resting metabolic rate technology (SMART) trial and behavioral management design. Findings concluded that participants had no clinically significant differences between study groups though there were significant statistical differences in regard to age, education, HDL Cholesterol, Blood glucose, and systolic blood pressure. Of the 704 participants screened only 210 were enrolled, with a 90% completion rate of the first cohort.

A study by McDoniel et al evaluated the short-term motivational effect of a technology-based weight loss program for obese adults.[22] The self-monitoring

and resting metabolic rate technology (SMART) trial utilizes hand-held electronic diaries for food records, and internet technology for motivational - contact with investigators.

Eighty subjects were enrolled and completed protocol requirements in the SMART trial over a period of a 12 week interventional weight loss program. Participants were randomly assigned to either a control group or interventional group. Participants in the SMART cohort received a nutrition program based solely on measured resting metabolic rate with caloric restrictions intended to result in weight loss of 1lb per week. Food records and activity logging were reported using proprietary software produced by Microlife Medical Home Solutions, Inc. The control group received a standard nutrition plan consisting of a three day diet menu and instructions on self-monitoring diet and physical activity daily.

At weeks 4 and 12 all participants returned for counseling using motivational interviewing principles by an exercise physiologist trained in nutrition and motivational interviewing. Additionally, all participants received a weekly news letter by email following the first clinical visit for eight weeks. Results indicated all participants regardless of cohort benefitted from the weight loss interventions. These results were attributed to motivational interviewing and the measure termed weight attitude. There was no significant evidence to indicate the use of technology based diet management was more effective at

stimulating weight loss compared to the control group method of paper diaries and 3 day food menus.

A study by Beasley et al. evaluated the effectiveness of a personal digital assistant (PDA)-based dietary assessment software program in monitoring dietary intake and improving adherence to a dietary regimen.[23] This study enrolled 174 participants for a 4 week diet intervention utilizing a PDA-based software program to record food intake versus a control group using traditional hand written diaries. Participants were randomly assigned and given instruction regarding the study procedures. During the first week of the trial participants were assigned to record their normal dietary intake. Following a 24 hour recall was performed on the last day of the week to assess participant competency. Participants were then instructed to follow a restricted calorie diet following the guidelines associated with the Ornish Prevention Diet. At the end of the remaining three weeks another 24 hour recall was performed to assess record accuracy.

Initial findings indicated that the paper and pencil method of food recording had more accurate correlations to 24 hour recalls than the PDA-based Software. Findings also indicated that the PDA-based software over-estimated caloric intake and macronutrient intake compared to the control group. Dietary adherence was higher among the PDA-based software group by as much as 15%. However when participants were asked to assess their compliance to the diet protocol using a Likert-Scale, there was no significant

difference between groups. Investigators concluded the PDA-based software may improve on diet compliance, but does not have a significant benefit in diet intake validity.

In 2006 another study using PDA technology produced significant results. The purpose of this study was to determine whether the use of a hand-held computer equipped with diet monitoring software would increase compliance to a weight loss program by reducing the difficulty of recording food intake and providing instantaneous feedback to dietary choices as compared to traditional paper and pencil methods.

In this study by Glanz, J. et al. as previously mentioned, 33 women in the Diet Modification arm of the Women's Health Initiative (WHI) trial were enrolled as participants in this study.[16] Focus groups were used to determine software features of the intervention software program prior to study inception. Women used Personal Digital Assistant (PDA) devices which provided immediate and weekly feedback for a period of 1-month. Outcomes were evaluated using surveys and self-reported food frequency questionnaires.

Participants increased their self-monitoring significantly with the use of the PDA program. Surveys indicated their attitudes toward self-monitoring improved, and they were able to meet their dietary goals more often. Total fat intake was reported to be lower as well as percent energy from fat. There was

also a significant decrease in mean caloric intake. Some limitations of this study are that the duration was only 1 month, while it is suggested that successful weight loss maintenance be over a period of 1 year.

Based on the historical data it is clear that the mode of delivery of the weight loss program is less important compared to the design of the weight loss program. The studies that had the most effective weight loss delivered feedback and motivational messaging on a periodic basis. While it was not statistically analyzed in any of the studies it appears this constant feedback and counselor interaction proves to result in the greatest compliance and most successful weight loss and weight loss maintenance. This also appears to attribute to higher costs of treatment compared to non-technologically based programs. Additionally, all the studies found evaluated one form of technology against a control, there has been no study evaluating one form of technology against another for cost or effectiveness.

Methods of evaluating Diet Quality

Of all the studies found assessing weight loss with the use of modern technology, there are currently no studies that have assessed dietary quality and whether the use of technology in a weight loss program results in improved diet quality. While in all studies, weight loss was successfully achieved, weight loss is not synonymous with improved diet quality.

There are many ways of measuring diet quality. The gold standard for measuring diet quality would be to measure the precise nutrient intake of an individual and compare it to the Dietary Reference Intakes (DRIs) which are calculated recommendations of nutrients needed to meet the needs of 98% of the population. Measuring nutrient intake and interpreting the DRI's for an individual can be difficult. Many simplified recommendations have been developed to help the average person consume adequate nutrition. Example of this would be the USDA Choose My Plate initiative and the Dietary Guidelines for Americans which is revised every 5 years.[24] To evaluate how well people follow these recommendations diet quality measures have been developed such as the Healthy Eating Index (HEI) which captures the recommendations found in the Dietary Guidelines for Americans and provides a scoring mechanism from which a person's diet intake can be measured against these recommendations.[25]

The HEI was developed in the year 2000 to assess diet quality across ages and ethnic groups. In 2005 the HEI was further refined to include calorie density to account for energy from solid fats, alcohol, and added sugar. Four major strengths of the HEI-2005 are (1) it captures key recommendations of the 2005 dietary guidelines for Americans, (2) diets are assessed on quality while controlling for quantity by defining intake on a per 1000 kcal density, (3) it accounts for energy dense, nutrient poor foods, and (4) it addresses aspects of each food group furthest from current recommendations: whole fruit, dark green vegetables, orange vegetables, legumes, whole grains,

sodium, and discretionary calories.

Limitations of the HEI-2005 stem largely from limitations of the Dietary Guidelines for Americans. One is that it does not apply to children under 2 years old. Two, the Dietary Guidelines for Americans falls short on the RDA's for Vitamin E, and the AI's for potassium, therefore a perfect score may not ensure adequate intake of these nutrients. Third, density standards in the meat, milk, and beans groups of the HEI-2005 may fall short when it comes to measuring calcium and iron, because the variable needs of subjects based on age and gender may not be adequately covered by an intake measured in units per 1000 kcal. Fourth, the HEI-2005 does not address over consumption of major food groups or oils. And last, the HEI-2005 does not address total fat, trans fat, or cholesterol directly though they are mentioned in the Dietary Guidelines for Americans.[25, 26]

Calculating the HEI scores is a relatively simple though timely process once all of the instruments are in place. The process uses two data bases of foods to determine scores for the HEI food group categories. Links to these tables on the internet can be found in the references to this paper as their entire content would be too excessive to include in the appendices.[27] Diet records obtained from the subjects must first be computed into grams consumed for each food. The grams consumed are multiplied by the factors given to the matching food in one of the two databases for each of the food groups

assessed in the HEI-2005. The factor converts the grams of foods consumed to a score of each food group in per 1000 kcals consumed.

The score is given as either cup equivalents for Total Fruit, Whole Fruit, Total Vegetables, Dark Green and Orange Vegetables and Legumes, and Milk, or oz equivalents for Total Grains, Whole Grains, and Meat and Beans. For Measures of Oils and Sodium measured in grams is divided by the total kcals consumed and multiplied by 1000 to get grams per 1000 kcals. For Saturated Fats, and Calories from Solid Fats, Alcoholic beverages, and Added Sugars, the amount of calories consumed is calculated as percentage of total calories consumed. The final score is determined using the scoring Fact Sheet found in Appendix 1. Some calculations have to be made to assign a point value to the values given per 1000 kcals and a calculation sheet is provided on the web at the address listed in the references and is also included in Appendix 2.[28] Total score of the HEI-2005 adds up to a possible 100 points. The HEI-2005 was designed for use with large epidemiology studies such as the National Health and Nutrition Examination Survey (NHANES). Its validity has been widely demonstrated and all tools necessary to accurately use the instrument are made readily available on the internet.

The LoseIt app is one of many apps available on the market today. Some of its strengths include a link to the ChooseMyPlate.Gov web based nutritional counsel web page, a food database consistent with the USDA's food database, the ability to function with or without internet access, and many new

features which make it easy to use and user friendly. With the capabilities of tracking both diet and exercise this app gives users the ability to monitor their energy intake and exertion with ease and accuracy. The connection this app has with the Choose My Plate initiative by the USDA to improve nutritional quality among Americans poses the quest under review in this study whether users will experience an improvement in nutritional quality over alternative methods of tracking dietary intake and exercise.

Chapter 3: Methods

Eligibility

Individuals with smart phones were recruited from a campus population. Participation was limited to healthy individuals who were between the ages of 18 and 65 years of age and had a BMI between 25 and 40 kg/m^2. Participants had to be willing to record their dietary intake for a period of 8 weeks and follow an energy restricted diet for weight loss purposes. Participants could not be on a weight loss protocol or taking any weight loss medications at base line or for 6 months prior. In addition participants could not have previously used a smart phone application for recording food intake or dieting. Participants could not have a history of weight change over the past 3 months exceeding ± 5 lb. Written informed consent was required for participation in the study. This study was approved by the Arizona State University Institutional Review Board.

Recruitment, Screening and Enrollment

Sixty healthy individuals were recruited for the study. Participants were recruited from the general population in Mesa, Arizona and surrounding areas. Recruitment strategies included email through list servers maintained by the ASU Nutrition Program comprising present and former students, former study participants who had expressed interest in participating in future trials, and faculty. Fliers were distributed at various locations throughout the ASU Campuses and surrounding community. Participants were screened on first contact and during an information meeting. Of the 60

participants recruited, 31 completed the study with sufficient records to complete a proper dietary analysis.

Randomization and Measurements

Once eligibility of participation was confirmed, participants with smart phones were cluster-randomized into 3 groups: group 1 (app group; n=11) composed of participants who own iPhones who were trained to use the diet/exercise tracking "Loseit" application; group 2 (memo group; n=11) participants were trained to track dietary intake through use of the "notes" or "memo" function on their smart phones; group 3 (paper group; n=10) participants were trained to record dietary intake using traditional paper and pencil methods. Every effort was made to equally distribute among groups variations in age and gender however because randomization was dependent on participants ownership of an iPhone, there was no choice but to place certain participants in one group or the other.

Prior to the start of the study, all participants recorded dietary intakes for 3 consecutive days including one weekend day for a base line measure. At the start of the study, participants were weighed on a calibrated Tanita scale and a waist/hip circumference was taken. The weight loss goal for each participant was 1 pound per week. The app group followed instructions as detailed by the 'Loseit' application. The memo group and paper group were provided diet goals using the exchange system and standard diet advice as outlined in the Choose My Plate initiative. Participants in the memo and

paper/pencil group attended biweekly meetings with a dietitian or diet counselor to review diet records and receive diet counsel in accordance with Dietary Guidelines for Americans or Choose My Plate initiative.

To determine the caloric allotment for each participant, the Mifflin St. Jeor equation was calculated using the activity value of 1.25 and subtracting 500 calories from the total.[29] All groups were instructed to expend ~150 calories per day via structured exercise. A list of activities that expend ~150 calories was provided for participants as a guide.

The app group using the LoseIt application had their Smart Phones programed to send daily reports to researchers for data entry. The memo group recorded their daily food intake and exercise using the notes or memo application on their smart phones and sent it via email to researchers on a daily basis. The paper group was recording daily food intake and exercise using a notebook provided by the researchers and had brought the notebook with them to the biweekly meetings.

At the end of each day participants were instructed to record on their diet record whether the day's recording was 'complete' or 'not complete'. Each group was instructed not to retro-record missed days (i.e., participants were only to record foods and exercise for the present day – not for any previous days). Participation in this study spanned a period of 8 consecutive weeks.

Data Analysis

Food records submitted by participants were analyzed using Food Processor SQL Nutrition and Fitness Software by ESHA Research Inc. version 10.6.3. Dietary quality was analyzed using the Healthy Eating Index – 2005 (HEI-05). This assessment tool was chosen because of its broad applicability and validity. The HEI-05 has been used in several other studies to assess diet quality. Its validity has been statistically proven and is therefore a reasonable instrument for this application.[25-28,31-34]

All data were statistically analyzed using The Statistical Package for the Social Sciences (SPSS 18.0 for Windows, SPSS Inc., Chicago, IL). Descriptive statistics; means with standard deviation were tabulated to describe participants pre-intervention and post intervention. Data was checked for normality and transformed if needed to achieve normality. HEI-05 scores were tabulated and One-Way ANOVA was used to examine significance of change in dietary intake over time from base line, and over conditions.

Chapter 4: Results

Participants were cluster randomized to either a control group, memo group or app group. The LoseIt app group was composed of the participants with iPhones. Only 31 participants completed the study protocol with complete records at base line and week 8. Participants with incomplete records were omitted from -the study. When participant measures were taken at 8 weeks average calorie intake had declined, average weight, and BMI had declined. Descriptive statistics at base line and week 8 can be found tabulated in Table 1.

Table 1. Descriptives for all participants at baseline for age, height , and waist circumference, and at baseline and week 8 for weight, BMI, and kcal intake. [a]

	Paper/Pencil Group		Smart phone memo group		iPhone LoseIt app group	
n	11		10		10	
Gender (M/F)	3/8		2/8		3/7	
Age	44.0±15.8		40.3±15.7		41.5±16.0	
Height (cm)	66.1±3.8		66.2±3.6		66.2±4.7	
Waist (cm)	92.5±14.4		93.8±13.6		87.9±9.1	
	Baseline	Week 8	Baseline	Week 8	Baseline	Week 8
Weight (lb)[b]	182.9±42.0	177.7±40.2	199.0±43.6	191.6±41.5	178.8±25.0	174.2±25.9
Body mass index (kg/m^2)[c]	29.3±4.4	28.3±4.3	32.0±6.5	30.6±6.0	28.7±3.2	27.9±3.2

[a]Data are mean±SD; no differences between groups at baseline with the exception of height.
[b]Repeated measures ANOVA results: time, p=.000; interaction, p=.234
[c]Repeated measures ANOVA results: time, p=.000; interaction, p=.374

For evaluation of nutritional quality HEI-05 was calculated pre and post intervention and participants were given a score out of 100. See Table 2 for average scores.

Table 2. Average HEI-05 scores [a] and Kcal by group for all participants at base line and 8 weeks out of a possible 100.

	HEI – 05 Scores				
	N	Pre	SD	Post	SD
Paper & Pencil					
Total Kcal	11	2162.8	459.8	2052.3	1106.1
Total HEI -05	11	61.1	8.4	66.5	9.4
Memo					
Total Kcal	10	1996.9	840.2	1706.1	514.2
Total HEI -05	10	59.8	10.9	61.6	9.9
App					
Total Kcal	10	1791.2	571.6	1513.6	448.7
Total HEI -05	10	63.9	12.0	60.1	9.9
Total					
Total Kcal	31	1989.4	636.0	1766.9	774.6
Total HEI -05	31	61.6	10.3	62.9	9.8

HEI-05 is a combined score of 10 food categories adding up to a total score out of 100.

Average HEI-05 scores improved across all categories with the exception of the app group which declined. Calorie intake across all groups decreased pre to post intervention. One-Way ANOVA demonstrated no significant difference between groups for HEI -05 scores on the total and individual category calculations (see table 3).

Table 3. One-Way ANOVA between group HEI –05 scores for total and individual averages post 8wk intervention.

	One-Way ANOVA				
	Squares	Degrees of Freedom	Mean Square	F	Sig.
Total HEI -05	240.551	2	120.276	1.273	0.296
Total Grain HEI -05	1.868	2	0.934	0.709	0.501
Total Whole Grain HEI -05	1.890	2	0.945	0.532	0.593
Total Vegetable HEI -05	4.279	2	2.139	0.974	0.390
Total DGOVL HEI -05[a]	1.035	2	0.518	0.243	0.786
Total Whole Fruit HEI -05	1.844	2	0.922	0.396	0.677
Total Fruit HEI -05	0.352	2	0.176	0.113	0.894
Total Milk HEI -05	6.333	2	3.166	0.580	0.566
Total Meat and Beans HEI -05	6.032	2	3.016	0.757	0.478
Total Oil HEI -05	10.835	2	5.417	0.696	0.507
Total SoFAAs HEI -05[b]	22.388	2	11.194	0.639	0.535
Total Saturated Fat HEI -05	7.150	2	3.575	0.443	0.647
Total Sodium HEI -05	31.235	2	15.617	2.747	0.081

Total Dark Green and Orange Vegetables and Legumes category of HEI -05.
Total Solid Fats, Alcohol, and Added Sugars category of HEI -05.

Because the app group was dependent on the LoseIt app for feedback and counsel and the memo and paper and pencil groups received feedback from a dietitian, non-parametric Mann-Whitney U test was performed to identify any difference between the groups that received counseling and the group using the LoseIt app. Complete results can be found in table 4. Overall, there was found to be no significant difference between mean HEI Scores on any category.

Table 4. Mann-Whitney U Independent Samples Non-Parametric Statistics between groups receiving counselor feedback versus LoseIt app users.		
Mann – Whitney U		
	Asymptotic Significance (*p*-value)	Decision
Total HEI -05	0.091	Retain Null Hypothesis
Total Grain HEI -05	0.966	Retain Null Hypothesis
Total Whole Grain HEI -05	0.673	Retain Null Hypothesis
Total Vegetable HEI -05	0.375	Retain Null Hypothesis
Total DGOVL HEI -05[a]	0.127	Retain Null Hypothesis
Total Whole Fruit HEI -05	0.331	Retain Null Hypothesis
Total Fruit HEI -05	0.375	Retain Null Hypothesis
Total Milk HEI -05	0.108	Retain Null Hypothesis
Total Meat and Beans HEI -05	0.459	Retain Null Hypothesis
Total Oil HEI -05	0.597	Retain Null Hypothesis
Total SoFAAs HEI -05[b]	0.866	Retain Null Hypothesis
Total Saturated Fat HEI -05	0.526	Retain Null Hypothesis
Total Sodium HEI -05	0.410	Retain Null Hypothesis
Total Dark Green and Orange Vegetables and Legumes. Total Solid Fats, Alcohol, and Added Sugars.		

Based on these results the primary hypothesis that there will be no significant difference between the Losit app group, the memo group, and the pencil and paper group in diet quality based on HEI scores before and after an 8 week weight loss intervention must be retained.

Although visual inspection of stem and leaf graph appears to show an obvious improvement in HEI for the Paper and Pencil and Memo groups (Figure 1).

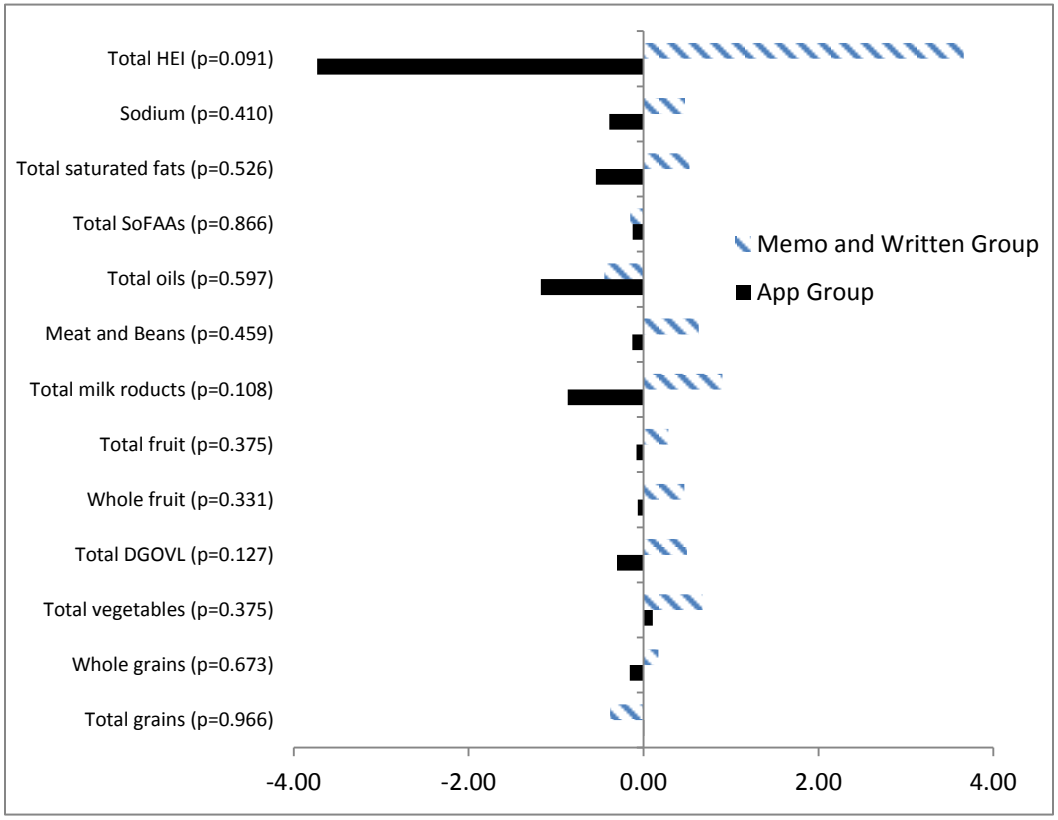

Figure 1: Stem and Leaf mean change in HEI scores pre and post 8 week intervention with associated p level of significance from non-parametric statistics.

Moderate trend of total HEI Score is noted p=0.091 which may correspond to improved nutrition in dieters receiving bi-weekly counsel.

Chapter 5: Discussion

The results of this study indicate that there is no statistically significant difference between change in HEI-05 scores among participants recording diet intake with a paper and pencil versus a memo function on a smart phone versus the LoseIt phone app where HEI-05 is an indicator of nutritional quality. Therefore based on the present research the null hypothesis must be retained that there is no difference in dietary quality as measured by the HEI -05 dietary intake scoring method among study participants of any group over a period of 8 weeks with a weight loss intervention program.

During the course of the study many observations regarding the use of the LoseIt app were made which warrant additional research to determine the benefits and limitations of the app. Additionally, many trends were observed in the current body of literature across the various types of technological applications. In the current literature there are no studies assessing nutrition quality specifically while participants are undergoing a weight loss intervention using a smart phone application. Therefore there is little to compare the present findings to.

Some trends and similarities have been identified however with method of reporting and weight loss success which may also correlate to nutritional status. One such trend is that participants who received in-person counsel tended to have slightly better adherence to a diet plan over those with feedback from a device or phone app alone. This trend is noted in prior

research as addressed by Noell et al in a review of literature which identified some limitations of technology based counseling being that participants cannot respond to visual or verbal communication cues such as facial expressions or voice inflections. This added feature of human communication has been hypothesized to be critical to increasing self-efficacy and motivation.[30] In other examples, participants in each of the studies reviewed seemed to have better outcomes in regards to successful weight loss when a weight loss program was administered with in-person behavioral modification counseling as compared to technology based administration of the same weight loss program with few exceptions.[8-14,16-23]

Compliance of participants with recording their daily food intake and the accuracy of their food recording was not evaluated in this study. The initial recruiting efforts resulted in enrollment of 62 participants of which only 31 records could be admitted for statistical evaluation with the majority of participants being dropped due to incomplete records either at base line or week 8. Additional research may benefit by showing whether compliance with recording food records improves with the iPhone app versus traditional recording methods. This research could be done along with an evaluation of the ease with which users can identify foods and record it compared to writing a self determined description. Because the LoseIt app utilizes the USDA food database it could be challenging for participants to identify the correct item in the database to represent the food which they consumed with accuracy and consistency. As a researcher one of the more difficult tasks had

to do with evaluating the participant's food records. Frequently the same participants would write one food down one day and give a completely different description of the same food the next day. Because the LoseIt app provides a list of foods based on the USDA food database it would be interesting to know if the accuracy of records improved with its use.

As a researcher a great deal of time was also spent identifying the appropriate foods in the food database which best matched the description given by the participant. This effort became greatly reduced with the records provided by the LoseIt app because the items were selected by the user directly from the USDA food database and therefore were often a direct match when using the Food Processor to analyze their diets. Again there needs to be research to determine how capable an untrained user is of deciding upon the appropriate food item to match the items consumed. And to determine how closely the nutritional content as evaluated by these records match that actually consumed as compared with hand written food records.

A great deal of effort was made to ensure food records were analyzed in this study with the most accuracy and consistency possible. In most cases the food items described had a very close match to the descriptions in the USDA food database and the Food Processor database for nutritional analysis. But quite often foods were given very little description and a set default had to be determined for each of these items. For example participants would often describe bread consumed as just "bread". With no further description

available, a decided upon default for bread was “white bread sliced”. Likewise when a participant would identify milk as just “Milk”, a 2% Milk would be used as the default. A list of over 100 different entries was developed to accommodate these descriptions common to the hand written and memo groups. However, the LoseIt app group required no interpretation of this sort as each item identically matched or very closely matched that of the USDA Food Database. This led us to wonder whether participants made more accurate reporting because they were prompted to by the selection options available in the app, or whether the selections were less accurate because of the more descriptive options. More research is needed to assess the accuracy of the food choices by app users. More research is also needed to determine the cost saving for clinicians in terms of time spent analyzing food records.

There are a few studies in the present body of research which assess record accuracy and patient compliance using paper or electronic reporting devices. Stone et al assessed compliance with paper versus electronic diaries in patients reporting incidences of pain in a study intended to analyze the benefits of an electronic diary versus a paper diary. It was found that the patients reported significantly more frequent and on a more consistent time schedule with the electronic diaries over the paper diaries.[7] Similarly, Beasley et al assessed the accuracy of a PDA-based dietary assessment program in participants in a behavioral modification weight loss program finding no significant difference in electronic records versus a 24 hr recall.[12]

This study supports the hypothesis that the LoseIt app for food recording and weight loss program administration is at least equivalent to that of counselor mediated weight loss programs and traditional paper and pencil methods of monitoring food intake. What remains to be determined is whether the combination of counselor mediated weight loss program and the LoseIt app would result in better outcomes of nutritional quality during a weight loss intervention over those of traditional methods.

Future trials should consider evaluating the effectiveness of administration of a weight loss intervention using the LoseIt app with regular counselor feedback sessions compared to participants using the LoseIt app alone. Future trials should also consider evaluating the accuracy and efficacy of participant food substitutions when using the food database provided with the LoseIt app compared to the interpretation of hand written records by a trained researcher.

Chapter 6: Conclusion

In conclusion, the results of this study show no difference between subjects nutritional quality based on HEI-05 scoring when recording data and following a weight loss program administered either by a smart phone app or in-person counsel, and electronic food record versus hand written food record. Further research is needed to evaluate the accuracy of food records interpretation and evaluation when using the smart phone app for diet record keeping, and to further identify the benefits in terms of time and cost savings to users, clinicians and researchers.

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APPENDIX A

HEI Fact Sheet

Healthy Eating Index–2005

USDA

Center for Nutrition Policy and Promotion

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CNPP
Fact Sheet No. 1

December 2006
Slightly Revised
June 2008

THE HEALTHY EATING INDEX (HEI) is a measure of diet quality that assesses conformance to Federal dietary guidance. The original HEI was created by the U.S. Department of Agriculture (USDA) in 1995. Release of new Dietary Guidelines for Americans in 2005 motivated a revision of the HEI. The food group standards are based on the recommendations found in MyPyramid (see Britten *et al.*, *Journal of Nutrition Education and Behavior* 38(6S) S78-S92). The standards were created using a density approach, that is, they are expressed as a percent of calories or per 1,000 calories. The components of the HEI-2005 and the scoring standards are shown below.

Healthy Eating Index–2005 components and standards for scoring[1]

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Total Fruit (includes 100% juice)	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruit (not juice)	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables	5	≥1.1 cup equiv. per 1,000 kcal	No Vegetables
Dark Green and Orange Vegetables and Legumes[2]	5	≥0.4 cup equiv. per 1,000 kcal	No Dark Green or Orange Vegetables or Legumes
Total Grains	5	≥3.0 oz equiv. per 1,000 kcal	No Grains
Whole Grains	5	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Milk[3]	10	≥1.3 cup equiv. per 1,000 kcal	No Milk
Meat and Beans	10	≥2.5 oz equiv. per 1,000 kcal	No Meat or Beans
Oils[4]	10	≥12 grams per 1,000 kcal	No Oil
Saturated Fat	10	≤7% of energy[5]	≥15% of energy
Sodium	10	≤0.7 gram per 1,000 kcal[5]	≥2.0 grams per 1,000 kcal
Calories from Solid Fats, Alcoholic beverages, and Added Sugars (SoFAAS)	20	≤20% of energy	≥50% of energy

[1]Intakes between the minimum and maximum levels are scored proportionately, except for Saturated Fat and Sodium (see note 5).
[2]Legumes counted as vegetables only after Meat and Beans standard is met.
[3]Includes all milk products, such as fluid milk, yogurt, and cheese, and soy beverages.
[4]Includes nonhydrogenated vegetable oils and oils in fish, nuts, and seeds.
[5]Saturated Fat and Sodium get a score of 8 for the intake levels that reflect the 2005 Dietary Guidelines, <10% of calories from saturated fat and 1.1 grams of sodium/1,000 kcal, respectively.

Using data from the National Health and Nutrition Examination Survey, 2001-2002, a psychometric evaluation found the HEI-2005 to satisfy several types of validity tests. Reliability analyses suggest that the individual components provide additional insight to that of the summary score. The HEI-2005 is a standardized tool that can be used in nutrition monitoring, interventions, and research. Further details on the development and evaluation of the HEI-2005 and population scores are available at www.cnpp.usda.gov/HealthyEatingIndex.htm.

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